

SEMESTER	I					
YEAR	I					
COURSE CODE	20MSC5101					
TITLE OF THE COURSE	FUNDAMENTALS OF CHEMISTRY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES :

- To reintroduce the students to the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistry.
- To make the students to understand the interdisciplinary nature of chemistry and to integrate knowledge of various branches of chemistry with other higher biological courses.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will acquire a foundation of chemistry of sufficient breadth and depth to enable them to understand and critically interpret the primary concepts in chemistry.	L2

C02	Students will familiarize with the basic concepts related to chemical bonding, electrochemistry, thermodynamics, chemical kinetics, stereochemistry, reaction mechanism and their interdisciplinary role in thorough understanding of higher biological courses	L3

COURSE CONTENT:	
MODULE 1 General Chemistry	13 Hrs
Types of chemical bonds in biological molecules , Hydrogen bonding & its relevance in biological systems, importance of water in biological systems, pH, pKa, pKb, pOH, preparation of buffers, Henderson-Hasselbalch equation and numerical problems associated with buffer preparation VSEPR, Crystal field theory, Ligand field theory – explanation of coordination bonds in biomolecules - bonding of iron in haemoglobin & cytochromes, cobalt in vitamin B12, magnesium in chlorophyll.	
MODULE 2 Physical Chemistry	13 Hrs
Electrochemistry : Electrode potential, standard & reference electrode, calculation of biological standard potential & biological equilibrium constant, Nernst's equation. Thermodynamics : First & second laws of thermodynamics, enthalpy, entropy, free energy, free energy change & its applications in biology, activity, chemical potential. Chemical Kinetics : Rate of reaction, order & molecularity of reactions, effect of temperature on reaction rates, Arrhenius equation, activated complex theory, catalysis.	
MODULE 3 Organic Chemistry - I	13 Hrs
Stereochemistry : Geometric & Optical Isomerism, Symmetry elements, R/S notation, chirality & optical activity, Stereochemistry of glucose & amino acids.	

Reactive intermediates: Reactive intermediates, Ionic, radical & concerted reactions, transition state theory, kinetically & thermodynamically controlled reactions.	
MODULE 4 Organic Chemistry - II	13 Hrs
Reaction mechanism: S _N 1, S _N 2 E1 & E2 reactions, aromatic electrophilic and aromatic nucleophilic reactions, mechanistic study of reactions important for biology, metabolic reactions, aldol condensation – collagen and elastin, esterification of acids, oxidation and reduction. Heterocyclic compounds: aromaticity, Chemistry & biological relevance of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole, chemistry of porphyrins.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. A New Concise Inorganic Chemistry”, J. D. Lee, 5th Ed, Chapman & Hall, London(2096).
2. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Ed. Prentice Hall, India (2092)
3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
4. Organic Mechanisms, Peter Sykes, Longman, (2077).
5. Inorganic Biochemistry. G.L. Eicharn, Elsevier
6. Physical Biochemistry. David Frifielder. 2nd Ed. W.G.Freeman and Co
7. Introduction to Biophysical Chemistry, Robert Bruce Martin, McGraw-Hill (2064).
8. Bioinorganic Chemistry Ei-Ichiro Ochiai, Elsevier (2008).
9. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
10. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (2099).
11. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
12. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
13. Basic Inorganic Chemistry”, F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (2095).

SEMESTER	I					
YEAR	I					
COURSE CODE	20MSC5102					
TITLE OF THE COURSE	BIOMOLECULES					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To create in depth understanding about fundamentals of biomolecules, their structure and significance.
- To know about the structural and functional classification of biomolecules

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will be able to draw structures of biomolecules and comprehend their properties based on the structures.	L2
CO2	They will have a better understanding of metabolism of these biomolecules in second and third semesters.	L3

COURSE CONTENT:	
MODULE 1 CARBOHYDRATES	13 Hrs
Simple Carbohydrates: Structure and classification of carbohydrates. Configuration and conformational aspects of monosaccharides and sugar derivatives. Structural elucidation of carbohydrates through oxidation and exhaustive methylation, Glycosidic linkages in disaccharides and glycosides. Complex Carbohydrates: Homopolysachharides and heteropolysachharides - starch, glycogen, cellulose chitin, glycosaminoglycans and proteoglycans; Glycoproteins and Glycolipids - O and N linked oligosaccharides, Blood group determinants, Lectins, lipo-polysaccharides.	
MODULE 2 AMINO ACID AND PROTEINS	13 Hrs
Primary structure – structure, classification and acid-base properties of amino acids, Peptide bond, peptides, Merrifield synthesis of peptides; Primary structure –scheme of determination –amino acid composition analysis, N and C terminal analysis, cleavage of Disulfide bond, chemical and enzymatic fragmentation and sequencing through Edman's reagent. Secondary structure: α-, PP-, 310 and π-helix, β pleated sheet, β and γ bend, Peptide bond geometry and conformational map, Chou and Fasman algorithm; Super secondary structures: motifs and domains	
MODULE 3 PROTEIN CONFORMATION AND FOLDING	13 Hrs
Tertiary structure: interactions stabilizing tertiary structure; denaturation of proteins, secondary and tertiary structure of fibrous proteins: α-keratin, silk fibroin and collagen.	

Quaternary structure: Hemoglobin Structure and mechanism of co-operativity, molecular basis of Sickle-cell anemia; Cross linking agents to determine subunit composition.	
Protein folding: Protein renaturation, significance of Anfinsen's experiment, Classical model of folding, Levinthal paradox, Landscape model of folding, accessory proteins- protein disulfide isomerases and molecular chaperones; conformational diseases: Alzheimer's and Prion diseases.	
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MODULE 4 LIPIDS AND NUCLEIC ACID	13 Hr
Lipids: Classification and biological importance of lipids. Structure, nomenclature, properties and functions of Simple lipids - free fatty acids, acyl glycerols & wax; Complex lipids - phospholipids, ether lipids, sphingolipids, galactolipids and Derived lipids – sterols and icosanoids including prostaglandins, thromboxanes and leukotrienes. Lipid peroxidation. Nucleic acids: Nucleosides, nucleotides and polynucleotides; Specialized sequences: stem-loops, G-quadruplexes, palindromic and mirror repeats; denaturation and renaturation curves of nucleic acids; Oligonucleotide synthesis by phosphoramidite method.	
List of Laboratory/Practical Experiments activities to be conducted (if any) :	
1 No	
2 No	

TEXT BOOKS:

1. Biochemistry 4th Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
3. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
4. Proteins Structures and Molecular Properties 2nd Ed. Thomas E. Creighton, W H Freeman and Co. (1993).
5. Principles of Protein Structure, Function, & evolution, Dickerson & Geis, 2nd Ed. Benjamin-Cummings (1983).
6. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).
7. Biochemistry 6th Ed; Jeremy M Berg, John L Tymoczko and Lubert Stryer, W H Freeman and Co. (2006).
8. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER	I					
YEAR	I					
COURSE CODE	20MSC5103					
TITLE OF THE COURSE	MOLECULAR GENETICS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- Laying foundation in genetics with classical Mendelian and Non-Mendelian genetics.
- Understanding central principles and fundamental mechanisms for the organization, replication, expression, variation, and evolution of the genetic material.
- Theoretical knowledge about modern molecular genetic methods and tools.
- Insights into how molecular genetics contributes to progress in areas like medical genetics, cancer, and population genetics.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
C01	Students will exhibit a comprehensive knowledge base in Molecular Genetics.	L2
C02	The course will emphasize commonalities between different types of organisms, and will therefore be useful	L3

	for students with many different types of specializations or interests.	
C03	A main theme of the course is to understand molecular genetics as an experimental discipline, and to appreciate how knowledge in the field is based on experimental evidence.	L3
C04	Students will appreciate the interplay between genotype and phenotype and how it affects complex disease traits.	L4

COURSE CONTENT:	
MODULE 1 Concepts in Genetics and Genomics	13 Hrs
Mendelian genetics: Concepts and theories, gene interactions, Morgan's linkage analysis, chromosome theory of inheritance. Features of <i>E. coli</i>. and Human genome, C-value paradox, Fine structure of gene, Split genes and overlapping genes. Concept of Epigenetics and Genomic imprinting. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance. Organization of Chromosomes: Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains and scaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes.	
MODULE 2 Molecular Mechanisms of Recombination	13 Hrs
Bacterial Recombination: plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of <i>E. coli</i>. Mechanism of Recombination: Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in <i>E. coli</i>; role of Rec A in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein in Meiotic recombination; Gene Conversion. Site-specific	

recombination: integration of lambda genome in <i>E. coli</i> . Topological manipulation of DNA	
MODULE 3 Molecular Basis of Mutation and Transposable Genetic Elements.	13 Hrs
Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation: Ames test, Mutations in mitochondrial genome and related disorders. Karyotype - normal and abnormal karyotype analysis for genetic disorders. Transposons and Molecular mechanism of transposition: Transposable elements in prokaryotes and eukaryotes – IS elements, Composite Transposons, Tn3 elements, <i>Ac</i> and <i>Ds</i> elements, P elements, Retrotransposon and their significance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesis	
MODULE 4 Sex Determination and Cancer Genetics	13 Hrs
Sex Determination: Factors affecting sex determination, Mechanism of sex determination in <i>Drosophila</i> (role of <i>sxl</i> gene) and mammals (role of <i>sry</i> gene). Secondary sex determination in mammals. Mechanism of dosage compensation in <i>Drosophila</i> (role of MSL genes) and mammals (X-chromosome inactivation, role of Xist RNA). Medical Molecular Genetics: Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzheimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1No
2No

TEXT BOOKS:

1. John Ringo (2004). Fundamental Genetics. Cambridge University Press.
2. Griffith et al (2011) An introduction to genetic analysis (10th Edition) W.H. Freeman and Company
3. Strachan and Read (2010) Human Molecular genetics (4th Edition) Taylor and Francis.
4. Principles of Genetics by Snustad and Simmons, 6th Edition (2011) John Wiley and Sons, Inc publisher.
5. David Freifelder (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
6. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastysdairs and Darnell, J. (2004).Molecular cell biology. Scientific American Books Inc., NY.
7. Snustad and Simmons. (2006). Principal of Genetics. 8th Edn. John Wiley & sons. Klug, W.S.,Cummings. (2003). Concepts of genetics, 7th Edn. Pearson Education.

SEMESTER	I					
YEAR	I					
COURSE CODE	20MSC5104					
TITLE OF THE COURSE	GENERAL MICROBIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To deliberate existing theories about the origin of life, microbial evolution and systematics
- To understand basic techniques, morphological, biochemical and cultural characteristics
- To study the applications of microbes with respect to various

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students are equipped with strong grounding in fundamental aspects of the basic microbiology.	L1
CO2	Enable to understand the diversity of microbial, structure, function and their environment	L2
CO3	To apply the importance of microbes in different fields and enable students to employ the knowledge	L3

COURSE CONTENT:

MODULE 1: History and Systematics of Microorganisms	13Hrs
History and development of Microbiology: Scope and Applications of Microbiology, Discovery of microorganisms, Spontaneous generation theory, Biogenesis theory, Germ theory of diseases. Contributions of scientists to Microbiology. Microbial Systematics - Classification systems: Criteria for classification of microorganisms, classification systems artificial and phylogenetic, Haeckel's three-kingdom classification, Whittaker's five-kingdom classification, three-domain concept of Carl Woese. Taxonomy: Identification and nomenclature, binomial nomenclature, international code of nomenclature of prokaryotes, taxonomic ranks and hierarchical organization. Molecular methods (DNA homology, DNA-RNA homology, G+C ratio), phage typing and Serological methods in taxonomy, Numerical taxonomy. Concepts and Applications of Bergey's manual of systematic and determinative bacteriology.	
MODULE 2: Microbial Techniques	13Hrs
Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM). Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective, enriched, enrichment and differential media). Isolation and purification	

techniques of bacteria and fungi (aerobic and anaerobic). Microbial Nutrition and kinetics: Growth curve, Macro and Micronutrients, Factors influencing the growth of microbes.	
MODULE 3: Applied Microbiology-I	13Hrs
Agriculture Microbiology- Biofertilizer: Biological Nitrogen fixation- symbiotic and asymbiotic, Phosphate solubilizing microbes, Microbial antagonism in soil, PGPR, Biological control of plant diseases (<i>Trichoderma</i>, <i>Pseudomonas</i> and AM fungi). Biopesticides: <i>Bacillus thuringiensis</i> and <i>Beauveria bassiana</i>. Medical Microbiology: pathogens, host-pathogens interaction, infection and its types. Bacterial diseases: <i>Staphylococcus</i> and <i>Salmonella</i>. Fungal diseases: Candidiasis, and Aspergillosis. Viral Diseases- Pox virus and Hepatitis viruses. Protozoan and Helminthic diseases: Malaria and Filaria.	
MODULE 4: Applied Microbiology-II	13Hrs
Environmental Microbiology: Microbes in biogeochemical cycle, biodegradation of pesticides (2,4D and DDT), crude oil, oil spillage in ocean, Xenobiotic (PET), biosorption of heavy metals. Industrial Microbiology: Fermentation, types, fermentor design, fermentation products- organic acids, vitamins, antibiotics and enzymes, fermented food- bread, cheese, Alcoholic products- wine and beer.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.
2.

TEXT BOOKS :

1. Ananthanarayanan, R. and Jayaram Panicker C.K. (2004) Text book of Microbiology. Orient Longman, Hyderabad.
2. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
3. Dubey, R.C. Microbiology 1st Edition. Chand and company.

- 4 Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1998.
- 5 Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.

REFERENCES :

- 1 Edward Alcamo. Microbiology. Cliffs Notes 1996.
- 2 Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
- 3 Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.
- 4 Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005.

SEMESTER	I					
YEAR	I					
COURSE CODE	20MSC5105					
TITLE OF THE COURSE	BIOINFORMATICS – I (PROTEOMICS)					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	26	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To understand proteins at in-silico platform and to explore the possibilities in drug design and development
- To establish structure activity relationship for elucidating proteomic targets

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will be familiarized with detection and assay techniques for various biomolecules.	L2
CO2	They will have an understanding of composition of inorganic materials.	L3

COURSE CONTENT:	
MODULE 1	13 Hrs
History, scope, definitions and basic concepts in bioinformatics and its relation with molecular biology. Basic concepts in computer and its organization. Software & operating system - Windows, UNIX, Linux, Java, PERL and python. Application software- word processor, spread sheet. Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group policies Fire-walls. Data management - Relational Databases Management (RDMS) - Database generation. Data mining and applications, accessing bibliographic databases-Pubmed, Google Scholar, NCBI, EMBL and DDBJ. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB) & UniProt, Metabolic pathway data bank (KEGG)	
MODULE 2	13 Hrs
Introduction to protein structure. Data generation; Generation of large scale molecular biology data (Through, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction and protein biochips). Tools in proteomics: databases (GENBANK, Pubmed, PDB), Sequence analysis (FASTA, BLAST, BLAT), Structure viewer (RASMOL, PyMOL). Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and analysis tools. Secondary structure prediction (GOR), tertiary structure prediction, protein modelling- principles of homology and comparative modelling phylogenetics; Structure prediction methods – high accuracy and template based, free modelling (new folds); Pattern recognition – PSSMs, weight matrices; hidden Markov models. Threading, structure evaluation and validation and <i>ab initio</i> Modelling, Applications - Molecular docking – Autodoc.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2006.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (2008). Bioinformatics.

SEMESTER	I					
YEAR	I					
COURSE CODE	20MSC5106					
TITLE OF THE COURSE	BIOSTATISTICS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	26	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To demonstrate the significance of statistical analysis in biology.
- To understand basic definitions, usage of proper mathematical calculations to analyse the biological data

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will be able to execute and understand proteins at a virtual platform which will enable them for pharmaco-proteomic studies	L3

COURSE CONTENT:

MODULE 1 Measures of Central Tendencies, Dispersion And Correlation	13 Hrs
Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance. Sampling methods and their significance	
MODULE 2 Probability Distributions and Testing of Hypothesis	13 rs
Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions- Binomial, Poisson and Normal distributions with simple numerical. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of "p" value. Statistical package- Features of statistical software, SPSS for various applications in Biostatistical program.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS:

1. Daniel (2099). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (2099). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (2085). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (2083). Mathematics in microbiology Academic press
5. Green, R.H. (2079). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (2074). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (2067). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER	I					
YEAR	I					
COURSE CODE	20MSC5171					
TITLE OF THE COURSE	ANALYSIS OF BIOMOLECULES - LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	6	-	26	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To familiarize the students with good lab practice and laboratory instruments.
- To create in depth understanding about detection of biomolecules.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will be familiarized with detection and assay techniques for various biomolecules.	L3
CO2	They will have an understanding of composition of inorganic materials.	L3

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Estimation of lactose in milk by Miller's method

2. Estimation of amino acids by Ninhydrin method
3. Estimation of Iodine number of fats
4. Estimation of nucleic acids by Orcinol and DPA method
5. Potentiometric titration of amino acids
6. The study of kinetics of potassium persulphate and potassium iodide via calorimetry
7. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation
8. Estimation of percentage of iron in hematite ore using barium diphenylamine sulphonate as an internal indicator
9. Estimation of calcium in lime stone by titrimetric method
10. Determination of the percentage of available chlorine in the given sample of bleaching powder

TEXT BOOKS:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER	I					
YEAR	I					
COURSE CODE	21MSC5172					
TITLE OF THE COURSE	TECHNIQUES IN MICROBIOLOGY AND GENETICS - LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	-	6	-	-	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To equip students with the basic microbiological techniques
- To gain insight to different genetic interactions and their effect on phenotype
- To understand the role of allele frequency in evolution and genetic diversity

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand microbial structure, functions and their environment	L3
CO2	Students will be capable to recognise various gene interactions, predict crosses and decipher the role of alleles in inheritance.	L3
CO3	Ability to calculate allele frequency and its role in genetic diversity.	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1.	Preparation of culture media: Autotrophic, Heterotrophic, Selective, Enriched and Differential culture media.
2.	Isolation of Microorganisms from different sources (Soil, water and air): Serial dilution and Pure culture techniques.
3.	Staining- simple, differential - Gram's, acid fast, endospore, capsular and flagella. Motility test by Hanging-drop method.
4.	Study of fungi: <i>Aspergillus</i> , <i>Penicillium</i> , <i>Fusarium</i> , <i>Yeast</i> , <i>Mucor</i> , <i>Rhizopus</i> , <i>Agaricus</i> and <i>Puccinia</i> .
5.	Study of algae (permanent slides): <i>Spirulina</i> , <i>Nostoc</i> , <i>Spirogyra</i> , <i>Microcystis</i> , <i>Scytonema</i> , <i>Oscillatoria</i> and <i>Rivularia</i> .
6.	Study of Protozoa (permanent slides): <i>Euglena</i> , <i>Plasmodium</i> , <i>Paramecium</i> and <i>Amoeba</i> .
7.	Study of mitosis in onion root tips
8.	Study of <i>Drosophila</i> mutant types.
9.	Mounting of polytene chromosomes – in <i>Drosophila</i> .
10.	Preparation of buccal smear to study Barr bodies.

TEXT BOOKS :

1. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

REFERENCES :

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill
3. K. R. Aneja. (2017) Experiments in Microbiology, Plant Pathology and Biotechnology.

SEMESTER	II					
YEAR	I					
COURSE CODE	20MBC5201					
TITLE OF THE COURSE	METABOLISM – I					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES :

- Learning structure and reactions of carbohydrates and amino acids used in metabolism.
- Learning about the metabolic reactions undertaken by living systems to breakdown carbohydrates and amino acids for release of energy.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to draw structure of mono, di and polysaccharides and amino acids. They will have an in depth idea about the role these biomolecules play in energy storage and usage.	L3
CO2	Students will be able to comprehend the metabolic, enzyme assisted reactions undergone by carbohydrates and amino acids to fuel to living systems.	L3

COURSE CONTENT:	
MODULE 1 Carbohydrate metabolism	13 Hrs
Introduction to anabolic, catabolic, amphibolic pathways and intermediary metabolism. Glycolytic pathway; energetics and regulation, aerobic and anaerobic fates of pyruvate, entry of sugars other than glucose into metabolism, Gluconeogenesis, reciprocal regulation, anapleurotic reaction and Cori cycle, substrate cycle, Pyruvate dehydrogenase complex, TCA cycle: amphibolic nature and regulation, pentose phosphate pathway, Glyoxylate cycle- scheme; Degradation, synthesis and regulation of glycogen. Role of RER and Golgi complex in synthesis of glycoproteins and GPI anchored proteins.	
MODULE 2 Disorders of Carbohydrate metabolism	13 Hrs
Regulation of blood glucose level by organs and hormones, hypo and hyper glycemia. Diabetes mellitus- classification, biochemical and clinical changes associated with DM. Diagnosis by glycated hemoglobin test (A1-C test), Glucose tolerance test curves, and management of DM by medication, exercise and meal planning. Glycogen storage disorders, galactosemia, fructose and lactose intolerance, pentosuria. Introduction to metabolomics.	
MODULE 3 Amino acids and peptides	13 Hrs
General metabolic reaction of amino acids- transamination, deamination, oxidative and non-oxidative deamination, glucose – alanine cycle. Urea cycle- regulation and metabolic disorders. Biosynthesis of creatine and creatine phosphate, polyamines, glutathione, physiologically active amines (serotonin and α – histamine) and catecholamines (dopamine, epinephrine and norepinephrine). Synthesis of porphyrin rings and their breakdown into bilirubin. Biogenic amines – polyamines. Bioactive peptides – Bradykinin, angiotensin, oxytocin and vasopressin.	
MODULE 4 Metabolism of standard amino acids	13 Hrs

Regulation of amino acid and purine/pyrimidine levels by Glutamine Synthetase. Biosynthesis and degradation of twenty standard amino acids – A, G, T, S, C, E, N, D, Q, R, H, P, V, I, M, L, K, W, F & Y. Disorders associated with amino acid metabolism

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. No

2. No

TEXT BOOKS :

1. Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3rdEd. John Wiley and Sons(2009).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds], 6th Edn. Macmillan Publications (2012).
3. Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and LubertStryer, W H Freeman and Co. (2006).
4. Textbook of Biochemistry with Clinical Correations – Thomas M. Devlin, John Wiley & Sons; 7th edition (22 January 2010)
5. Biochemistry of Foods, Eskin, Elsevier (2012).
6. Biochemistry and Molecular Biology; 5thEd. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University Press (2014).
7. Harpers Illustrated Biochemistry; 30th Ed. V.W. Rodwell , D. Bender , K.M. Botham , P. J. Kennelly, P. A. Weil (2015)

SEMESTER	II					
YEAR	I					
COURSE CODE	20MBC5202					
TITLE OF THE COURSE	HUMAN PHYSIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES :

- To give a detailed idea about various physiological systems in human beings.
- To make the students understand the biochemical reactions and physical process that underline biological systems

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
C01	The students will be equipped with knowledge about several physiological processes.	L3
C02	The student will be aware of the biochemical basis of human physiology	L3

COURSE CONTENT:	
MODULE 1	13 Hrs
Tissue level of organization Types of tissues, cell junctions, tight junctions, adherens junctions, desmosomes , hemi desmosomes, gap junctions comparison between epithelial and connective tissues , epithelial tissues, classification of epithelial tissues, covering and lining epithelium, glandular epithelium, connective tissues, general features of connective tissues, connective tissue cells, connective tissue extracellular matrix, classification of connective tissues , embryonic connective tissues, mature connective tissues.	
The muscular system Overview of muscular tissue; types, functions & properties. Microscopic anatomy of skeletal, smooth & cardiac muscle; muscle proteins; mechanism of muscle contraction, Contraction and relaxation of skeletal muscle fibers. Neuromuscular Junction. Muscle metabolism.	
MODULE 2	13 Hrs
Nervous system: Organization of nervous system - CNS, PNS. ANS, somatic nervous system; autonomic nervous system-sympathetic and parasympathetic system; enteric nervous system, structure and function of neuron and glial cells, Synapse, nerve impulse transmission, function of voltage-dependent and neurotransmitter-gated ion channels; the role of these ion channels in synaptic transmission, synaptic modification, and neuromodulation; neurotransmitters: glutamate, acetyl CoA, glycine, dopamine & serotonin	
Endocrine system: Introduction to endocrinology, classification, general properties and mechanism of action of hormones. Glands – Pituitary, Adrenal, pancreas & thyroid; hormones – action, regulation, tests and disorders. Control of calcium metabolism by parathyroid hormone, calcitonin and vitamin D.	
MODULE 3	13 Hrs
Cardiovascular system: Functions and properties of blood, functions of blood, physical characteristics of blood, components of blood. Formation of blood cells. Red blood cells, anatomy & physiology. White blood cells, types & functions. Platelets- Hemostasis, vascular spasm, platelet plug formation, blood clotting, role of vitamin K in clotting, hemostatic control mechanisms, Disorders of clotting. Systemic and pulmonary circulations, coronary circulation. Cardiac cycle. Cardiac output. ECG – its principle and significance. Structure and function of blood vessels. Blood pressure. Role of the cardiovascular center.	

Respiratory system: Respiratory system anatomy. Pulmonary ventilation, Lung volumes and capacities, Bohr and Haldane effect, chloride shift; effect of 2, 3- BPG on O ₂ affinity of Hb; Clinical importance of 2, 3 BPG. Respiratory center. Respiratory Acidosis and alkalosis. Dyspnoea, Asphyxia, Cyanosis, Decompression sickness, artificial respiratory methods.	
MODULE 4	13 Hrs
Digestive system: Overview of digestive system. Composition, function and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Mechanism of breakdown and absorption of sugar, fat, protein, carbohydrate, vitamins and drugs. Structure of esophagus, liver, stomach and intestine. Absorption of food The urinary system: Overview of kidney functions. Urine formation: glomerular filtration, tubular reabsorption and tubular secretion. Evaluation of kidney function: urinalysis, blood tests, renal plasma clearance. Fluid, electrolyte, and Acid–Base homeostasis. Kidney hormones.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. Guyton and Hall Textbook of Medical Physiology; 12th Ed., J.E.Hall , Saunders Elsevier (2010)
2. Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc. (2010).
3. Text Book of Biochemistry with Clinical correlations; Thomas Devlin. Wiley–Liss (2007).
4. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
5. Molecular Cell Biology, Harvey Lodish , David Baltimore and Arnold Berk, Scientific American Publication (2005).
6. Molecular Biology of Cell; Albertis et. al., Garland Science (2002).
7. Harper’s Review of Biochemistry, 24th Ed , Murray et. al., , Lange (2007)
8. Cellular Physiology of Nerve and Muscle. Gary G Mathew , Blackwell Scientific Inc. (2008)
9. Review of Medical Physiology, Gannong, W.F.15th Ed. Maruzen Asial, (2001).
10. Human Biochemistry, Orten and Neuhans, 10th Ed. Mosbey International, (2003).
11. Mammalian Biochemistry; White, Handler and Smith, McGraw-Hill, (2006).
12. Principles of Human Physiology; 4th Ed. Cindy L. Stanfield Pearson, (2010).

SEMESTER	II					
YEAR	I					
COURSE CODE	20MSC5201					
TITLE OF THE COURSE	MOLECULAR BIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To introduce the basic concepts of central dogma of molecular biology
- To provide in-depth knowledge of DNA replication and repair mechanisms with proteins involved in these processes.
- To give substantial knowledge on the processes involved in gene expression and its regulation in prokaryotes and eukaryotes.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will understand the key events of central dogma comprising mechanism of replication, transcription and translation.	L1
CO2	Student will understand the molecular mechanisms of expression, regulation, and maintenance of genetic information, within a biological system.	L2
CO3	Student will be able to critically think in the field of application of molecular biology.	L3

COURSE CONTENT:	
MODULE 1: DNA replication and repair	13Hrs
Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA. Structure and functions of different types of RNA. C-value paradox, repetitive DNA sequences and gene families. Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson & Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication. Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomere synthesis-telomerases regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model. Mechanism of DNA Repair: DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.	
MODULE 2: Gene expression – Transcription	13Hrs
Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination- Rho dependent and Rho independent. Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, elongation and termination. Post transcriptional modifications of mRNA (5' cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.	
MODULE 3: Gene expression- Translation	13Hrs
Protein synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of amino acids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Co and post translational modifications of proteins, translation control in eukaryotes.	

Protein targeting and localization: Export of secretory proteins- signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxisomes and membrane.	
MODULE 4: Regulation of gene expression in prokaryotes and eukaryotes.	13Hrs
Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP in the expression of lac genes and catabolite repression Regulation of tryptophan operon by attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage. Regulation of eukaryotic gene expression: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, <i>cis</i> control elements, promoters, enhancers, transacting factors, DNA binding motifs of transcription factors, post-transcriptional control. Gene Silencing: transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and miRNA), Applications of Antisense RNA & Ribozymes.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.
2.

TEXT BOOKS :

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition)
2. James D. Watson. Molecular Biology of the Gene (7th Edition)
3. Benjamin A Pierce. Genetics A conceptual approach (5th Edition)
4. Robert Weaver. Molecular Biology. (4th Edition)
5. Nancy L Craig. Molecular Biology: Principles of Genome Function.

REFERENCES :

1. Pukkila P J., 2001. Molecular Biology: The Central Dogma. (<https://doi.org/10.1038/npg.els.0000812>)
2. Mejía-Almonte, C., Busby, S. J. W., Wade, J. T., van Helden, J., Arkin, A. P., Stormo, G. D., ... Collado-Vides, J. (2020). Redefining fundamental concepts of transcription initiation in bacteria. Nature Reviews Genetics. (doi:10.1038/s41576-020-0254-8)

SEMESTER	II					
YEAR	I					
COURSE CODE	20MSC5202					
TITLE OF THE COURSE	ANALYTICAL TECHNIQUES					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES :

- To create detailed understanding about theoretical concepts of techniques used to detect and assay biomolecules.
- To acquaint students with concepts, principles and advanced application of cuttingedge techniques.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will receive adequate knowledge of high-end techniques like Microarray, Mass spectroscopy & NMR	L3
CO2	Students will be able to have a basic understanding of techniques used in drug discovery.	L3

COURSE CONTENT:

MODULE 1	13 Hrs
Spectroscopy: Electromagnetic radiation & its interaction with matter, Lambert- Beer's law, extinction coefficient & its importance, design of colorimeter & spectrophotometer, chemiluminescence, thermofluorescence, principles & biological applications of UV& visible spectroscopy, Principles & applications of fluorescence, nephelometry, AAS. Structural elucidation: CD, IR, NMR, ESR, Raman spectroscopy & their applications in biology, x-ray Diffraction & their application in structural analysis of macro molecules.	
MODULE 2	13 Hrs
Electrophoresis: Moving boundary & zonal electrophoresis, paper & agarose gel electrophoresis, native and SDS PAGE, isoelectric focusing, 2D gel electrophoresis. Concepts and instrumentation of pulse field electrophoresis and capillary electrophoresis, Western, Northern and Southern blotting techniques. Mass spectrometry: principles, ionization mechanisms, mass analysis TOF, ion trap quadrupole, Ionization methods: electron impact, chemical ionization, fast atom bombardment, field desorption, electron spray ionization, MALDI, protein identification using MS. Microarrays, protein biochips.	
MODULE 3	13 Hrs
Chromatography: partition coefficient, paper& thin layer chromatography, adsorption chromatography, gel permeation & affinity chromatography, ion exchange chromatography, amino acid analyzer, gas chromatography, GCMS, HPLC, hydrophobic interaction chromatography, covalent, metal chelate & hydroxyapatite chromatography, special chromatographic techniques for nucleic acids, FPLC Radioactivity: Disintegration of radionuclides, half-life, detection & measurement, liquid scintillation counter, isotopic tracer techniques, preparation of labeled compounds & their use in biology, autoradiography.	
	13 Hrs
MODULE 4	
Centrifugation: principle, Svedberg's constant, types of centrifuges, differential & density gradient centrifugation, preparative & analytical centrifuges, sedimentation velocity, equilibrium analysis & its applications.	

Techniques in drug discovery: General protocol of classical drug discovery and clinical trials, In-Silico Drug Designing, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, QSAR, Database generation and Chemical libraries, ADMET property.

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. No

2. No

TEXT BOOKS :

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (2083)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (2090)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (2094)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER	II					
YEAR	I					
COURSE CODE	20MSC5203					
TITLE OF THE COURSE	BIOINFORMATICS - II (GENOMICS)					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	26	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To understand genes at in-silico platform and to explore the possibilities in drug design and development
- To establish structure activity relationship for elucidating genomic targets

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will be able to execute and understand genes at a virtual platform which will enable them for pharmaco-genomic studies	L2

COURSE CONTENT:

COURSE CONTENT:	
MODULE 1	13 Hrs
Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER. Global and Local, Similarity searching, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs	
MODULE 2	13 Hrs
Translating DNA into proteins reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank files, Genbank	

libraries, separating sequence and annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files.

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factors binding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies and Graphical models (including Markov chain and Bayes notes). Genetic variability and connections to clinical data.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2006.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Baxavanis (2008). Bioinformatics.
7. Fry, J.C. (2003). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81

SEMESTER	II					
YEAR	I					
COURSE CODE	20MSC5204					
TITLE OF THE COURSE	EVOLUTION AND DEVELOPMENTAL BIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	26	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- Demonstration of how the lives originate from the a-biotic factors in the universe and learn the dynamics of different populations, their interactions with the ecosystems, intricacies and integration of the ecosystems with the populations.
- Understanding of the mechanisms of cell metamorphosis into different cell types, tissues, organs and life

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Have an enhanced skills and knowledge of origin of life, evolution, and development	L2
CO2	Be able to critically analyse the basic concepts and fundamentals of the course and integrate the related fields and pursue this area in the future.	L3

COURSE CONTENT:	
MODULE 1 Ecology and Evolution	13 Hrs
Ecology: Introduction, biotic and abiotic factors, Biomes Population ecology: Dynamics of population, Population growth-Exponential model Logistic growth model Community ecology: Interactions, Biogeography, Speciation, Ecological succession, Disturbances Structure-Contrasting views Ecosystems: Energy flow and trophic levels, Biological and geochemical processes (BC cycles, B Pyramids etc) Human impacts on ecosystems Evolution: Introduction, Early ideas of evolution, Darwinian view of life. Speciation and Evolutionary Rates: The nature of evolutionary units; the modern synthesis and biological speciation, rates of evolutionary change. Natural selection: Stabilizing, directional, and disruptive selection. Microevolutionary and Macroevolutionary phenomena: insights into genetic drift, mutation and gene flow, Ontogeny and phylogeny	
MODULE 2 Developmental Biology	13 Hrs
Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in <i>Drosophila</i>.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :	
1.	No
2.	No

TEXT BOOKS:

1. Concepts of Ecology, Edward.J.Kormondy
2. Ecology and environmental science, S.V.S. Rana
3. Cell biology, Genetics, Molecular biology, evolution and ecology
4. Minkoff, E. C. (2083). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company.
5. Sober, E. (2094). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.
6. Fundamentals of ecology by Eugene Odum,Cengage; 5 edition (2005).
7. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
8. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)
9. Development Biology by N Arumugam,Saras Publication (2014)

SEMESTER	II					
YEAR	I					
COURSE CODE	20MBC5271					
TITLE OF THE COURSE	CLINICAL BIOCHEMISTRY - LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	6	-	26	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To give a practical idea about various physiological systems in human beings
- To make the students understand the biochemical reactions that underline biological systems and the reactions used to detect them

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will be equipped with practical knowledge about several physiological processes and their detection techniques	L3
CO2	The student will be aware of discrepancies in biomolecular levels and thereby detect diseases.	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :	
1.	Estimation of sugar from blood and urine
2.	Estimation of Hemoglobin in blood by Wong's method
3.	Estimation of blood albumin: globulin ratio
4.	Estimation of blood cholesterol by Zak and Zlatkis method
5.	Estimation of uric acid in urine by Caraway's method
6.	Estimation of creatinine in urine by Jaffe's method
7.	Estimation of urea in urine by Nessler's reagent
8.	Estimation of bilirubin in urine
9.	Titrateable acidity of urine
10.	Serum SGOT/SGPT assay

TEXT BOOKS:

1. Practical Clinical Biochemistry, ed. Harold Varley, 4th edn. CBS Publishers (2088).
2. Practical Clinical Biochemistry: Methods and Interpretation, ed. Ranjna Chawla, Jaypee Brothers Medical Publishers (2096).
3. Practical and Clinical Biochemistry for Medical Students, ed. T.N. Pattabhiraman, Gajanna Publishers (2094).
4. Hawk's Physiological Chemistry, ed. Oser, 14th Edn.(2076), Tata-McGrawHill.
5. Biochemistry, ed. Plummer Tata-McGraw Hill, (2071).

SEMESTER	II					
YEAR	I					
COURSE CODE	20MSC5271					
TITLE OF THE COURSE	BIO-ANALYTICAL TECHNIQUES - LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	6	-	26	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- Practical exposure for biomolecules and their quantification using standard estimations and spectroscopy
- Biophysical equipments will be explored for the analysis of biomolecules

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will have hands on practical exposure for quantitation of biomolecules using modern techniques and equipments	L3

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Isolation of plant genomic DNA using SDS/CTAB method and its analysis.
2. Isolation of genomic DNA from bacteria/animal tissue and its analysis.
3. Isolation of total RNA from biological source and its analysis
4. Study of conjugation in *E. coli*.
5. Study of mutation in *E. coli* by Physical method (UV).

6. Determination of extinction coefficient of biomolecules using UV spectroscopy (Protein/DNA/RNA)
7. Separation of biomolecules (amino acids/carbohydrates) using TLC.
8. Separation of phytomolecules (secondary metabolites) using silica column chromatography
9. Separation of proteins using SDS-PAGE and molecular weight determination.
10. Separation of cell organelles using density gradient centrifugation.

TEXT BOOKS:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (2083)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (2090)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (2094)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MBC5301					
TITLE OF THE COURSE	METABOLISM II					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- Learning the role electron transport chain plays in connecting fuel breakdown and metabolism.
- Learning about the metabolic reactions undertaken by living systems to breakdown lipids and nucleic acids for release of energy

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to comprehend the integration of metabolism, oxidative phosphorylation and ATP production.	L3
CO2	They will have an in-depth idea about the role lipids play in energy storage and usage.	L3
CO3	Students will be able to comprehend the metabolic, enzyme assisted reactions undergone by nitrogen bases and fat to fuel to living systems.	L3

COURSE CONTENT:

MODULE 1 Bioenergetics	13 Hrs
Reduction Potential, Biological redox couplers, Mitochondrial electron transfer system- Sequence and structure of electron carriers. Proton motive force and the Mitchell hypothesis. F_0F_1 -ATPase- structure and mechanism, Coupling of electron transfer to ATP synthesis. Mechanism of oxidative phosphorylation. P/O ratios and their use in localization of sites of ATP synthesis along the chain. Uncouplers, inhibitors and ionophores. Microsomal electron transport. Proton motive force in Halobacteria, H^+ pumping by bacteriorhodopsin.	

MODULE 2 Nucleotide Metabolism	13 Hrs
Nitrogen Cycle, nitrogen fixation, nif genes. Structure of nucleoside and nucleotide; Synthesis of purine and pyrimidine nucleotides – the de novo and the salvage pathway and their regulation. Degradation of purine and pyrimidines and disorders associated with degradation: gout, Lesch-Nyhan syndrome, oroticaciduria, and xanthinuria. Heme Metabolism: Biosynthesis and degradation of porphyrin and their regulation, porphyrias, jaundice and Hemoglobinopathies.	
MODULE 3 Lipid metabolism	13 Hrs
Basic scheme of fat absorption, mobility, degradation and synthesis; Degradation of triacylglycerol and phospholipids- lipases and phospholipases. Fatty acid oxidation- even, odd and unsaturated fatty acids by β -oxidation, scheme and energetics of β -oxidation, peroxisomal β -oxidation, branched chain fatty acids by α -oxidation, medium chain fatty acids by ω -oxidation. Metabolism of ketone bodies with physiological significance, Fatty acid biosynthesis, FAS- multi functional enzyme, chain elongation and desaturation. Biosynthesis of triacylglycerol, phospholipids and sphingolipids, sphingolipid storage disorders.	
	13 Hrs
MODULE 4 Cholesterol and Circulating lipids	
Cholesterol structure, brief idea of synthesis from acetyl CoA, regulation through HMG CoA reductase and utilization as hormones and bile salts, normal and abnormal levels in the body; Insoluble lipid mobilization by lipoproteins- chylomicrons, HDL, LDL, and VLDL – composition, markers and metabolic fate; Receptor mediated endocytosis of LDL. Regulation of cholesterol metabolism; Biochemistry of obesity, atherosclerosis and hypercholesterolemia; synthesis of prostaglandins and related compounds, Non steroidal anti-inflammatory drugs (NSAIDs).	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed.
2. Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed.
3. Biochemistry – Voet and Voet. Wiley & Sons 2011, 4th Ed
4. Textbook of Biochemistry with clinical correlations - Devlin, John Wiley & Sons, 7th Ed, 2010

SEMESTER	III					
YEAR	II					
COURSE CODE	20MBC5302					
TITLE OF THE COURSE	ENZYMOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- Learning about enzyme properties and coenzymes
- Knowledge of enzyme assay, enzyme kinetics and drawing enzyme assisted reaction plots.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Brief idea about regulation of enzyme activity along with enzyme Inhibition.	L3
CO2	Studying active site structure and catalysis.	L3

COURSE CONTENT:

MODULE 1 Introduction to Enzymes	13 Hrs
Introduction to enzymes: Classification, Specificity, active site groups, theories of enzyme action, enzyme assay – principle and types, enzyme units, Enzyme localization (chemical and immune-fluorescence method) and purification. Criteria of purity. Enzyme classification and nomenclature. Monomeric, oligomeric and multifunctional enzymes, multienzyme complexes. Coenzymes: The mechanistic role of the following coenzymes in enzyme catalysed reactions – nicotinamide nucleotides, flavin nucleotides, pyridoxal phosphate, coenzyme-A, lipoic acid, thiamine pyrophosphate, biotin, tetrahydrofolate and coenzyme B	
MODULE 2 Enzyme Kinetics	13 Hrs
Enzyme kinetics of single substrate reactions – Michaelis-Menten and Briggs and Haldane theory (rapid equilibrium and steady state theory). Effect of substrate, temperature, pH and modulators on enzyme activity. Kinetic data evaluation: linear transformation of Michaelis-Menten equation. Pre-steady state kinetics. Methods used in the investigation of the kinetics of enzyme-catalyzed reactions, initial velocity studies and rapid reaction techniques. Integrated velocity equation. Haldane equation. King-Altman procedure for deriving the rate equation. Arrhenius plot and determination of activation energy	
MODULE 3 Enzyme Inhibition	13 Hrs
Types of reversible inhibitors; competitive, non-competitive, uncompetitive, and mixed inhibitors. Partial, substrate, allosteric and Irreversible inhibition. Regulation of enzyme activity: Allostery & Sigmoidal kinetics -- Binding of ligands to proteins, Cooperativity, Hill equation, Adair equation, Scatchard plot and equilibrium dialysis techniques. MWC and KNF models. Allosteric enzymes and metabolic regulation. Study of ATCase as typical allosteric enzyme. Other mechanisms of metabolic regulation reversible covalent modifications, proteolytic cleavage (zymogen activation – digestive enzymes, blood clotting cascade), transcriptional and translational regulation	
MODULE 4 The investigation of active site structure	13 Hrs
The identification of binding sites and catalytic sites –trapping the E-S complex, use of substrate analogs, enzyme modification by treatment with proteolytic enzymes, photo – oxidation and chemical modification of amino acid side chains. Affinity labelling studies, super-reactive amino acid side chains, X-ray crystallographic and NMR studies.	

Enzyme catalysis: Chemical nature of enzyme catalysis-General acid/base catalysis, electrostatic catalysis, covalent catalysis, intramolecular catalysis and enzyme catalysis. Mechanisms of action of specific enzymes: lysozyme, serine proteases (chymotrypsin), sulphhydryl enzymes (alcohol dehydrogenase), Metal – activated and metallo-enzymes (mechanism of action of creatine kinase).

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. No

2. No

TEXT BOOKS :

1. Enzymes - Biochemistry, Biotechnology, Clinical Chemistry, Palmer and Bonner, Elsevier Press (2007).
2. Biochemistry, Voet and Voet, 4th Ed, Wiley (2010).
3. Fundamentals of Enzymology, Price and Stevens, Oxford University Press (2009).
4. Fundamentals of Enzyme Kinetics, Bowden, Portland Press (2004).
5. Biophysical Chemistry Part II, Charles R. Cantor, Paul R. Schimmel, W.H. Freeman & Companys (2080).
6. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland, Wiley-VCH Publishers (2000).
7. Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, Blackwell Science (2000).
8. Biochemical Calculations, 2nd Ed. Irwin H. Segel, John Wiley and Sons (2076).

SEMESTER	III
YEAR	II
COURSE CODE	20MBC5321
TITLE OF THE COURSE	IMMUNOLOGY

SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	40	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To understand the role of different cells and organs of immune system.
- To provide basic understanding on antigen recognition by B and T cells, development of immune cells and various immunotechniques.
- To understand the importance of immune system in disease and therapeutics.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be acquainted with the basic understanding of immune system as a whole and critically think about its role in diagnosis and control.	L2
CO2	Student will gain fundamental knowledge about the consequences of immune system failure. They will also gain insights about the spread of cancer and its therapeutics	L3

COURSE CONTENT:

MODULE 1 Introduction and Innate Immunity	10 Hrs
Introduction: Basic concepts in immunology, role of immune system, principles of innate and adaptive immunity. Innate immunity: Different lines and layers of defence, secretions: skin, lysozyme, pH, mucous. Pattern recognition in innate immune system, the complement system: activation through classical, alternate and lectin pathway, Induced innate responses to infections. Functions of natural killers, monocytes, macrophages, eosinophils, neutrophils and basophils.	
MODULE 2 Antigen Antibody interactions	10 Hrs
Antigen recognition by B-cells: Clonal selection, effector and memory cells, Antibody types, structure, functions, isotypes, allotype, idiotype, Interaction between the antibody and specific antigen, epitope, paratope, affinity, avidity, radio-equilibrium dialysis study, Diversity of Immunoglobulins. Antigen recognition by T cells: T_H, T_C and T_{Reg} cells, T-specific markers, TCR, MHC, Types, functions, gene structure, receptor structure, antigen processing and presentation, exogenous and endogenous antigen.	
MODULE 3 Lymphocyte development and inflammation	10 Hrs
Development and survival of lymphocytes: Lymphocytes in bone marrow and thymus, positive and negative selection of lymphocytes, survival and maturation of lymphocytes, self/non self-recognition. Transplantation and Network theory: Transplant rejection, immunosuppressants. Immuno-surveillance, idiotypes and immune network theory	
MODULE 4 Pathoimmunology & immunotechniques	10 Hrs
Pathoimmunology: Effector mechanisms in allergic reactions and IgE, hypersensitivity diseases; Autoimmune diseases- Rheumatoid arthritis, multiple sclerosis Immuno-techniques: Generation of monoclonal antibodies, Immuno-diffusion techniques, RIA, ELISA. Immuno-electrophoresis, immuno-staining techniques, Immuno-florescence and flow cytometry.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No

TEXT BOOKS :

1. Cellular and Molecular Immunology, 7th Ed. Abbas and Lichtman. Saunders Publishers (2011).
2. Immunology, 5th Ed, Golsby, Kindt, Osborne and Kuby. Freeman Publishers (2003).
3. Roitt's Essential Immunology, 12th Ed., Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, Wiley-Blackwell (2011).
4. Medical Immunology made memorable, 2nd Ed., John H. L. Playfair and P.M. Lydyard, Churchill Livingstone Publications (2000).
5. Textbook of Immunology – Sai Leela K, Mohanty SK, Veerendra Reddy P. Jaypee Publishers (2007).
6. Cell and Molecular Biology: Concepts and Experiments, 7th Ed., Karp. Wiley & Sons (2013).
7. Molecular Cell Biology, 3rd Ed., by Harvey Lodish, David Baltimore and Arnold Berk, Scientific American Publishers (1995).

REFERENCE PAPERS

8. Research paper: The Hallmarks of Cancer, by Hanahan and Weinberg, Cell, Vol. 100, 57– 70 (2000).
9. Research paper: Hallmarks of Cancer: Next generation, D.Hanahan and R.A.Weinberg, Cell, 144(5):646-74 (2011).

SEMESTER	III					
YEAR	II					
COURSE CODE	20MBC5322					
TITLE OF THE COURSE	MOLECULAR PHYSIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	40	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To understand the role of different cells and organs of immune system.
- To provide basic understanding on antigen recognition by B and T cells, development of immune cells and various immunotechniques.
- To understand the importance of immune system in disease and therapeutics.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will have an idea as to how hormones control the physiology of an organism via signalling mechanisms.	L3
CO2	They will have a greater understanding of how the homeostasis of a body is maintained and a slight change in the system could tip the balance which could lead to disease.	L3

COURSE CONTENT:

MODULE 1 Endocrine signaling	10 Hrs
Cell Signaling: Endocrine organs in human, classification and chemistry of hormones. Principles of cell signaling, Classification of hormones. Signal transduction, Signal transduction pathways of – G – protein linked (epinephrine / serotonin); Ion– channel (ACh); Tyrosine kinase (RTK), [insulin] and Intrinsic enzyme / cytokine, receptors.	

Intracellular signaling proteins: adaptors, activators, bifurcators, integrators and effectors. Second messengers: cAMP, CREB, cGMP, phosphoinositides, arachidonic acid, Ca ²⁺ , and NO. Effectors on intercellular signaling: Adenylate cyclase, Phospholipase- C, Nitric oxide synthase and guanylate cyclase.	
MODULE 2 Nerve signalling and neurotransmitters	10 Hrs
Nerve signaling: Morphology of a neuron. Types and functions of Nerve fiber. Resting membrane and action potential, Nernst equation. Mechanism of initiation and propagation of action potential. Structure and mechanism of actions of neurotransmitters (Acetylcholine, catecholamine, serotonin; amino acids (glutamate/GABA) and neuropeptides (somatostatin/enkephalins). Exo – and endocytosis of synaptic vesicles. Role of agonists & antagonists of neurotransmitters. Biochemical basis of neurological diseases (Alzheimer's/ Parkinson/MS).	
MODULE 3 Nuclear signaling and Cell Cycle	10 Hrs
Nuclear signaling: Steroid, thyroid, Vitamin-D and retinoic acid receptors and transcriptional activation. Cell Cycle: Cell cycle (entry of cell from G ₂ to M – phase) Role of M – Cdk, MPF. Promotion of G ₁ /S by growth factors, cell cycle arrest at G ₁ , role of Rb proteins in cell cycle arrest. Regulation of M- phase (role of mitogen, survival factor and TGF- β). Role of ubiquitin. Growth factors and cytokines, growth phases and check points of cell cycle (DNA replication and spindle- attachment checkpoint) and their regulation. Stem Cells: Embryonic and adult stem cells; unique properties, and potential applications.	
MODULE 4 Apoptosis and Cancer	10 Hrs
Apoptosis: Structure and function of caspases in apoptosis. Direct signal transduction (TNF pathway, Fas pathway, caspases, execution, Inhibition of Protein synthesis, DNA damage and removal of dead cells). Cell death receptors and their ligands: Role of MAP/Erk in cell death. Apoptotic signaling by TNFRF1 and DR3. Regulation of Bcl-2 and IAP. Necrosis, Role of HeLa cells, hyperactive apoptosis and treatments. Cancer: Introduction, Signs and symptoms, causes pathophysiology, diagnosis, prevention and management. Signaling cascades in cancer (MAP kinases and JAK-STAT pathways). Concept of tumor suppressors.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
2. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan Publications (2012).
3. Text Book of Biochemistry with Clinical correlations; 6th Edn. Thomas M. Devlin (2012), Wiley-Liss.
4. Biochemistry; David Rawn, Panima Publishers, (1989).
5. Biochemistry; Geoffrey Zubey,(1998), WCB Publishers.
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGraw Hill.
7. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.
8. Biochemistry- R. Garret, Charles M Grisham, Belmont (2013)
9. Bioenergetics; David Nicholls and Stuart Ferguson, Elsevier (2013)

SEMESTER	III					
YEAR	II					
COURSE CODE	20MBC5323					
TITLE OF THE COURSE	GENETIC ENGINEERING					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	40	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To understand how DNA can be manipulated using different enzymes.
- Varied vector systems to transfer DNA from one species to another, express recombinant proteins etc.
- Diverse methods to visualise modified genetic materials.
- Applications of genetic engineering.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	This course will enable students to learn techniques which can be used to manipulate DNA, to amplify, propagate and express proteins in different host systems.	L3
CO2	It will also teach techniques to detect the engineered DNA, RNA and protein	L3
CO3	Students will also learn various applications where genetic engineering can be used	L3

COURSE CONTENT:	
MODULE 1 Basic Concepts	10 Hrs
DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors;	

Homopolymeric tailing; Labelling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern and Southern, Fluorescence in situ hybridization.	
MODULE 2 Cloning and expression vectors	10 Hrs
Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/baculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors.	
MODULE 3 Cloning strategies and study of protein-DNA interactions	10 Hrs
Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; electrophoretic mobility shift assay; DNase I footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.	
MODULE 4 Sequencing, PCR and its applications	10 Hrs
Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina and 454 platform).	
PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Handling PCR reactions, Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: RFLP, Oligo Ligation Assay (OLA) and ASA (Allele-Specific Amplification).	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. S.B. Primrose, R.M. Twyman and R.W. Old; Principles of Gene Manipulation. 6th Edition, S.B. University Press, 2001.
2. J. Sambrook and D.W. Russell; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
5. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Meerut,
6. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
7. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication
8. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers
9. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd. 10. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MBC5324					
TITLE OF THE COURSE	MEMBRANE BIOCHEMISTRY AND NANO SCIENCE					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	40	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- Learning the role lipids play in maintaining plasma membranes and techniques to isolate and study membranes.
- Learning about nanotechnology and its application in various fields.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will have a theoretical knowledge about isolating plasma membranes and studying its components to draw conclusions about the multitude of role played by membranes.	L3
CO2	They will have an in-depth idea about nanotechnological solutions used to treat industrial and health related problems.	L3

COURSE CONTENT:

MODULE 1 Lipid properties	10 Hrs
Structure and properties of glycerolipids, sphingolipids, glycolipids and sterols. Properties of lipids in solution, formation of mono, bi-layers and micelles, Langmuir trough. Effect of lipid composition and modification on viscosity and fluidity; role of cholesterol, cardiolipin, Isolation and characterization of membrane lipids. Composition of plasma- and organelle membranes; transbilayer asymmetry; membrane sidedness. lipid domains, lipid rafts, caveoli, Non bilayer lipids and their role in membranes.	

MODULE 2 Membrane topology	10 Hrs
Liposomes; preparation, properties and application in membrane biochemistry. Detergent solubilization of membrane proteins. Erythrocyte ghosts; Classification of membrane proteins based on membrane-protein interaction. Techniques for determination of membrane protein topology: Biophysical methods: X-ray crystallography, Freeze-fracture electron microscopy, Lateral and rotational diffusion of integral membrane proteins. Fluorescence photobleaching recovery (FRAP). Membrane transport- passive diffusion, facilitated diffusion, active transport and co-transport.	
MODULE 3 Nanoscience	10 Hrs
Definition of Nanoscale, Scientific revolution-Atomic Structure and atomic size. Nanoparticles – properties, emergence and challenges of nanoscience and nanotechnology, carbon age-new form of carbon (CNT to Graphene), influence of nano over micro/macro, size effects and crystals, large surface to volume ratio, surface effects on the properties. Nanotechnology for waste reduction and improved energy efficiency, nanotechnology based water treatment strategies. Nanoporous polymers and their applications in water purification, Nanotoxicology.	
	10 Hrs
MODULE 4 Nanobiotechnology	
Synthesis of nanoparticles and nanostructures – bottom-top and top-bottom approaches, Carbon nanotube (CNT), structure of CNT, synthesis and functionalization of CNT, synthesis and functionalization of Graphene, electronic application of Graphene. Applications of nanoscience in biological systems - drug targeting, drug delivery and biomedicine, Bionics and Biomimicry. Scanning Tunneling microscope, Atomic force Microscopy, Zetasizer.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. Chemistry of nanomaterials: Synthesis, properties and applications by CNR Rao et.al.
2. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.
3. Instrument E L Principe, P Gnauck and P Hoffrogge, Microscopy and Microanalysis (2005), 11: 830- 831, Cambridge University Press.
4. Processing & properties of structural nanomaterials - Leon L. Shaw Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, Cambridge UK 2005.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MBC5325					
TITLE OF THE COURSE	PHYTOCHEMICALS AND MICROBIAL SECONDARY METABOLITES					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	40	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- Learning the role of phytochemicals and microbial metabolites.
- Learning the qualitative and quantitative with its application in various fields.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will have a theoretical knowledge about isolation and characterization of phytochemicals and microbial metabolites, this enables the student to draw conclusions about the multitude of role played by phytobioactives.	L3
CO2	They will have an in-depth idea about phytochemical and microbial metabolites solutions used to treat industrial and health related problems.	L3

COURSE CONTENT:

MODULE 1 Introduction to Phytochemicals	10 Hrs
Definition, history, scope and development of phytochemistry. Historical perspectives of herbal medicine: local, national and global level. Phytochemical extraction techniques: Introduction, definition, factors influencing the choice of extraction, principles of extraction methods, types of extraction (Cold and hot extraction methods, concentration and evaporation techniques, lyophilisation.	
MODULE 2 Methods to analyse Phytochemicals	10 Hrs
Techniques for quantitative and structural analysis of plant secondary metabolites: Application of TLC, column chromatography; gel filtration chromatography, affinity chromatography, ion-exchange chromatography, GLC and HPLC in phytochemistry. Application of UV/Visible, IR, ¹ H and ¹³ C NMR and Mass spectrometry in structural elucidation of natural products in relation with a specific example (terpenoids/flavonoids).	
MODULE 3 Microbial metabolites	10 Hrs

Industrial viable microbial metabolites: Industrial alcohol production, recovery and applications of ethanol; acetone-butanol production, recovery and application; production of glycerol through microbial process. Organic acids and Enzymes: Citric acid: strains for citric acid production, biosynthesis, nutrient media, production process, product recovery and application. Lactic acid: Nutrient media, production process recovery and purification. Enzymes: Production of Amylases-Fungal and Bacterial Amylase. Production of proteases: Alkaline proteases, Neutral proteases and acid proteases.	
	10 Hrs
MODULE 4 Special Microbial Metabolites	
Metabolites for food fortification: Definition and examples of food additives; strains for amino acid production, methods of production, product recovery (Eg: L-Glutamic acid and L-lysine). Health care products: Industrial production and recovery: Penicillin and Streptomycin. I P R: Patents: Patent regulations of processes, products and microorganisms.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :	
3	No
4	No

TEXT BOOKS :

1. Barsanti, L and Gualtieri, P. 2005. Algae: Anatomy, Biochemistry, and Biotechnology. Taylor and Francis New York.
2. Casida, L.E. 1997. Industrial Microbiology. New Age International Publishers.
3. Crueger, W. and Crueger, A. 2003. Biotechnology- A text book of Industrial Microbiology. Panima Publishing corporation.
4. Demain, A. L. 2001. Industrial Microbiology and Biotechnology IIInd Edition. ASM Press, Washington.
5. Demain, A.L. and Davies, J.E. 1999. Manual of Industrial Microbiology and Biotechnology II Edition. ASM Press, Washington.
6. El-Mansi, E.M.T. and Bryce, C.F.A. 2004. Fermentation Microbiology and Biotechnology. Taylor and Francis Group.
7. Horton, H.R., Moran, L. A., Scrimgeour, K.G. Perry, M.D and Rawn, J.D. 2006. Principles of Biochemistry, IV Edition. Pearson Education Internationl. London.
8. Julian E Davies and Arnold L Demain 2009 Manual of Industrial Microbiology and Biotechnology ASM Publisher.
9. Maheshwari, D.K., Dubey, R.C. and Saravanamtu, R. 2010. Industrial Exploitation of Microorganisms. I.K. International Publishing House. New Delhi.
10. Mansi El-Mansi, C. F. A. Bryce. 2007. Fermentation microbiology and biotechnology. CRC Press.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MBC5371					
TITLE OF THE COURSE	ENZYMOLOGY AND PROTEIN PURIFICATION					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	6	-	26	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- Learn about the nature of enzymes and their mode of action along with the analytical techniques of protein purification.
- To learn isolation and purification of enzymes with classical examples.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	This course will enable students to learn enzymology and analytical techniques which can be used to understand biomolecules specific to proteins.	L3

CO2	It will also enable them to learn protein chemistry techniques routinely used in medical laboratories	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :	
1.	Isolation and assay of phosphatase; effect of dilution
2.	Effect of substrate on phosphatase
3.	Effect of Temperature & pH on phosphatase
4.	Inhibition kinetics of phosphatase by L-B plot
5.	Extraction of phosphatase from plants and stepwise purification through organic acid
6.	precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step.
7.	Extraction of phosphatase from plants and stepwise purification through ammonium sulphate precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step.
8.	Criteria of purification of phosphatase – chromatography of purified samples – ion exchange/gel permeation.
9.	Criteria of purification of phosphatase visualized through SDS-PAGE.
10.	Concepts of Isoelectric Focusing (Demonstration)

TEXT BOOKS:

1. Biochemical methods, S Sadasivam, A. Manickam, New Age International (2096)
2. Modern Experimental Biochemistry, 3rd Ed., Rodney F. Boyer, Dorling Kindersley (India) (2000)
3. Biochemistry Laboratory-Modern Theory and Techniques, 2nd Ed., Rodney F. Boyer, Prentice Hall (2011)
4. Principle and techniques in Biochemistry and Molecular biology,(Eds) Keith Wilson and John Walker, Cambridge University Press (2005).
5. Biochemical Calculations, Irwin H. Segel (2076) 2nd Ed. John Wiley and Sons.
6. Principles and Techniques of Biochemistry and Molecular Biology; 7th Edn. Keith

Wilson and John Walker (2012).

7. Laboratory methods in Enzymology; Part-A; Jon Lorsch, Academic Press (2014).

SEMESTER	III					
YEAR	II					
COURSE CODE	21MBC5372					
TITLE OF THE COURSE	GENETIC ENGINEERING & IMMUNO TECHNIQUES					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	6	-	26	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
	-	-	-

COURSE OBJECTIVES:

- Learn molecular techniques to modify DNA, introduce foreign DNA in *E.coli* host and express proteins.
- To learn immune techniques used as diagnostic tools.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	This course will enable students to learn techniques which can be used to manipulate DNA, to amplify, propagate and express proteins in different host systems.	L3
CO2	It will also teach diagnostic immune techniques routinely used in medical laboratories	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. PCR amplification and analysis by agarose gel electrophoresis.
2. Preparation of plasmid DNA from E. coli.
3. Restriction digestion and Restriction mapping
4. Ligation
5. Preparation of competent E. coli. cells
6. Transformation in E. coli.
7. Induction of protein expression and analysis by SDS-PAGE
8. Serum Separation from whole blood and isolation of immunoglobulins from serum.
9. Study of different cells in whole blood using Giemsa/Leishman stain.
10. Blood grouping
11. ELISA/Dot ELISA
12. Radial Immunodiffusion/Ouchterlony Double Diffusion
13. Rocket Immuno Electrophoresis
14. WIDAL/RPR Test

TEXT BOOKS:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.

2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Glick and Pasternak (2098) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
5. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.
6. Kuby J, Judy Owen, Jenni Punt, Sharon Stranford (2013). Immunology. 7th Edition. W.H. Freeman and Company.
7. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Springer, 2008.
8. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt (2011). 12th edition, Essential Immunology, ELBS, Blackwell Scientific Publishers, London
9. William E Paul (2012). Fundamentals in Immunology. 7th edition, Raven Press.

SEMESTER	III					
YEAR	II					
COURSE CODE	21MSC5301					
TITLE OF THE COURSE	CLINICAL RESEARCH					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	26	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To introduce basic principles involved in preclinical evaluation of a drug, basic pharmacokinetics and dynamics of regulatory requirements for a clinical trial.
- To equip students with the proper designing and planning of clinical trial.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will acquire sufficient knowledge on the process and regulatory perspectives of preclinical evaluation studies.	L2
CO2	Students will gain the concepts of designing and monitoring of clinical trial studies.	L3

COURSE CONTENT:**MODULE 1 Concepts of Clinical Research****13
Hrs**

General introduction, routes of drugs administration, Dose, threshold dose, no observed effect level (NOEL), measurement of cumulative effects- time relationship. The *area under the curve (AUC)* of the concentration-time profiles, absolute bioavailability, Volume of Distribution (*Vd*). maximum tolerated dose (MTD). Basics of pharmacokinetics, calculation of pharmacokinetic estimates. Outline of drug metabolism and elimination. Organ toxicity. Scheme of preclinical evaluation of toxicity study. Calculation of LD₅₀ & ED₅₀. Acute, subacute and chronic toxicity studies. Irwin profile test. Lipinski's rule for drug like molecule.

MODULE 2 Regulatory Perspectives of Clinical Research**13
Hrs**

Overview of Clinical Trials: Clinical evaluation of new drug, phases of clinical trial, Preparation of clinical trial. Outline of new drug development process and drugs registration.

Regulatory Perspectives of Clinical Trials: Origin and Principles of International Conference on Harmonization - Good Clinical Practice (ICH-GCP) guidelines, Ethical Committee: Institutional Review Board, Ethical Guidelines for Biomedical Research and Human Participant- Schedule Y, ICMR Informed Consent Process: Structure and content of an Informed Consent Process Ethical principles governing informed consent process. Clinical Trials: Types and Design. Experimental Study- RCT and Non RCT, Observation Study: Cohort, Case Control, Cross sectional Clinical Trial Study, Team Roles and responsibilities of Clinical Trial Personnel: Investigator, Study Coordinator,

Sponsor, CRO. Clinical Trial Documentation- Trial Monitoring- Safety Monitoring in CT Adverse Drug Reactions.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS:

1. Central Drugs Standard Control Organization- Good Clinical Practices, Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health;2001.
2. International Conference on Harmonization of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonized Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 2006.
3. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi.
4. Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
5. Clinical Data Management edited by R K Rondels, S A Varley, C F Webbs. Second Edition, Jan 2000, Wiley Publications.
6. Handbook of clinical Research. Julia Lloyd and Ann Raven Ed. Churchill Livingstone.
7. Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes.
8. Essentials of medical pharmacology. TRIPATHI (K D). 6th edition, 2009, Jaypee Brothers Publihsers.
9. Textbook of modern toxicology. HODGSON (Ernest), 4th Ed. 2010, John Wiley.
10. Concepts of toxicology , OMKAR, 2014, Vishal Publishers.
11. Foyes principles of medicinal chemistry, LEMKE (Thomas L);6th edition, 2008, Wolter Klu Publishers.
12. Foyes principles of medicinal chemistry, WILLIAMS (David A); 5th edition, 2002, Wolter Klu Publishers.
13. Introduction to biochemical toxicology, HODGSON (Ernest); 3rd edition, 2001, Wiley Publishers.

SEMESTER	III
YEAR	II
COURSE CODE	21MSC5302
TITLE OF THE COURSE	SCIENTIFIC WRITING AND IPR

SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	26	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

1. To acquaint students with the concepts, types and elements, formats of Report and Proposal writing.
2. To help the students get an idea about intellectual property rights, patent laws and how to file a patent.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	After completion of the course students will able to understand the concept and scientific writing. They will be able to draft suitable and effective reports and scientific journal papers.	L2
CO2	They will also get an idea about patent laws and will know how to file a patent	L3

COURSE CONTENT:

MODULE 1 Scientific writing	13 Hrs
Introduction and overview: Types of projects (Hypothesis- driven projects, Discovery-driven projects, Technology- driven projects) Outlining the proposal, Project Summary, background, Specific aims, Hypothesis, Research strategy: Significance, Innovation and Approach, Bibliography and Reference writing. Ethics in proposal writing- Plagiarism. Writing Reports and Proposal: Objectives, Concept of report writing; Elements of report; types of reports; Dos and Don'ts of report writing; Formats for report. Concepts of Proposal writing, Characteristics of proposal, Types of proposal, Elements of proposal writing; Purpose of a research proposal.	
MODULE 2 Intellectual Property Rights	13 Hrs
Intellectual property rights-TRIPS, GATT-International conventions patents and methods of application of patents-Legal implications- Biodiversity and farmer rights. Patents and Patent Laws: Concept of Patenting law - Objectives of the patent system (Basic principles and general requirements of patent law), biotechnological inventions and patent law-Legal Development-Patentable subjects and protection in biotechnology-The patenting living organisms.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS:

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2. Ganguli Prabuddha Gearing up for Patents.....The Indian Scenario” , Universities Press (2098)
3. Ganguli Prabuddha “Intellectual Property Rights--Unleashing the Knowledge Economy”, Tata McGrawHill (2001)
4. Ganguli Prabuddha and Jabade Siddharth, “Nanotechnology Intellectual Property Right Research, Design, and Commercialisation”, CRC Press , Taylor and Francis Group, USA (2012)

5. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local communities Darrell A. Posey and Graham Dutfield , IDRC Books; annotated edition (June 2006).
6. Vedder, Scott. Signs of a Great Résumé: How to Write a Resume that Speaks for Itself. Veterans Edition. 2014. Print.
7. Block, Jay A. and Michael Betrus. 101 Best Resumes: Endorsed by the Professional Association of Resume Writers . New York: Mcgraw-Hill., 2007. Print.
8. Kulkarni, R. A. (2001). A Handbook of Communication Skills in English. Kolhapur: PhadakePrakashan.
9. Chand, S. (2073). Modern Commercial Correspondence. New Delhi: S. Chand & Company Ltd.

M.Sc. – BIOCHEMISTRY SYLLABUS

SEMESTER – IV

SEMESTER	III					
YEAR	II					
COURSE CODE	20MSC5303					
TITLE OF THE COURSE	RESEARCH METHODOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2		-	-	26	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	-	-

COURSE OBJECTIVES :

1. Students understand research terminology one that can be used to carry out different approaches to research
2. To be aware of the ethical principles of research, challenge and approval processes

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Demonstrate knowledge of research processes (reading, evaluating and developing)	L2
CO2	Compare and contrast qualitative and quantitative research	L4

COURSE CONTENT:	
MODULE I	13Hrs
Meaning, Objectives and Characteristics of research. Research Methods Vs Methodology. Types of research. Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical. Research process. Criteria of good research. Developing a research plan. Defining the research problem. Techniques involved in defining the problem Survey of literature. Primary and secondary sources. Reviews, treatise, monographs patents. Identifying gap areas from literature review. Development of working hypothesis.	

MODULE II:	13Hrs
Research design and methods - Basic Principle. Features of good design. Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan. Exploration, Description, Diagnosis, and Experimentation. Determining experimental and sample designs. Sampling design - Steps and types in sampling design. Measurement and scaling techniques. Methods of data collection. Testing of hypotheses. Procedure for hypotheses testing flow diagram for hypotheses testing. Data analysis with Statistical Packages. Correlation and Regression. Important parametric test. Chi-square test. Analysis of variance and Covariance.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.NO
2. NO

TEXT BOOKS :

REFERENCES

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
6. Day, R.A., 1992. How to Write and Publish a Scientific Paper, Cambridge University Press.
7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications

SEMESTER	IV					
YEAR	II					
COURSE CODE	20MSC5401					
TITLE OF THE COURSE	PROJECT WORK					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	-	36	-	18

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	-	-

COURSE OBJECTIVES :

1. Construct a project from Plan, schedule, monitor and control students' own work and to exhibit ideas in discussions and presentations
2. Apply tools and techniques to the applied courses taught and to communicate their findings through a written report and poster presentation

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To provide a postgraduate level knowledge in Microbiology, including understanding, analysis, management, and handling of real life information technology problems in workplace.	L4
CO2	To provide graduate education that will prepare students to become thoughtful, productive members of the competing profession and community.	L4
CO3	To provide a high-quality post graduate education and training in microbiology which prepares students for productive careers and lifelong learning.	L5

SEMESTER/YEAR : I SEM
COURSE CODE : 17MMB101
TITLE OF THE COURSE : BACTERIOLOGY AND VIROLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: HISTORY AND SYSTEMATICS OF MICROORGANISMS 13HOURS

History and development of Microbiology: Scope and Applications of Microbiology, discovery of microorganisms, Spontaneous generation theory, Biogenesis theory, Germtheory of diseases. Contributions of Louis Pasteur and Robert Koch. Microbial Systematics:

Classification systems: Criteria for classification of microorganisms, classification systems artificial and phylogenetic, Haeckel's three-kingdom classification, Whittaker's five-kingdom classification, three-domain concept of Carl Woese.

Taxonomy: Identification and nomenclature, binomial nomenclature, international code of nomenclature of prokaryotes, taxonomic ranks and hierarchical organization.

Techniques in taxonomy: Chemotaxonomy, Numerical Taxonomy, Molecular taxonomy, Serology and Phage typing. Concepts and Applications of Bergey's manual of systematic anddeterminative bacteriology.

MODULE 2: BACTERIOLOGY 13HOURS

Microbial growth and nutrition: Over view of cell Growth, Phases of growth, Generation time;Growth Kinetics; Physical conditions required for growth; Nutritional uptake, nutritional factors required for growth and reproduction. Classification of micrororganisms based on environmental and nutritional requirements.

Bacteriology: Ultrastructure of bacterial cell, Cell morphology, size, shape and arrangement; flagella, pili, capsule, cell wall, cell membrane, cytoplasm. Intracytoplasmic inclusions: nucleoid, plasmids, transposons, gas vacuoles, cellulosomes, carboxysomes, magnetosomes, phycobilisomes, parasporal crystals, reserved food materials (metachromatic granules, polysaccharide granules, poly βhydroxybutyrate granules, glycogen, oil droplets, cyanophycean granules and sulphur globules), endospores and exospores. Reproduction in bacteria.

MODULE 3: SPECIAL MICROBIAL FORMS 13HOURS

Ultrastructure, classification. cultivation, reproduction and importance of Archaeobacteria, Myxobacteria, Sheathed, budding and appendaged bacteria, Spirochaete, Rickettsia, Chlamydiae,

Mycoplasma, Actinomycetes, Cyanobacteria.

MODULE IV: VIROLOGY

13HOURS

History of Virology, General properties of viruses, ICTV and classification of viruses, **Morphology and ultrastructure of viruses** - capsids and their arrangements; types of envelopes and their composition- viral genome (RNA, DNA), general replication of viruses. Cultivation, purification and assay of viruses.

Type studies: Bacteriophages (T4 and λ phage), animal viruses (Polio) and plant viruses (TMV). (Ultra-structure, replication and importance).

General Account and Importance of Virioids and Prions.

REFERENCES:

1. Addison Wesley, New York. Holt J.G., Kreg N.R., Sneath P.H., Staley J.T and Williams S.T. Bergey's manual of Determinative Bacteriology, 9th Edtn. Williams and Wilkins, Baltimore.1994.
2. Balows, A., H.G., Dworkin, M., Harder, W and Schleifer, K.H. The prokaryotes. A hand book on the biology of bacteria ecophysiology, isolation, identification, applications. Volumes I-IV. Springer-Verlag, New York, 1992.
3. Breiman, L., Friedman, J.H., Olsen, R.A and Stone. C.J. Classification and Regression Trees.
4. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
5. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.
6. Edward Alcamo. Microbiology. Cliffs Notes. 1996.
7. Eldowney, S.Hardmen, D.J and Waite, S. Pollution. Ecology and Biotreatment. Longman Scientific Technical. 1993.
8. Flint L.W.,Enquist, V.R., Racaniello and Skalka A.M. Principles of Virology: Molecular Biology, Pathogenesis and control of Animal Viruses by 2nd edition, ASM Press, Washington, DC, 2000.
9. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
10. Johri, B.N. Extremophiles. Springer Verlag, New York. 2002.
11. McKinney, R. Environment Microbiology. Principles and applications. Science Publishers. 2004.
12. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
13. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition. Pub.1986.
14. Nigel Dimmock N, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005.
15. Schlegel,H.G. General Microbiology, Cambridge University Press.
16. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005.
17. Salle, A.J. Principles of Microbiology, 2ndedition., 1997, Mc Graw Hill.1997.

18. Tortora, Funke and Case. Microbiology, 9th Edition. Benjamin Cummings. 2009.
19. Dubey, R.C. Microbiology 1st Edition. Chand and company
20. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.
21. Pelczar, M.J., Chan, E.C.S., and Kreig N.R. Microbiology Tata McGraw-Hill Pub.1986.
22. Breiman, L., Friedman, J.H., Olsen, R.A. and Stone. C.J. Classification and Regression Trees.
23. Felsenstein, J. Numerical Taxonomy, NATO ASI series, Springer-Verlag, New York. 1961
24. Edward Alcamo. Microbiology. Cliffs Notes 1996.
25. Tortora, Funke and Case. Microbiology, 9th Edition. Benjamin Cummings. 2009
26. Ec. Eldowney, S. Hardmen, D.J., and Waite, S. Pollution: Ecology and Biotreatment. Longman Scientific Technical. 1993.
27. Jacquelyn G. Black, Larry M and Lewis. Microbiology: Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
28. S.J. Flint L.W. Enquist, V.R. Racaniello and A.M. Skalka. Principles of Virology: Molecular Biology, Pathogenesis and control of Animal Viruses by 2nd edition, ASM Press, Washington, DC, 2004
29. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005
30. Balows, A., H.G., Dworkin, M., Harder, W., and Schleifer, K.H. The prokaryotes. A hand book on the biology of bacteria ecophysiology, isolation, identification, applications. Volumes I-IV. Springer-Verlag, New York, 1992.
31. Madigan and John M Martinko, Paul V. DunlP, David P. and Clark Benjamin Cummings Brock Biology of Microorganisms (12th edition), 2008.
32. H.G. Schlegel. General Microbiology., Cambridge University Pres
33. Johri B.N. Extremophiles. Springer Verlag., New York. 2002.
34. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005
35. Salle, A.J. Principles of Microbiology, 2nd edition., 1997, Mc Graw Hill.1997
36. Addison Wesley, New York. Holt JG, Kreg NR, Sneath PHA, Staley JT and Williams ST. Bergey's manual of Determinative Bacteriology, 9th Edtn. Williams and Wilkins, Baltimore.1994
37. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MMB102
TITLE OF THE COURSE : EUKARYOTIC MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: PHYCOLOGY

13 HOURS

Comparative study of Eukaryotic and Prokaryotic cells and its significance. General characteristics of Algae, occurrence, thallus organization, classification, ultra structure of cell, vegetative, asexual and sexual reproduction. Algal life cycles- Haplontic, Diplontic, Diplohaplontic, Haplobiontic, and Diplobiontic type, Isolation from soil and water; Algal cultivation, measurement of algal growth. Structure and life cycle of *Chlamydomonas*, *Spirogyra*, *Diatoms*, *Sargassum* and *Porphyra*. Symbiotic algae: Lichens. Economic importance of algae.

MODULE 2: MYCOLOGY

13 HOURS

General characteristics of fungi including habitat, classification, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal cell wall structure and synthesis, fungal spores – dormancy and dispersal.

Type studies: *Aspergillus*, *Yeast*, *Pythium*, *Rhizopus*, *Fusarium*, *Puccinia* and *Agaricus* (Classification, Ultrastructure, reproduction, lifecycle, importance)

MODULE 3: FUNGAL PHYSIOLOGY & REPRODUCTION

13 HOURS

Reproduction (asexual and sexual). Fungal growth (yeast cell cycle and growth of hyphae); mechanism of growth in Fungi; measurement and kinetics of growth, nutritional and environmental requirements. Fungal life cycles, mating system and genetic exchange, sex hormones in fungi; physiological specialization, phylogeny of fungi. Saprotrophic, parasitic, aquatic, endophytic, keratinophilic, coprophilous and mutualistic fungi. Economic importance of fungi.

MODULE 4: PROTOZOOLOGY

13 HOURS

General features of Protozoa, classification. Structure, reproduction and significance of: *Leishmania*, *Trichomonas*, *Paramecium*, *Amoeba*, *Entamoeba* and *Plasmodium*. Cultivation of protozoa.

REFERENCES:

1. Mark F. Wiser. Protozoa and Human Disease. Garland Science, (2010).
2. D.K. Maheshwari. Industrial Exploitation of Microorganisms. I.K. International Publishing House Ltd.NewDelhi.. (2009)
3. JIS Khattar.. Algal Biology and Biotechnology. I.K. International Publishing House Ltd.NewDelhi,(2009)
4. K R Sridhar. Frontiers in Fungal Ecology, Diversity and Metabolites. I.K. International Publishing House Ltd.NewDelhi.(2009)
5. Marjorie Cowan, Kathleen Park Talaro. Microbiology: A Systems Approach. 2nd Edition. The McGraw/Hill.(2009)
6. Mahendra Rai. Mycotechnology: Present Status and Future Prospects. I.K. International Publishing House Ltd.NewDelhi.(2007).
7. M.K.Sateesh. Comprehensive Biotechnology (Microbiology and Biostatistics). New Age International Publishers, New Delhi-110 002, India. (2007).
8. R.C. Kuhad. Lignocellulose Biotechnology: Future Prospects. I.K. International Publishing House Ltd.NewDelhi.(2007).
9. Nagamani.. Handbook of Soil Fungi. I.K. International Publishing House. NewDelhi.(2006)
10. A.V.S.S. Sambamurty. A Textbook of Algae. I.K. International Publishing. (2005).
11. Nick Talbot. Molecular and Cellular Biology of Filamentous Fungi: A Practical Approach Oxford(2005).
12. Mehrotra, R.S. and Aneja, K.R. An Introduction to Mycology, New Age Publications.(2002).
13. Alexopoulos, C. J. and Mims, C.W.. Introduction to Mycology, Wiley.(2001)
14. Singh, P.K., Dhar, D.W., Pabbi, S., Prasanna R., Arora A.. Recent Advances in the Exploitations of Blue Green Algae and Azolla, National Center for Conservation of Blue Green Algae, IARI, New Delhi. (2001)
15. Singh, P.K., Dhar, D.W., Pabbi, S., Prasanna R., Arora, ABiofertilizers- Blue Green Algae and Azolla, National Center for Conservation of Blue Green Algae, IARI, New Delhi. (2000).
16. Becker, E.W. Microalgae: Biotechnology and Microbiology, CambridgeUniversity Press.(1994)
17. Kashyap and Kumar, H.D. recent advances in phycology-Rastogi Company (1994).
18. Janet R Stein Phycological methods. Cambridge university press. (1975).
19. Chapman, V.J. and chapman, D.J. The Algae. English language book society & MacMillan(1973).

SEMESTER/YEAR	: I SEM
COURSE CODE	: 17MMB103
TITLE OF THE COURSE	: MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY
L: T/A: P: C	: 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: BIOMOLECULES

13 HOURS

Carbohydrates: Structure of mono, di and polysaccharides, asymmetric centre in sugars, dextro and leavo-rotatory, anomers, epimers, reducing and non-reducing sugars. Oligo saccharides – starch, glycogen and chitin. Complex carbohydrate.

Amino acids and Proteins: Structure of amino acids, classification of amino acids, amino acids as acids and bases, peptide linkage, Classification of proteins, Structural organisation of proteins (primary, secondary, tertiary and quaternary) N-terminal and C-terminaldetermination.

Lipids: Structure of saturated, unsaturated fatty acids, phospholipids, glycolipids and steroids; structure and function of fat soluble vitamins A, D, E and K.

Nucleic acid: Structure of Nucleotides, Nucleosides and Bases, Nucleotide Coenzymes (NAD, Coenzymes A);

MODULE 3: METABOLISM

13 HOURS

Photosynthesis: Photosynthetic pigments, light reactions in eukaryotes, cyanobacteria, green and purple bacteria, process of photosynthesis with special reference to microorganisms.

Fermentation: Alcohol fermentation, Lactic acid: Homo and Heterolactic fermentation; Acetic acid, butyric acid, mixed acid and proponic acid fermentation.

Carbohydrate and Protein Metabolism: Glycolysis, Entner – Doudoroff. TCA cycle, Gluconeogenesis, Transamination, oxidative deamination, decarboxylation, Urea cycle. Brief account of porphyrins.

Fungal and bacterial secondary metabolism: Brief account on biosynthesis and action of secondary metabolites antibiotics, bacterial and fungal toxins, pigments, fungal hormones.

Bioluminescence – mechanism and significance.

MODULE III: BIOENERGETICS

13 HOURS

Introduction, Principles of thermodynamics, high energy compounds- ATP, NAD, FAD, FMN, quinones, components and mechanisms of respiratory chain. Energy production in aerobic and anaerobic organisms: Structure of bacterial and mitochondrial ATPase, Substrate level phosphorylation; Electron transport chain and Oxidative phosphorylation: generation and maintaince of PMF, inhibitors and un-couplers of electron transport system, phosphorylation potential and its importance.

MODULE IV: METABOLITE TRANSPORT AND ENZYMOLOGY

13 HOURS

Metabolite transport: Facilitated diffusion mechanosensitive channels, ATP- binding cassette transport family, chemiosmotic driven transport, ion ingredients, specific transportsystem: ATP-linked ion motive pumps, histidine permease, iron, phosphorous transferase system.

Microbial stress responses: oxidative, thermal and heat shock response.

Enzymes: Definition, classification, specificity, active sites, coenzymes, activators and inhibitors, activity unit, isozymes, enzymes kinetics; Michaelis-Menten equation for simple enzymes, Determination of kinetic parameters. Principles and mechanism of reversible and irreversible enzyme inhibition, **Ribozymes and abzyme.**

REFERENCES:

1. Berg Jeremy, Tymoczko John, Stryer Lubert. *Biochemistry* 4th Ed, W. H. Freeman, New York. 2001.
2. Conn Eric, Stumpf Paul K., Bruening George, Doi Roy H. *Outlines of Biochemistry* 5th Ed, John Wiley and Sons, New Delhi. 1987.
3. Dawes Edwin A. *Quantitative Problems in Biochemistry*, Churchill Livingston, Edinburgh. 1972.
4. Hall D. D. and Rao K. K. *Photosynthesis* 5th Ed., Cambridge University Press.
5. Mandelstam Joel and McQuillen Kenneth (1976) *Biochemistry of Bacterial Growth*, Blackwell Scientific Publication London. 1996.
6. Lehninger. *Principles of Biochemistry*, 3rd edition by Nelson & Cox (Worth) pub. 2000.
7. Linda Sherwood and Chris Woolverto. *Prescott's Microbiology*, 8th Edition McGraw-Hill. 2011.
8. Metzler David E. *Biochemistry: The chemical Reactions of Living Cells*, Volume 1&2, Academic Press California. 2001.
9. Moat Albert G. and Foster John W. *Microbial Physiology* 2nd Ed. John Wiley and Sons New York. 1988.
10. Nelson D. L. and Cox M. M. *Lehninger's Principles of Biochemistry*, Fourth edition, W.H. Freeman & Co. New York. 2005.
11. Palmer Trevor. *Enzymes: Biochemistry, Biotechnology and Clinical chemistry*, Horwood Pub. Co. Chinchester, England. 2001
12. Segel Irvin H. *Biochemical Calculations* 2nd Ed., John Wiley and Sons, New York. 1997.
13. Stanier R. Y., Adelberg E. A., Ingraham J. L. *General Microbiology*, 4th edition, Mac Millan Press, London.
14. Voet Donald and Voet Judith G. *Biochemistry*, 2nd Ed.. John Wiley and sons New York. 1995.
15. White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) *Principles of Biochemistry*, Edition 6, Tata Mc-Graw Hill Companies, Inc. 1983.

16. White David. *Physiology and Biochemistry of Prokaryotes*. 2nd Ed. Oxford University Press, New York. 2000.
17. Zubay Geoffrey. *Biochemistry*, 4th Ed., W. C. Brown, New York.

SEMESTER/YEAR	: I SEM
COURSE CODE	: 17MMB104
TITLE OF THE COURSE	: MICROBIAL AND BIOPHYSICAL TECHNIQUES
L: T/A: P: C	: 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: MICROBIAL TECHNIQUES

13 HOURS

Microscopy: History and development of microscopes, Principles and concepts of microscopy, Working principles of compound, dark field, phase contrast, fluorescent, confocal, interference, polarizing, electron microscopy (TEM and SEM) and atomic force microscope; micrometry.

Stains and Staining techniques: Principles, protocols and applications of stains and staining techniques. Simple, differential and vital staining techniques.

Control of microorganisms: Terminologies, principles and applications of sterilization. Physical and chemical methods of control of microorganisms

Pure Culture Techniques: Isolation of pure cultures; serial dilution, spread plate, streak plate, pour plate, micromanipulator method, colony morphology and other characteristics of cultures, fatty acid analysis, Fluorescent in situ hybridization (FISH) genomic in situ hybridization (GISH)

MODULE 2: MICROBIAL CULTURE AND GROWTH TECHNIQUES

13 HOURS

Microbial culture media: Culture media, requirements, types, preparation and uses of different microbial culture media. .

Microbial Growth Measurements: Microbial growth; Concept, growth type, measurement of microbial growth-cell number, turbidity and biomass, determination of microbial growth curve, Continuous and synchronous culture, balanced and unbalanced growth, diauxic-growth curve, aerobic and anaerobic growth.

Microbial culture preservation: Concept, types of microbial culture preservation, type culture collections. Advantages and limitations of culture preservation techniques.

Microbial Safety measures: Concept, safety measures in handling microbiological samples and microorganisms.

MODULE 3: CHROMATOGRAPHY AND ELECTROPHORESIS

13 HOURS

pH and Buffers: Preparation of buffers, Henderson and Hesselbach equation, pK_a and pK_b , pH measurements, electrodes and its types, viscometer and osmometer in relation to molecular size and shape, membrane filtration techniques, Dialysis and its applications.

Chromatography: Introduction, Principle types and application of: paper, thin layer, gel permeation, affinity, ion-exchange chromatography, adsorption chromatography, High pressure liquid chromatography and Gas chromatography.

Electrophoresis: Basic principle and application of Gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE) – SDS and native PAGE, Agarose gel electrophoresis, capillary electrophoresis, immune electrophoresis, isoelectric focusing, 2D electrophoresis.

MODULE 4: SPECTROSCOPY AND RADIOISOTOPES

13 HOURS

Spectroscopy and Spectrophotometry: Electromagnetic spectrum, Beer- Lamberts law, Principle and application of UV/VIS spectroscopy, IR spectroscopy, ESR and NMR spectroscopy, Fluorescence spectroscopy, Atomic absorption spectroscopy, Raman spectroscopy, Mass spectroscopy, circular dichroism, XRD, Microarray.

Radio-isotopes detection and measurements: Nature and types of radiations, stable and unstable isotopes, labelling of biological samples, tracer technique, detection and measurement of radioactivity by Dosimetry, Ionisation chamber, GM counter, Photographic method, Scintillation counter, Autoradiography. Handling methods and safety, non-radioactive labelling.

REFERENCES:

1. A Biologist Guide to Principle and Techniques: Willson K. and Gounding K.H.
2. Ackerman, E. I. Biophysical Science. Prentice Hall Inc. NJ, USA. 1962
3. Alonso, A., and Arrondo, J.L.R. Advanced Techniques in Biophysics. Springer, UK. 2006
4. An Introduction to Practical Biochemistry: Plummer D. T.
5. Analytical Chemistry: Christion G. D.
6. Arora, M. P. Biophysics. Himalaya Publishing House, New Delhi. 2007
7. Biochemical Techniques theory and practice : White R
8. Biophysical techniques : Principles and techniques Upadhaya and Upadhaya
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10. Edward, A.L. Radiation Biophysics. Academic Press, NY, USA. 1997.
11. Gupta A. Instrumentation and Bio-Analytical Techniques. Pragati Prakashan, Meerut. 2009.
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13. Narayanan, P. Essentials of Biophysics. New Age International (P) Ltd. Publishers, New Delhi. 2002.
14. Nuclear Magnetic Resonance: Williams
15. Roy, R.N. A Textbook of Biophysics. New Central Book Agency (P) Ltd. Calcutta. 1996.
16. Srivastava, P.K. Elementary Biophysics. An Introduction. Narosa Publishing House, New Delhi. 2006.

SEMESTER/YEAR	: I SEM
COURSE CODE	: 17MMB171
TITLE OF THE COURSE	: GENERAL MICROBIOLOGY AND EUKARYOTIC MICROBIOLOGY
L: T/A: P: C	: 0: 0: 8: 4

PRACTICALS

1. Preparation of culture media: Autotrophic, Heterotrophic, Selective, Enriched and Differential culture media.
2. Isolation of Microorganisms from different sources: Serial dilution and Pure culture techniques.
3. Staining- simple, differential, acid fast, endospore, capsule, flagella, vital, cell wall and nuclear staining.
4. Determination of bacterial motility by hanging drop method.
5. Determination of microbial size by micrometry
6. Enumeration of microorganisms by haemocytometer.
7. Determination of bacterial growth curve by turbidometry and plate count.
8. Isolation of bacteriophages from sewage.
9. Isolation and identification of fungi from soil: Dilution plate method, Warcup method, stamping method.
10. Isolation of fungi from plant material: Epibiotic fungi, washing method, implant method, impression method, maceration method; endophytic fungi.
11. Growth measurement of fungi- linear and biomass.
12. Study of fungi: *Aspergillus*, *Penicillium*, *Fusarium*, *Yeast*, *Mucor*, *Rhizopus*, *Agaricus*, *Puccinia*,
13. Isolation and identification of microscopic algae from soil and water
14. Study of algae (permanent slides): *Spirulina*, *Nostoc*, *Spirogyra*, *Microcystis*, *Scytonema*, *Oscillatoria*, *Rivularia*,
15. Isolation and identification of protozoans from soil and water.
16. Study of Protozoa (permanent slides): *Euglena*, *Plasmodium*, *Paramecium*, *Amoeba*,

SEMESTER/YEAR	: I SEM
COURSE CODE	: 17MMB172
TITLE OF THE COURSE	: MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY
L: T/A: P: C	: 0: 0: 8: 4

PRACTICALS

1. Biochemical tests for identification of bacteria:
Catalase, Oxidase, IMViC, Gelatin hydrolysis, Hydrogen sulfide production in TSIA ,
Coagulase, Nitrate Reduction test, Sugar Fermentation test, Casein hydrolysis and
Starch hydrolysis. Identification of bacteria by API system. (6 units)
2. Preparation of standard buffers and determination of pH of a solution.
3. Qualitative analysis of proteins.
4. Qualitative analysis of carbohydrates.
5. Quantitative estimation of glucose by DNS method
6. Quantitative estimation of reducing sugars by Benedict's method.
7. Quantitative estimation of protein by Lowry's/ Bradford method.
8. Quantitative estimation of amino acids by ninhydrin method.
9. Study of enzyme kinetics, Km and Vmax of amylase.
10. Separation of amino acids by paper / thin layer chromatography.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB203
TITLE OF THE COURSE : ENVIRONMENTAL MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: SOIL MICROBIOLOGY

13HOURS

Soil Microbiology: Soil as Dynamic system, Soil profile, Soil morphology; Biotic and abiotic interactions; Habitat and niche; Diversity and distribution (The rhizosphere, Mycorrhizosphere, Actinorhizae); Soil erosion and soil conservation; Microbial interaction in soil; Soil pathogens and soil microflora and human health; Isolation of soil viruses; Genetic exchange between communities; Biogeochemical cycles-Carbon cycle, Nitrogen cycle and Sulphur cycle; Hg transformation.

Diversity in anoxic eco system: Methanogens-reduction of carbon monoxide- reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of Carbon, Phosphorus, Sulphur, Nitrogen and Mercury.

MODULE 2: AQUATIC BIOLOGY AND SEWAGE TREATMENT

13 HOURS

Aquatic Microbiology: Natural waters, Microbial flora of aquatic environment, Zonation of water system, Upwelling; **Marine microbiology**; Hydrothermal vents, Nutrients in aquatic environments; Water pollution and water borne diseases; Eutrophication; Water purification; Ground water types and contamination; **Water quality assays** and public health (SPC, MPN, MFT, ONPG and MUG).

Sewage treatment: Primary, Secondary and Tertiary treatment. Solid waste treatment (Landfills and Composting); Biogas production; Role of microbes in sewage treatment; Methanogens and methylotrophs. **Newer approaches to sewage treatment** and Enzyme technology for treating Industrial waste water; Application of Recombinant DNA Technology in wastewater treatment.

MODULE 3: AEROBIOLOGY

13 HOURS

Aerobiology: Air spora in different layers of atmosphere, bioaerosol; Microbiology of indoor and outdoor air; Significance of microorganisms in air; Enumeration of microorganisms in air (Impingement in liquids, Impingement in solids, suction and filtration); Control of air borne microorganisms. Molecular methods of air quality assessment; The Green house effect, Ozone depletion , UV radiation and Acid rain. Aeroallergens and Allergies: Causes and tests for detection of aero allergens.

MODULE 4: BIOLEACHING AND BIODEGRADATION

13HOURS

Biobleaching- Principles, microorganisms and microbe-mineral interactions. Biobleaching of copper, uranium and gold; Dump, heap and bioreactor operations. Role of acidophilic microorganisms in environmental pollution.

Biodegradation: Biodegradation of xenobiotic compounds and Recalcitrant compounds, Mechanism and enzymes involved in biodegradation. Role of plasmids in biodegradation. Biodegradation of cellulose and lignin paper and plastic. Hazards from xenobiotics. Microbiology of environmental remediation- Bioremediation. Soil and water 'insitu' remediation- Engineering developments - Constructed wet lands; Bioremediation of oils from contaminated soils; Biosorption; Phytoremediation.

REFERENCES:

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2. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
3. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press.
4. Baker K.H and Herson D.S. Bioremediation. Mc Graw Hill Inc., New York. 1994.
5. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
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7. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
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9. Robert L Tate, Soil Microbiology, 2nd Edition, John Wiley and Sons.
10. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
11. Grant W.D and Long P.E. Environmental Microbiology. Kluwer Academic Publishers, 1981.
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14. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB204
TITLE OF THE COURSE : FOOD AND DAIRY MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52 HOURS

MODULE 1: SCOPE OF FOOD MICROBIOLOGY AND FOOD PRESERVATION 13 HOURS

Scope of food microbiology: Development of food microbiology as a science, scope of food microbiology. Food as a substrate for microorganisms; intrinsic and extrinsic factors affecting the growth of microbes. microorganisms in food and their source.

Principles of Food preservation: Principles of preservation (Asepsis, Removal, Anaerobic conditions). Methods of food preservation (High temperature, Low temperature, irradiation, Drying and Food Additives), Chemical method of Food preservation (Class I and Class II Preservatives). D, Z and F values; Biopreservation, Food Packaging and benefits.

MODULE 2: PRINCIPLES OF FOOD SPOILAGE AND ILLNESS 13 HOURS

Microbial spoilage of food: Causes and sources of food spoilage, Spoilage of Vegetables, fruits, cereals, sugar products, meat and meat products, fish, poultry, canned products and miscellaneous foods. **Methods for microbial examination of foods:** indicator organisms, direct examination, cultural techniques, enumeration methods and molecular methods.

Foodborne Illness: Food borne Infections and Intoxications. Bacteria –*Clostridium, Bacillus, Brucella, Escherichia, Listeria, Campylobacter, Staphylococci, Salmonella, Shigella, Yersinia*. Virus- Hepatitis A and E, rota viruses, toxigenic algae, Rickettsia, Various parasites, Sea toxicants; Poisoning by chemicals; Mycotoxins (Aflotoxins, Ochratoxins, Fuminosins, Trichothecenes, Zealenone, Ergot alkaloids); Recent methods in detection of food pathogens.

MODULE 3: FERMENTED FOODS AND FOOD REGULATIONS 13 HOURS

Fermented foods: Fermented Vegetables, Meat Sausages, Beverages, Bread, Idli, Nutritional and therapeutic importance, Single cell Protein (Bacteria, Yeast, Algae); Probiotics and Synbiotics; Nutraceuticals, Quorn and Single Cell Oil and their industrial production).

Food Sanitation and Food control Agencies: **HACCP**, Employees Health standards, **GMP**, Plant sanitation, Waste treatment, Disposal, Criteria of microbiological quality control. Food control agencies and their regulations.

MODULE 4: DAIRY MICROBIOLOGY: 13 HOURS

Nutritional level of milk, microbial flora of milk, sources of milk contamination

Bacteriology of milk: Incidence and characterization of pathogenic microorganisms in milk, bacteriological aspects of pasteurization, sterilization of milk; predominant types of microorganisms in chilled and refrigerated milk supplies and their importance; heat resistant bacteria in milk and their role in milk spoilage; use of detergents and sanitizers in the cleaning and sanitation of dairy equipment's; principles of quality control tests for milk; bacteriological grading, market milk production and public health control.

Microbiology of dairy products: Microbiology of cream, butter, ice-cream and indigenous dairy products such as khoa, peda, yogurt, acidophilus milk, dahi, kefir, koumiss, shrikhand, cultured butter milk, cheese and other fermented milk products; use of rennet and microbial rennet substitutes in cheese making. Quality standards of milk products.

Advances in Food and Dairy Microbiology: Biosensors in Food Industry; Genetically modified foods; Food fortification; Food parks.

REFERENCES

1. James M.J. Modern Food Microbiology, CBS Publishers and Distributors, Delhi. 1996
2. James M. and Jay J.M. Food Borne Pathogen An Illustrated Text, Wolfe publications Ltd, England. 1991.
3. Colin Rand Bjorn K. Basic Biotechnology 2nd Edition. Cambridge University Press. 2002.
4. Mary E.T and Richard E. I. Microbial Food Safety Animal Agriculture: Current Topics, Iowa state University Press. 2003
5. Bibek R. Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press. 2001.
6. Adams M.R. and Moss M.O. Food Microbiology. Royal Publishing Corporation. 2000.
7. Robinson. Dairy Microbiology Vol I and II.
8. John G. Essentials of Food Microbiology. Arnold International Students Edition.
9. Riemann H. Food borne infections and intoxications. Academic Press Inc., New York. 1969.
10. Powar and Dagainawala. General Microbiology. Himalayan Publication. 1982.
11. Frazer W.C. Food Microbiology. Mc Graw Hill, New York. 1979.
12. Jay J.M. Modern Food Microbiology. Van Nostrand Rheinhold. New York. 1970.
13. Foster E.M. et al., Dairy Microbiology. Prentice Hall Inc., Englewood. 1975.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB205
TITLE OF THE COURSE : BIOINFORMATICS
L: T/A: P: C : 2: 0: 0: 2

TOTAL HOURS: 26 HOURS

MODULE I COMPUTER NETWORK AND PROGRAMMING LANGUAGES 8HOURS

Introduction to Computer: Computer soft wares- operating system- Windows, UNIX, Linux, Application software- word processor, spread sheet. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases - sequence, structure, non-redundant Computer Network: Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls.

Programming Languages: Introduction to programming languages - C and PERL

MODULE II BIOLOGICAL DATABASES AND THEIR APPLICATIONS 10HOURS

Introduction - Relational Databases Management (RDMS) - Oracle, SQL, Database generation.

Data mining and applications, accessing bibliographic databases- Pubmed, Nucleic acid sequence databank – NCBI and EMBL. Protein sequence databank- NBRF- PIR, SWISSPROT Structural databases - protein data Bank (PDB) & UniProt Metabolic pathway data bank (Pub gene), Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER, Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids and protein sequences, Identification of ORFs, Identification of motifs

MODULE III PROTEIN STRUCTURE AND MOLECULAR INTERACTION 8HOURS

Introduction to protein structure – secondary structure prediction, tertiary structure prediction, protein modeling- principles of homology and comparative modeling phylogenetics; Structure prediction methods – high-accuracy, and template based, free modeling (new folds); Secondary structure prediction; Pattern recognition – PSSMs, weight matrices; hidden Markov models Threading, structure evaluation and validation and *ab initio* Modeling Applications - **Molecular docking - Autodoc**

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (1998). Bioinformatics.
9. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
10. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
11. Programming Python by M.Lutz, O'Reilly media, 2011, 4th edition.
12. Learning Perl by R.L.Schwartz, B.D.Foy, T.Phoenix, O'Reilly meida, 2011, 6th edition.
13. The C++ programming language, by B. Stroustrup, Addison-Wesley professional publishers, 2013, 4th edition.
14. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81
15. Mangan ME, et al. The UCSC Genome Browser: What Every Molecular Biologist Should Know. Curr Protoc Mol Biol. 2014 Jul 1; 107:19.

SEMESTER/YEAR	: II SEM
COURSE CODE	: 17MMB271
TITLE OF THE COURSE	: MICROBIAL GENETICS AND MOLECULAR BIOLOGY
L: T/A: P: C	: 0: 0: 8: 4

PRACTICALS

1. Quantification of DNA by colorimetry/ spectrophotometry
2. Quantification of RNA by colorimetry/ spectrophotometry
3. Conjugation in *E. Coli*
4. Transformation in *E.coli*
5. Antibiotic resistant mutant isolation by gradient plate technique
6. Isolation and electrophoretic analysis of genomic DNA
7. Isolation and electrophoretic analysis of plasmid DNA
8. Isolation and electrophoretic analysis of RNA
9. Identification of lytic and lysogenic cycles in bacteriophage
10. Induction and assay of β -galactosidase
11. Study of replica plating techniques.
12. Mutagenesis: Identification and isolation of fungal mutants [physical (UV)].
13. Genetics problems.
14. Protoplast fusion (Demonstration)

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB272
TITLE OF THE COURSE : ENVIRONMENTAL, FOOD AND DAIRY MICROBIOLOGY
L: T/A: P: C : 0: 0: 8: 4

PRACTICALS

1. Quantification of microorganisms in air.
2. Study of microbial interactions in soil (antagonism)
3. Detection and Estimation of Protein and Polysaccharide in Biofilm.
4. Isolation and characterization of Iron, Manganese and Methanogenic bacteria.
5. Detection of Metal tolerance in microorganisms.
6. Isolation of xenobiotic degrading organisms and estimation of chloride
7. Detection of coliform in water (MPN test)
8. Determination of Total solids, Dissolved Oxygen, Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)
9. Study of Bacteriocin.
10. Study of antimicrobial activity of chemical preservative.
11. Quality test of Fermented Food.
12. Production and estimation of lactic acid by *Lactobacillus* sp.
13. Isolation of food poisoning bacteria from contaminated foods and dairy products
14. Detection of Aflatoxin production (*Aspergillus flavus*)
15. Quality test of milk – Platform and Dye reduction test

SEMESTER/YEAR	: III SEM
COURSE CODE	: 17MMB301
TITLE OF THE COURSE	: MEDICAL MICROBIOLOGY
L: T/A: P: C	: 4: 1: 0: 5

Total Credit Hours: 52 Hours

Module 1: Host Microbe Relationship and Epidemiology 13hours

Normal microbial flora of human body and its significance, tissue tropism. Contamination, Infection and Disease. Pathogens, pathogenicity and virulence. Koch's Postulates. Infections, nosocomial infections and non-infectious diseases. Entry of pathogen into human host, portals of entry. Mechanism of microbial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urinogenital tracts. Exotoxins and Endotoxins. G protein signalling, spreading, tissue damage and antiphagocytic factors. Specific and non specific host defense. Quorum sensing.

Epidemiology- Diseases in population, epidemiological studies, epidemics of emerging and re-emerging diseases, reservoirs of infection, modes of disease transmission, herd Immunity and public health organizations.

Module 2- Bacterial, Fungal and protozoan diseases 13hours

Study of diseases - Etiology, Epidemiology, Pathogenicity, Diagnosis, and prophylaxis of the following

Bacterial diseases: *Streptococcus, Staphylococcus, Shigella, Salmonella, Neisseria, Corynebacteria, Vibrio, Yersinia, Haemophilus, Helicobacter, Mycobacterium, Spirochetes-Treponema, Chlamydiae, Mycoplasma.*

Protozoan and Helminthic diseases- *E. histolytica, Plasmodium, Leishmania, Filaria* and tape worm.

Fungal diseases- Dermatormycosis, Subcutaneous mycosis, Systemic mycosis and Opportunistic mycoses.

Module 3- Viral diseases 13hours Etiology, Epidemiology, Pathogenicity, Diagnosis, and Prophylaxis of the following. Viral Diseases- Pox virus, Herpes virus, Varicella-zoster, Adenovirus, Picornavirus, Orthomyxoviruses (influenza), Paramyxovirus (mumps and Measels), Rhabdovirus, Hepatitis viruses, Oncogenic virus, Retrovirus, Arbovirus. Prion infection.

Module 4- Antimicrobial Prophylaxis and Diagnostic Microbiology. 13hours

Antimicrobial Prophylaxis: Antibiotics, Classification of Antimicrobial agents, Mechanism of drug action-antibacterial, antiviral, antifungal and antiprotozoans. Methods of testing

drug sensitivity, antibiotic assay in body fluids, drug resistance – causes, mechanism and prevention. **Probiotics as therapeutic agents**. Brief account of **vaccine- Conventional vaccines, Subunit vaccines and DNA vaccines**. Immunization schedules. Passive prophylactic measures and Interferons. Principles and applications of Immunological and PCR based diagnostic methods.

Diagnostic Microbiology: Collection, transport and storage guidelines; biosafety in diagnostic laboratory and regulations, specific procedures for collection of specimens, processing of specimens. **Biomedical waste management and treatment**.

References-

1. Brock T.D and Madigan M.T. (1992) Biology of Microorganisms 6th edition. Prentice Hall, Eagle wood cliffs N.J.
2. Connie R Mahon (2010). Textbook of Diagnostic Microbiology. 3rd edition. Pearson.
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5. Jenson, Wright, Robinson (1997), Microbiology for the Health Sciences 4th edition, Prentice hall.
6. Kufe, et al., (2003), Cancer Medicine, BC Decker Inc.
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9. Mackie and McCarthy (1996) Medical microbiology vol 1, Medical infection. Vol 2, practical medical microbiology, Churchill Livingstone.
10. Madigan, Martinko, Dunlap, Clark. (2009). Brock Biology of Microorganisms, Twelfth Edition, Benjamin Cummings.
11. Marjorie Cowan, Kathleen Park Talaro (2009). Microbiology: A Systems Approach. 2nd Edition. The McGraw/Hill.
12. Nester, Roberts, Pearsall Anderson (1998). Microbiology-A Human Perspective, 2nd edition, McGraw-Hill.
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14. Wadher and Bhoosreddy (2005) Medical microbiology. Himalaya Publisher.
15. Warren Levinson (2000) Medical Microbiology and Immunology: Examination and Board Review 8th Edition. McGraw Hill.
16. Warren Levinson (2000) Medical Microbiology and immunology examination and board review (8th edition) McGraw Hill.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB302
TITLE OF THE COURSE : IMMUNOLOGY
L: T/A: P: C : 4: 1: 0: 5

Total Credit Hours – 52 hours

Module I: Immune System

13hours

Innate, adaptive, humoral and cellular immunity; structure and functions of immune cells - T cells, B cells, macrophages, NK cells and dendritic cells, granulocytes, mast cells. Primary and secondary lymphoid organs; Clonal selection theory; Immunological memory; Structure and properties of antigens: Types of antigens, specificity, Haptens and adjuvants- structure and properties; Immunoglobulins: Structure and properties, types and subtypes. Antibody production: Polyclonal and **monoclonal**, Complement system – component, properties and functions. Complement pathways and biological significance.

Module II: Immune Responses

13hours

Primary and secondary immune responses, lymphocyte migration, homing and trafficking, immunoglobulin genes: organization and assembly; generation of immunological diversity; Major histocompatibility complex (MHC); structure and organization of MHC Class I and Class II molecules; HLA response; T-cell receptor; antigen processing, antigen presentation; products and factors produced by T-cell activation; dendritic cells; cytokines (interleukins and interferons) and chemokines; B & T cell development and regulation, B cell activators; B-cell and helper T-cell subset interactions; cytotoxic T-cell mediated killing.

Module III: Immune-Mediated Diseases and Transplantation

13hours

Autoimmune diseases- Insulin dependent diabetic mellitus, Systemic lupus erythematosus, Rheumatoid arthritis, Myasthenia gravis and their treatment; Immune response to infectious diseases; viral, bacterial and protozoal infections; H1N1; immune response to cancer; hypersensitivity reactions - types (I, II, III, and IV), symptoms, immunodiagnosis. Tissue transplantation-Tissue typing methods for tissue and organ transplantations, Graft versus host reaction and rejection, xenotransplantation, tolerance.

Module IV: Immunological Techniques and Vaccines

13hours

Immunoprecipitation; Agglutination; Immunoelectrophoresis; RIA; Immunofluorescence; Cytotoxicity assay; flow cytometry; ELISPOT; ELISA; RIA Western blotting; Hybridomas and their production.

Vaccines: Active and passive immunization, Immunization protocol. conventional vaccines- live vaccines, killed vaccines, toxoids, antisera, polysaccharide vaccines. novel vaccines- subunit and peptide vaccines, DNA vaccines, recombinant vaccines, edible vaccines. Common immunization programmes- BCG, small pox, DPT, polio, measles, Hepatitis-B.

REFERENCES:

1. Abbas & Lichtman & Pillai (2014) Cellular and Molecular immunology, 8th edition, Elsevier publisher
2. Bernhard Palsson and Sangeeta N Bhatia, Tissue Engineering, 2nd Edition, Prentice Hall, 2004.
3. C. Vaman Rao. (2012), An Introduction to Immunology. 2nd edition, Narosa publishing house
4. Ian Tizard R. (2013). Immunology, 9th edition, Elsevier publisher.
5. K.M. Pavri. 1996, Challenge of AIDS, 2nd edition, National Book Trust, India.
6. Kuby J, Judy Owen, Jenni Punt, Sharon Stranford (2013). Immunology. 7th Edition. W.H. Freeman and Company.
7. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Springer, 2008.
8. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt (2011). 12th edition, Essential Immunology, ELBS, Blackwell Scientific Publishers, London
9. William E Paul (2012). Fundamentals in Immunology. 7th edition, Raven Press. NY .

SEMESTER/YEAR	: III SEM
COURSE CODE	: 17MMB303
TITLE OF THE COURSE	: INDUSTRIAL MICROBIOLOGY
L: T/A: P: C	: 4: 1: 0: 5

Total Credit Hours – 52 hours

Module I: Introduction to Industrial Microbiology **13hours**

Concepts and scope of microbes in industry. Modern era of industrial fermentation technology. Pre-requisite of industrial microorganisms: Screening, isolation, identification and characterization of industrially important microbes. **Strain improvement**- mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centers.

Module II: Fermentation Process **13hours**

Basic components, design and scale-up of fermenters – Typical fermentor. Types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. **Types of fermentation** - Microbial growth in batch fermentor and chemostat. Other types like surface, submerged and solid state fermentation. Different parameters affecting fermentation - pH, temperature, dissolved oxygen, foaming and aeration.

Module III: Upstream and Downstream Processing **13hours**

Upstream processing: Formulation of fermentation media, rheology of fermentation media, Nutrients: growth factors, carbon, nitrogen, energy and mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization; culturing techniques of microbial strains; inoculum preparation and inoculum development.

Downstream processing: Steps in recovery and purification of fermented products. Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid-Liquid extraction, Solvent recovery, Supercritical fluid extraction, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing. Effluent treatment.

Module IV: Industrial Bioprocessing **13hours**

Industrial alcohol production and organic acids (citric acid), Non-alcoholic beverages (coffee, tea), food additives, biopolymers (dextran, alginate), biosurfactants, lipids & oils. Enzymes: Production of Amylases-Fungal and Bacterial Amylase. Amino acid production- L-Glutamic acid and L-lysine. Industrial production of health care product:

Vaccines (Hepatitis B) and hormones (human insulin), antibiotic (Penicillin and Streptomycin). Applications of genetic engineering in industrial bioprocessing.

Production economics and IPR: Concept of Patenting law, Copyrights, and Trademarks.

Patent regulations and filing, processes, products and microorganisms.

REFERENCES:

1. Bailey and Ollis (1996) "Biochemical Engineering Fundamentals", McGraw Hill(2nd Ed.).
2. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
3. Dubey, R.C. (2006) "A Textbook of Biotechnology" S.Chand and Co. Ltd.
4. McNeil B and Harvey LM. Fermentation. A Practical Approach, IRL press, New York.
5. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
6. Robert Mellor (2009) Entrepreneurship for Everyone: A student Textbook. SAGE Publication
7. Satyanarayana, U (2005). "Biotechnology" Books and Allied (P) Ltd. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
8. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
9. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
10. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.

SEMESTER/YEAR	: III SEM
COURSE CODE	: 17MMB322
TITLE OF THE COURSE	: APPLIED MICROBIOLOGY
L: T/A: P: C	: 4: 1: 0: 5

(Departmental Elective - 2)

Total credit hours: 52hours

Module 1: Food and Dairy Microbiology **13 hours**

Food as a substrate for microorganisms, spoilage of fruits, vegetables, meats and dairy products. Food preservation, examination, standards for food and milk production. Microbial and Fermented foods- fermented vegetables, meats, beverage and dairy products. Probiotics, prebiotics, synbiotics and nutraceuticals. Quality control and their regulation, HACCP.

Module 2- Environmental Microbiology **13hours**

Aerobiology- Significance of microorganisms in air, air spora in different layers of atmosphere, bioaerosol. Microbiology of indoor and outdoor environment. Air samplers and control of air borne microorganisms.

Aquatic Microbiology- Natural waters, microbial flora of aquatic environment, pollution and water borne diseases. Municipal treatment of drinking and waste water. Water quality assays and public health.

Soil Microbiology- Soil profile, soil microorganisms, microbial interactions in soil. Bioaccumulation, biomagnification biodegradation and bioremediation. Bioleaching of Minerals.

Module 3: Industrial and Agricultural Microbiology **13hours**

Industrial Microbiology – Industrially important microorganisms, preservation and strain improvement, design and types of fermenters, upstream and downstream processing, production of beverages, antibiotics, organic acids, and enzymes .

Agricultural Microbiology- Concepts and scope of agricultural microbiology, biofertilizers and biopesticides. Plant diseases, plant defence mechanisms and disease control.

Module 4- Clinical Microbiology and Microbial Biotechnology **13hours**

Clinical Microbiology- Disease epidemics, Role of Microbiologist in diagnostic laboratory, General concepts for specimen collection, handling, processing, laboratory safety and infection control. Disease diagnosis - Microscopic examination, growth and biochemical characteristics, rapid methods of identification.

Microbial Biotechnology: Introduction to microbial biotechnology, applications of microbial biotechnology in the field of medicine, industry, agriculture and environment.

References

1. Alexander M (2000) Introduction to soil microbiology, John Wiley and Sons Inc. N.Y.
2. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
3. Bhatia A.L. Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009
4. Brock T.D and Madigan M.T. (1992) Biology of Microorganisms 6th edition. Prentice Hall, Eagle wood cliffs N.J.
5. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
6. Credric A. Mims (2004) Medical Microbiology 3rd edition Mostly Inc.
7. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press.
8. Fritz H. Kayser (2005) .medical microbiology, TR hiemeVerlag.
9. Grant W.D and Long P.E.Environmental Microbiology. Kluwer Academic Publishers, 1981.
10. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
11. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
12. James M.J Martin, J. Loessner and David, A.G. (2006) Modern food microbiology (7thEds)
13. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
14. Microbiology by MJ PelczarJr, ECS Chan, NR Krieg 5th edition, Pub: Tata Megra Hill Publishing Co Ltd.
15. Norman G Marriott, (1995). Principles of Food Sanitation, 4th Edition, (Chapman and Hall Food Science Book). Aspen Publishers Inc.
16. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science Publishers.
17. Robert L Tate, Soil Microbiology, 2nd Edition, John Wiley and Sons.
18. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesy, Gary Sayler (1998) Techniques in Microbial Ecology, Oxford University Press. New York.
19. T.J Montville and K Wikowski, Eds: M.P., Doyle, L.R. Beuchat and T.J., Montville, (Eds). 1997. Fundamentals and Frontiers. ASM Press, Washington DC.

SEMESTER/YEAR	: III SEM
COURSE CODE	: 17MMB371
TITLE OF THE COURSE	: MEDICAL MICROBIOLOGY AND IMMUNOLOGY
L: T/A: P: C	: 0: 0: 8: 4

(PRACTICALS)

1. Isolation and identification of normal microflora on simple, selective and enrichment media (throat, skin, sputum, nasal and urine sample).
2. Effect of antiseptics on normal microbial flora of hands.
3. Dental caries susceptibility assay by Snyder's agar test
4. Isolation and identification of fungal infections (skin, nail and hair sample).
5. Isolation and identification of nosocomial pathogens
6. Study of blood smear by Giemsa's/ Leishman's staining technique.
7. Study of *M. tuberculosis* by Ziehl-Neelsen (acid fast) staining .
8. Determination of MIC - T- test, Checker board method.
9. Drug susceptibility assay for susceptibility and resistance of antibiotics by Kirby-Bauer method.
10. Isolation of lymphocytes from peripheral blood
11. Serum separation and serological reactions:
 - a. Agglutination - Blood grouping and Rh typing
 - b. Precipitation reactions:
 - i. Ouchterlony Double Diffusion,
 - ii. Radial Immune Diffusion
 - iii. Rocket Immuno electrophoresis
12. Enzyme linked immunosorbant assay / Dot ELISA
13. Purification of IgG by column chromatography
14. WIDAL Test.
15. VDRL Test (RPR).

SEMESTER/YEAR	: III SEM
COURSE CODE	: 17MMB372
TITLE OF THE COURSE	: INDUSTRIAL MICROBIOLOGY
L: T/A: P: C	: 0: 0: 8: 4

(PRACTICALS)

1. Demonstration of a fermenter and its types.
2. Preservation techniques of industrially important microorganisms – soil, glycerol, mineral oil and lyophilisation.
3. Production and estimation of amylase from microbial sources.
4. Production of organic acids(lactic acid and citric acid) from microbes.
5. Immobilization technique: whole cell or enzyme- sodium alginate gel method.
6. Production of antibiotic (penicillin) by submerged and solid substrate fermentation.
7. Laboratory scale production of wine.
8. Estimation of alcohol from different sources by specific gravity method.
9. Alcoholic fermentation and determination of total acidity and non-reducing sugars
10. Detection and quantification of pigment from microbes: Melanin.
11. Detection and quantification siderophore produced by *Pseudomonas* spp.
12. Microbial assay of vitamin B12 and Glutamic acid
13. Sterility tests for pharmaceutical products

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MMB401

TITLE OF THE COURSE : AGRICULTURAL MICROBIOLOGY AND HYTOPATHOLOGYL:
T/A: P: C : 4:1: 0:5

Total Credit Hours – 52 hours

Module I: Plant-Microbe Interactions 13hours

Distribution of microorganisms in soil, **Soil fertility evaluation and improvement.** **Role of microorganisms in soil fertility.** Decomposition of organic matter by microorganisms: cellulose, hemicellulose, lignin, xylan and pectin. Biological nitrogen fixation: Symbiotic nitrogen fixation, (Rhizobium, Frankia), non-symbiotic nitrogen fixation (Azotobacter, Azospirillum). **Concepts of Siderophores and VAM** with suitable examples. Application of nitrogen fixing genes in rDNA technology in agriculture research.

Module II: Bioinoculants And Biological Control 13hours

Bioinoculants: Biofertilizer - types, production and quality control. Cultivation and mass production of bioinoculants- Azotobacter, Rhizobium, Azospirillum, Cyanobacteria, **phosphate solubilising microorganisms**, Azolla. Carrier-based inoculants – production, applications and limitations.

Biopesticides: Types and mechanism of application of different varieties. Examples includes Pseudomonas fluorescens, Bacillus thuringiensis, Trichoderma harzianum, Trichoderma virididis, Nuclear Polyhedrosis Virus. Production, applications and limitations.

Module III: Host Pathogen Interaction And Defense Mechanism 13hours

Host Pathogen Interaction: Infectious diseases, non-infectious diseases, Kochs' postulates. Parasitism and disease development: Parasitism and pathogenicity, Host range of pathogens, Disease triangle, Diseases cycle / Infection cycle, Relationship between disease cycles and epidemics; Mode of entry into the host plant – Mechanical forces, Microbial enzymes, toxins and growth regulators.

Defense Mechanisms: Plant Disease Pre-existing structural and chemical defenses. Induced structural (histological-cork layer, abscission layer, tyloses, gums) and biochemical defenses (hypersensitive response), systemic acquired resistance phytoalexins, pathogenesis related (PR) proteins, plantibodies

Module IV: Plant Diseases And Their Management 13hours

Plant diseases - Red rust of tea and Algal Leaf Spot (Algae), Grain and head smut of Sorghum, tikka disease of ground nuts, red rot of sugarcane and wilt of tomato (Fungi), Root knot of mulberry and lesion nematode disease (Nematode). Tobacco mosaic disease and Papaya

ring spot (Virus), Sandal Spike Disease and grassy shoot of sugarcane (Mycoplasma), Bacterial blight of Paddy, Citrus canker and fire blight of apple (Bacteria).

Plant disease control: Classification of plant diseases and plant diseases control. Principles and methods in disease control – Legislative methods (quarantine, crop certification), cultural methods (host eradication, crop rotation, and sanitation), soil and sand treatment (Controlling water flow, adding fertilisers, filtering water.), biological control (Suppressive soil and microbial antagonism) and chemical control (fungicides) Control through resistant varieties and quarantine. Plant disease epidemics and forecasting, plant clinic and plant doctor concept. Diagnosis of plant diseases, regulatory, **farming education and awareness.**

References

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.
2. Alexopoulos C.J and Mims C.W., Introductory Mycology, New Age International, New Delhi.
3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. Plant Pathology, Fifth Edition, Elsevier Academic Press, 2005.
5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbaroa N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.
7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
8. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
9. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press.
10. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.
11. Jabir Singh. Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
12. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science Publishers.
13. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
14. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
15. Robert L Tate, Soil Microbiology, 2nd Edition, John Wiley and Sons.
16. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.

17. Grant W.D and Long P.E. Environmental Microbiology. Kluwer Academic Publishers, 1981.
18. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
19. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
20. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MMB421
TITLE OF THE COURSE : CLINICAL MICROBIOLOGY
L: T/A: P: C : 4:1: 0:5

(Inter Departmental Elective - 1)

Total Credit hours: 52 hours

Module 1- Host Pathogen interaction and disease epidemics 13hours

Normal microbial flora of human body and its significance, infection and disease. Pathogens, pathogenicity and virulence. Koch's Postulates. Infectious and Non infectious diseases. Emerging and reemerging pathogens. Entry of pathogen into human host, portals of entry. Mechanism of microbial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urinogenital tracts. Exotoxins and Endotoxin. Epidemiology- Diseases in population, epidemiological studies, reservoirs of infection, modes of disease transmission, herd immunity and public health organizations.

Module 2: Infectious Diseases of Human Organ Systems 13hours

Etiology, Epidemiology, Pathogenicity, Diagnosis, and prophylaxis of the following diseases of the skin and eyes, urogenital diseases, disease of respiratory systems, oral & gastrointestinal diseases and wound infections. Cardiovascular, lymphatic diseases, zoonoses and vector transmission of human disease. Air, food and waterborne disease transmission. Immunization, Antimicrobial chemotherapy and drug resistance.

Module-3- Hospital acquired Infections (Nosocomial Infections) 13hours

Common types of hospital infection, diagnosis and control of hospital infection. Prevention of common hospital acquired infections, maintenance of hospital, surroundings and intravascular & indwelling devices. Role of the healthcare staff in infection control, restrictions in hospitals. Needle Stick Injury, vaccination of healthcare workers. Biosafety in biological laboratories.

Module 4- Diagnosis and Biomedical waste management. 13hours

Collection, transport, processing and storage of biological specimens. Care and handling of pathogens, biological materials and disposal. Laboratory Diagnosis of Infectious Diseases- bacterial, parasitic, viral and fungal diseases. Principles and applications of microscopic, microbiological, biochemical, immunological and molecular diagnostic methods. Recent advancements in disease diagnosis – scanning techniques and rapid identification systems. Regulations and accreditation of medical laboratories. Biomedical Waste, classification, types and treatment.

References-

1. Ananthanarayan and Panikar, Textbook of Microbiology for Nurses, University Press.
2. Brock T.D and Madigan M.T. (1992) Biology of Microorganisms 6th edition. Prentice Hall, Eagle wood cliffs N.J.
3. Fritz H. Kayser (2005), Medical Microbiology. ThiemeVerlag.
4. Jacquelyn G. Black, Larry M.L Lewis (2009). Microbiology, Principles and Exploration 6th Edition Wiley, John and Sons.
5. Jenson, Wright, Robinson (1997), microbiology for the Health Sciences 4th edition, Prentice hall.
6. Kufe, et al., (2003), Cancer Medicine, BC Decker Inc.
7. Leslic Collier, John Oxford (2000). Human virology a text book for students of medicine, dentistry and microbiology (2nd edition). Oxford University Press.
8. Mackie and McCartney (1996) Medical microbiology vol 1, Medical infection. Vol 2, practical medical microbiology, Churchill Livingstone.
9. Mackie and McCartney (1996) Medical Microbiology. Vol2, practical medical microbiology, Churchill Livingstone.
10. Madigan, Martinko, Dunlap, Clark. (2009). Brock Biology of Microorganisms, Twelfth Edition, Benjamin Cummings.
11. Marjorie Cowan, Kathleen Park Talaro (2009). Microbiology: A Systems Approach. 2nd Edition. The McGraw/Hill.
12. Nester, Roberts, Pearsall Anderson (1998). Microbiology-A Human Perspective, 2nd edition, McGraw-Hill.
13. R Connie R Mahon (2010). Textbook of Diagnostic Microbiology. 3rd edition. Pearson.
14. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesey, Gary Sayler (1998) Techniques in Microbial Ecology, Oxford University Press. New York.
15. Wadher and Bhoosreddy (2005) Medical microbiology. Himalaya Publisher.
16. Warren Levinson (2000) Medical Microbiology and immunology examination and board review (8th edition) McGraw Hill.
17. Warren Levinson (2000) Medical Microbiology and Immunology: Examination and Board Review 8th Edition. McGraw Hill.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MMB422
TITLE OF THE COURSE : MICROBIAL BIOTECHNOLOGY
L: T/A: P: C : 4:1: 0:5

(Inter Departmental Elective - 2)

Total Credit Hours – 52 hours

Module 1: History and Advancements in Microbial Biotechnology **13 hours**

Introduction to microbial biotechnology, principle, applications, economics and milestones in microbial technology. Manipulation of gene expression in prokaryotes – use of strong and regulatable promoters, fusion proteins, unidirectional tandem gene arrays. Recombinant protein production in eukaryotes – *S. cerevisiae* expression systems, Baculo virus expression vector system, mammalian cell expression vectors. Directed mutagenesis and protein engineering.

Module 2: Applications of Microbial Biotechnology –I **13 hours**

Molecular Diagnostics: Immunological diagnostics, monoclonal antibodies, DNA diagnostic systems – diagnosis of Malaria, *Trypanosomacruzi*, molecular diagnosis of genetic diseases – Sick cell anemia.

Microbial Production of Therapeutic Agents: Interferons, human growth hormone, antibody production in *E. coli*. Vaccines: peptide vaccines, vector vaccines. Antibiotics: Polyketide antibiotics. Single cell proteins.

Module 3: Applications of Microbial Biotechnology –II **13 hours**

Biosynthesis of biopolymers: Xanthan gum, animal adhesive biopolymers, rubber, polyhydroxyalkonates. Bioremediation and Biomass utilization: Degradation of xenobiotics, utilization of starch and cellulose. Plant growth promotion: Nitrogen fixation, nitrogenase, nodulation, biocontrol: siderophores, ice nucleation and antifreeze proteins. Microbial insecticides: *B. thuringiensis* and *Baculoviruses*. Brief account on transgenic plants, transgenic animals and human gene therapy

Module 4: Nanotechnology, Bioethics and Biosafety **13 hours**

Introduction, tools of nanosciences, synthesis of nanomaterials using microbes. Biopolymeric nanoparticles; nanosensors, biomedical applications, antimicrobial nanoparticles.

Introduction to Bioethics and biosafety, yeast genome project: its ethical, legal and social implications. Biosafety guidelines and regulations for Genetically Modified Microorganismss, GLP and GMP. Labelling of GM products. Ethics and safety of GM food.

References:

1. Anthony JF Griffiths, William M Gelbart, Jeffrey H Miller, and Richard C Lewontin (1999) Modern Genetic Analysis (1st Ed.) W. H. Freeman Publishers. NY.
application of recombinant DNA. ASM Press.
2. Benjamin Lewis, (2004) Genes VIII (3rd Ed.) Oxford University & Cell Press, NY.
3. Bernard, R.G. and Jack, J.P. (2003). Molecular Biotechnology: principles and
4. Brown T.A. (2009). Genome 3. Tylor and Francis.
5. Genetically Modified Crops. Wiley Dreamtech India.
6. Glick B.R and Pasternak J.J. (2010), Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
7. Glover D.M and Hames. B.D, (1996), DNA Cloning. A Practical Approach. 4-volume
8. Howe C. (1995). Gene Cloning and Manipulation. Cambridge University Press.
9. K., Adrian, M. and John W. (2000). Recombinant DNA and Biotechnology.
10. Nigel Halford. (2006). Plant Biotechnology: Current and Future Applications of
11. Old and Primrose. (1994). Principles of Gene Manipulation, Blackwell Scientific
12. Pierre Baldi G, Wesley Hatfield, (2002). DNA Microarrays and Gene Expression: From Experiments to Data Analysis and Modelling. Cambridge University Press.
13. Primrose, S. B. Twyman, P.M. and Old, R. W. (2001) Principles of gene manipulation Publications. (6th Ed.). Blackwell publishers.
14. Sambrose and Russell. (2001), Molecular Cloning. 3 volumes. CSH Lab Pres. Hellen, set. OUP.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MMB471
TITLE OF THE COURSE : AGRICULTURE MICROBIOLOGY AND PHYTOPATHOLOGY
L: T/A: P: C : 0:0: 8:4

(PRACTICALS)

1. Isolation of cellulose, hemicelluloses, lignin, xylan and pectin degrading microbes.
2. Isolation and enumeration of bacteria and fungi from rhizosphere soil.
3. Examination of bacteriodes from legume root nodules
4. Isolation of symbiotic and nonsymbiotic nitrogen fixing microorganisms
5. Isolation of phosphate solubilising bacteria and fungi-plate method.
6. Isolation of bioinoculants: *Bacillus thuringiensis*, *Bauveriabassiana*, *Trichoderma*, *Pseudomonas*.
7. Assay of bio fertilizers (seed treatment, seedling, inoculation and measurement of root and shoot length).
8. Seed health testing by standard moist blotter (SBM).
9. Effect of seed borne fungi on seed germination and seed vigour.
10. Effect of fungicides on fungal spore germination inhibition.
11. Mass multiplication techniques of Azolla.
12. Isolation and identification of Nostoc in Azolla (from paddy field).
13. Estimation of total phenols in diseased and healthy plant tissues.
14. Sample collection and Identification of following disease:
Tobacco mosaic disease, Sandal spike, Bacterial blight of paddy, Red rust of tea and Mango, Grain and Head smut of Sorghum, Wilt of Tomato, Root Knot of Mulberry, tikka disease of ground nuts and red rot of sugarcane.
15. Quality control assessment of biofertilizers (vialibity and shelf life).
16. Study of liquid and solid carrier material.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MMB471

**TITLE OF THE COURSE : AGRICULTURE MICROBIOLOGY AND
PHYTOPATHOLOGYL: T/A: P: C : 0:0: 8:4**

(PRACTICALS)

1. Isolation of cellulose, hemicelluloses, lignin, xylan and pectin degrading microbes.
2. Isolation and enumeration of bacteria and fungi from rhizosphere soil.
3. Examination of bacteriodes from legume root nodules
4. Isolation of symbiotic and nonsymbiotic nitrogen fixing microorganisms
5. Isolation of phosphate solubilising bacteria and fungi-plate method.
6. Isolation of bioinoculants: *Bacillus thuringiensis*, *Bauveriabassiana*, *Trichoderma*, *Pseudomonas*.
7. Assay of bio fertilizers (seed treatment, seedling, inoculation and measurement of root and shoot length).
8. Seed health testing by standard moist blotter (SBM).
9. Effect of seed borne fungi on seed germination and seed vigour.
10. Effect of fungicides on fungal spore germination inhibition.
11. Mass multiplication techniques of Azolla.
12. Isolation and identification of Nostoc in Azolla (from paddy field).
13. Estimation of total phenols in diseased and healthy plant tissues.
14. Sample collection and Identification of following disease:
Tobacco mosaic disease, Sandal spike, Bacterial blight of paddy, Red rust of tea and Mango, Grain and Head smut of Sorghum, Wilt of Tomato, Root Knot of Mulberry, tikka disease of ground nuts and red rot of sugarcane.
15. Quality control assessment of biofertilizers (viability and shelf life).
16. Study of liquid and solid carrier material.

SEMESTER	II					
YEAR	I					
COURSE CODE	20MMB5201					
TITLE OF THE COURSE	PROKARYOTIC AND EUKARYOTIC MICROBIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To understand microbial diversity, classification, structure of different groups of microbes and their functions
- To strengthen the knowledge on cell and cellular organisation of prokaryotic and eukaryotic systems
- To know about the economic importance

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
C01	Enable students to relate the principles in classifying microbes	L3
C02	Apply the knowledge in identifying different microorganisms and to study their life cycles	L3
C03	Elucidate the role of beneficial and harmful effects	L5

COURSE CONTENT:

MODULE 1: BIOLOGY OF VIRUS	13Hrs
Difference between prokaryotic and eukaryotic microorganisms. Discovery, distinctive properties, morphology and ultra-structure of Virus, Classification, Cultivation and Purification assay of virus. Bacteriophages - structural organization and life cycle - lytic, lysogenic. Application of viruses. Type studies: Bacteriophages (T4 and λ phage), animal viruses (Polio) and plant viruses (TMV), (Ultra-structure, replication and importance). Viral related agents - viroid and prion.	
MODULE 2: BIOLOGY OF BACTERIA	13Hrs
Bacteriology: Ultrastructure of bacterial cell, Cell morphology, size, shape and arrangement; flagella, pili, capsule, cell wall, cell membrane, cytoplasm. Intracytoplasmic inclusions: nucleoid, plasmids, transposons, gas vacuoles, cellulosomes, carboxysomes, magnetosomes, phycobilisomes, parasporal crystals, reserved food materials (metachromatic granules, polysaccharide granules, polyhydroxybutyrate granules, glycogen, oil droplets, and sulphur globules), endospores and exospores. Reproduction in bacteria. Special forms of bacteria: Actinomycetes, Spirochetes, Rickettsia, Chlamydiae, Archaeobacteria and extremophiles. Microbial growth and nutrition: Over view of cell Growth, Phases of growth, Generation time; Growth Kinetics; Physical conditions required for growth; Nutritional uptake, nutritional factors required for growth and reproduction. Classification of microorganisms based on environmental and nutritional requirements.	
MODULE 3: BIOLOGY OF FUNGI & PROTOZOA	13Hrs
General characteristics of fungi including habitat, classification, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal cell wall structure and synthesis, Sex and mating in fungi fungal spores – dormancy and dispersal. Type studies: <i>Aspergillus, Saccharomyces, Pythium, Rhizopus, Fusarium, Puccinia</i> and <i>Agaricus</i> (Classification, Ultrastructure, reproduction, lifecycle, importance). General features of Protozoa, classification. Structure, reproduction and significance of: <i>Leishmania, Amoeba, Entamoeba</i> and <i>Plasmodium</i>. Cultivation of protozoa.	

MODULE 4: BIOLOGY OF ALGAE	13Hrs
General characteristics of Algae, occurrence, thallus organization, classification, ultra-structure of cell , vegetative, asexual and sexual reproduction. Algal life cycles- Haplontic, Diplontic, Diplohaplontic, Haplobiontic, and Diplobiontic type, Isolation from soil and water; Algal cultivation , measurement of algal growth. Structure and life cycle of <i>Chlamydomonas</i>, <i>Spirogyra</i>, <i>Diatoms</i>, <i>Sargassum</i> and <i>Porphyra</i> . Symbiotic algae: Lichens . Economic importance of algae.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. Sambamurty, A.V.S.S.. A Textbook of Algae. I.K. International Publishing. (2005).
2. Alexopoulos, C. J. and Mims, C.W. Introduction to Mycology, Wiley.(2001)
3. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1986.
4. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.

REFERENCES :

1. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press. 2005
2. Tortora, Funke and Case. Microbiology, 9th Edition. Benjamin Cummings. 2009

SEMESTER	II					
YEAR	I					
COURSE CODE	20MMB5202					
TITLE OF THE COURSE	MICROBIAL PHYSIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To learn the fundamentals of molecular microbial physiology such as microbial structure, energetics, metabolism and genetics
- To understand antimicrobial resistance, differentiation, and ecology of microbes with respect to their genotype as well as phenotype

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand the complexity of microbial structures, genetics and metabolism.	L2
CO2	Enable to grasp the mechanisms of various interactions that exist between the microbes, microbes and higher forms of life/environment	L4

COURSE CONTENT:

MODULE 1 : MICROBIAL METABOLISM	13Hrs
Carbohydrate and Protein Metabolism: Glycolysis, Entner – Doudoroff. TCA cycle, Gluconeogenesis, Transamination, oxidative deamination, decarboxylation, Urea cycle. Brief account of porphyrins. Photosynthesis: Photosynthetic microorganisms, photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria. Carbon dioxide fixation pathways, Methanogenesis. Fermentation: Alcohol fermentation, Lactic acid: Homo- and Heterolactic acid fermentation; Acetic acid, butyric acid, mixed acid and propionic acid fermentation. Fungal and bacterial secondary metabolism: Brief account on biosynthesis and action of secondary metabolites antibiotics, bacterial and fungal toxins, pigments, fungal hormones. Bioluminescence – mechanism and significance.	
MODULE 2: ENZYMOLOGY	13Hrs
Enzymes: Definition, classification, nomenclature, specificity, active sites, coenzymes, activators and inhibitors, activity unit-prosthetic groups. Effect of temperature, pH and substrate concentration on reaction rate. Isozymes, Enzyme Kinetics and co-enzyme action Enzymes kinetics: Michaelis-Menten equation for simple enzymes, Determination of kinetic parameters, hyperbolic and LB plot. Regulation of enzymes: Covalent and noncovalent modification; Enzyme inhibition - types of inhibitors - competitive, noncompetitive and uncompetitive. Ribozymes and abzyme.	
MODULE 3: MICROBIAL RESPIRATION AND BIOENERGETICS	13Hrs
Introduction: Principles of thermodynamics, high energy compounds- ATP, NAD, FAD, FMN, quinones, components and mechanisms of respiratory chain. Bacterial aerobic respiration: Components of electron transport chain, free energy changes and electron transport, oxidative phosphorylation, structure of bacterial ATPase.	

Theories of ATP formation, generation and maintenance of PMF and inhibition of electron transport chain. Electron transport chain in heterotrophic and chemolithotrophic bacteria. **Anaerobic respiration:** Introduction. Nitrate, carbonate and sulfate as electron acceptors. Electron transport chains in some anaerobic bacteria.

MODULE 4 : MICROBIAL CELL MEMBRANE PHYSIOLOGY

13Hrs

Metabolite transport: Methods to study diffusion of solutes in bacteria, passive diffusion,

facilitated diffusion, different mechanisms of active diffusion (PTS, role of permeases in

transport, different permeases in E. coli. Transport of aminoacids and inorganic ions in microorganisms (Bacteria and fungi) and their mechanisms.

Stress physiology: Osmotic stress and osmoregulation by glutamate and disaccharide trehalose, Osmotic Control of Gene Expression. Aerobic to anaerobic transitions in facultative microorganisms (E. coli); **Oxidative stress** - superoxide dismutase and catalase, Regulation of the Oxidative Stress Response, pH stress and acid tolerance; Thermal stress and heat shock response (genes); Nutrient stress and starvation stress, stringent Control.

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. No

2. No

TEXT BOOKS :

1. Moat, A.G. and Foster, W.2002. Microbial Physiology, Fourth Edition, John Wiley and Sons, New York.
2. Byung Hong Kim and Geoffrey Michael Gadd. (2008). Bacterial Physiology. Cambridge
3. Donald Voet and Judith G. Voet, 2011. Biochemistry. Third Edition, John Wiley and Sons, Inc. New York.

- 4 Stryer, L. 2010. Biochemistry, Seventh Edition, W.H. Freeman and Company, New York.

REFERENCES :

1. Arora, D.K. and Seema Gupta (1996). Bacterial Physiology. Anmol Publications. New Delhi.
2. Caldwell. D.R. (1995). Microbial Physiology and metabolism, Brown Publishers.

YEAR	I					
COURSE CODE	20MMB5271					
TITLE OF THE COURSE	PROKARYOTIC, EUKARYOTIC AND MICROBIAL PHYSIOLOGY - LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	6	0	-	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To make students learn and identify microbes based on biochemical tests
- To estimate biomolecules by quantitative and qualitative methods

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be equipped with microbial isolation and identification techniques	L2
CO2	Knowledge of estimating biomolecules and enzyme kinetic studies will be imparted.	L1

List of Laboratory/Practical Experiments activities to be conducted (if any):	
1.	Isolation and culturing of fungi (yeasts and molds) by Dilution plate method, Warcup method implant and impression.
2.	Anaerobic culturing methods – anaerobic jar and its use, thioglycollate media culturing.
3.	Isolation and identification of microscopic algae from soil and water.
4.	Isolation and identification of protozoa from soil and water.

5.	Biochemical test: Catalase, Oxidase, IMViC, starch, casein and Gelatin hydrolysis, Hydrogen sulfide production in TSIA, Identification of bacteria by API methods.
6.	Growth measurement of bacteria (turbidity method) and fungi (Linear method).
7.	Estimation of DNA and RNA.
8.	Estimation of proteins
9.	Estimation of enzyme activity – amylase and protease.
10.	Enzyme kinetics – K_m and V_{max} of amylase

TEXT BOOKS :

1. Arora, D.K. and Seema Gupta (1996). Bacterial Physiology. Anmol Publications. New Delhi.
2. Caldwell. D.R. (2095). Microbial Physiology and metabolism, Brown Publishers.

REFERENCES :

SEMESTER	III					
YEAR	II					
COURSE CODE	20MMB5301					
TITLE OF THE COURSE	IMMUNOLOGY AND MEDICAL MICROBIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	1	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MMB5201	PROKARYOTIC AND EUKARYOTIC MICROBIOLOGY

COURSE OBJECTIVES :

1. Demonstrate an understanding at an advanced level of microbial virulence mechanisms and host response to infection.
2. To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
C01	To introduce and describe the classification, structure, classification and physiology of bacteria that infect humans.	L3
C02	To introduce the classes of antibiotics and the resistant mechanisms encoded in bacteria and to neutralise these antimicrobial agents.	L3
C03	To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories.	L4
C04		L3
C05		L2

COURSE CONTENT:

MODULE 1: Immune System and Immune Responses	13Hrs
Innate, adaptive, humoral and cellular immunity. Primary and secondary immune responses. Structure and properties of antigens: Types of antigens, specificity, Haptens and adjuvants- structure and properties; Immunoglobulins: Structure and properties, types and subtypes. Immunoglobulin genes: organization and assembly. Major histocompatibility complex (MHC); structure and organization of MHC Class I and Class II molecules. T-cell receptor; B and T cell activation. Antigen processing, antigen presentation, Complement system – pathways, component,	

properties and functions. Immune response to cancer. Hypersensitivity reactions - types (I, II, III, and IV).	
MODULE 2: Autoimmune Disorders, Transplantation and Pathogenic Diseases	13Hrs
Autoimmune diseases- Insulin dependent Diabetic mellitus, Rheumatoid arthritis, Myasthenia gravis and their treatment. Tissue transplantation- Graft versus host reaction and rejection, xenotransplantation, tolerance. Host Microbe Relationship- Normal microbial flora of human body and its significance. Koch's Postulates. Mode of entry of pathogen into human host. Infections and its types- nosocomial infections and non-infectious diseases. Immune response to infectious diseases; viral, bacterial, fungal and protozoal infections (Hepatitis, HIV, <i>Mycobacterium tuberculosis</i>, <i>Salmonella typhi</i>, <i>Tricophyton</i> spp., <i>Candida albicans</i>, <i>Plasmodium vivax</i>, <i>Entamoeba histolytica</i>).	
MODULE 3: Immunological Techniques and Diagnostic Microbiology	13Hrs
Techniques- Immunoprecipitation; Agglutination; Immuno-electrophoresis; RIA; Immunofluorescence; Cytotoxicity assay; flow cytometry; ELISPOT; ELISA; RIA, Western blotting; Tissue typing methods for tissue and organ transplantations. Polyclonal and monoclonal antibodies. Hybridomas and their production. Diagnostic Microbiology: Collection, transport and storage guidelines; biosafety in diagnostic laboratory and regulations, specific procedures for collection of specimens, processing of specimens. Biomedical waste management and treatment.	
MODULE 4: Vaccines and Antimicrobial Prophylaxis	13Hrs
Vaccines: Active and passive immunization, Immunization protocol. Conventional vaccines, live vaccines, killed vaccines, toxoids, antisera, polysaccharide vaccines. Novel vaccines subunit and peptide vaccines, DNA vaccines, recombinant vaccines, edible vaccines. Common immunization programmes- BCG, Small pox, DPT, Polio, Measles, Hepatitis-B. Antimicrobial Prophylaxis: Antibiotics, Classification of Antimicrobial agents, Mechanism of drug action-antibacterial, antiviral, antifungal and anti-protozoans-causes, mechanism and prevention. Probiotics as therapeutic agents.	

TEXT BOOKS :

REFERENCES:

1. Anathnarayana and Panikar (2013) Text Book of Microbiology, 9th Edition. University press.
2. Richard A, Goldsby, Thomas J, Kindt, Barbara A and Osborne (2000). Kuby Immunology. 4th Edition. W.H. Freeman and Company, New York.
3. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York.
4. Warren Levinson (2000) Medical Microbiology and Immunology, Examination and Board Review. 8th Edition. McGraw Hill.
5. Tortora, Funke, Case (2009) Microbiology, 9th Edition. Benjamin Cummings.
6. Connie R Mahon (2010) Text book of diagnostic Microbiology. 3rd edition, Pearson.
7. Fritz H Kayser (2005) Medical microbiology. ThiemeVerlag.
8. Mackie and McCarthey (2006) Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchill Livingstone.
9. Frank and Steven A (2002) Immunology and evolution of Infectious Diseases. Princeton University Press.
10. Wadher and Bhoosreddy (2005) Manual of Diagnostic Microbiology. Himalaya Publisher.
11. Kufe (2003) Cancer Medicine. BC Decker Inc.
12. Leslic Collier, John Oxford (2000) Human virology a text book for students of medicine, dentistry and microbiology. 2nd edition. Oxford university press.
13. Jenson, Wright robinson (2007) Microbiology vol 1, Microbial Infection vol 2, Practical Medical Microbiology, Churchill living stone.
14. Credric, A Mims (2004) Medical Microbiology, 3rd Edition. Mohshy Inc.
15. Nester Roberts Pearsall Anderson (2007) Microbiology- a human perspective, 2nd Edition, McGraw-Hill.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MMB5302					
TITLE OF THE COURSE	INDUSTRIAL, FOOD AND DAIRY MICROBIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	1	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. To exhibit depth of knowledge by demonstrating microbial sciences in the field of applied fields of industrial, food and dairy microbiology.
2. To relate microbes in interdisciplinary connections with other sciences, in particular to industrial productions, food sciences and dairy products.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	It will develop depth of understanding on fermentation technology, modern microbial techniques and analysis relating to industrial, food and dairy microbiology.	L3

C02	It will develop problem solving capabilities in practical working in teams in laboratory-based virtual experiments.	L2
C03	To gather and evaluate microbial data using a range of current analysis techniques relating to productions, food sciences and dairy products.	L4
C04		
C05		

COURSE CONTENT:

MODULE I: Introduction to Industrial Microbiology

13Hrs

Concepts and scope of microbes in industry. Screening, isolation of industrially important microbes. Strain improvement - mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centers.

Basic components and design of typical fermenter. Types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed, fluidized bed bioreactors and air-lift fermenter. Types of fermentation - Batch, chemostat, submerged and solid-state fermentation. Different parameters affecting fermentation.

MODULE II: Industrial Bioprocessing

13Hrs

Upstream Processing: Nutrients: growth factors, carbon, nitrogen, mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization; culturing techniques of microbial strains; inoculum preparation and inoculum development. **Downstream processing:** Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid extraction, Solvent recovery, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing. **Productions and Applications: Alcohol production, organic acids (citric acid), enzymes: amylases-(Fungal and Bacterial). Amino acid - L-Glutamic acid. Vaccines (Hepatitis B), hormones (human insulin), antibiotic (Penicillin).** Applications of genetic engineering in industrial bioprocessing.

Production economics and IPR: Concept of Patenting law, Copyrights, and Trademarks. Patent regulations and filing, processes, products and microorganisms.	
MODULE III: Scope of Food Microbiology and Food Preservation	13Hrs
Scope and Development of food microbiology. Food as a substrate for microorganisms; Principles and methods of food preservation by Physical, Chemical and food Additives, Bio-preservation. Microbial spoilage of food: Causes and sources of food spoilage. Food borne Infections and Intoxications. Bacteria – <i>Clostridium</i>. Virus- <i>Hepatitis A</i>, Sea toxicants; Mycotoxins (Aflatoxins, Ochratoxins,). Fermented foods: Fermented Vegetables, Meat Sausages, Beverages, Bread and Idli. Nutritional and therapeutic importance: Single cell Protein, Probiotics and Symbiotics; Neutraceuticals, Quorn and Single Cell Oil and their industrial production). Food control Agencies: HACCP, Employees Health standards, GMP. Industrial effluents treatment, Criteria of microbiological quality control.	
MODULE IV: Dairy Microbiology	13Hrs
Nutritional level and microbial flora of milk. Sterilization of milk; predominant types of microorganisms in chilled and refrigerated milk and their importance; heat resistant bacteria and their role in milk spoilage; principles of quality control tests for milk; bacteriological grading. Microbiology of dairy products: cream, butter, ice-cream and indigenous dairy products such as khoa, peda, yogurt, acidophilus milk, dahi, kefir, koumiss, shrikhand, cultured butter milk, cheese and other fermented milk products. Biosensors in Food Industry; Genetically modified foods; Food fortification.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.NO
2. NO

TEXT BOOKS :

REFERENCES:

1. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
2. Stanbury PF, Whitakar A and Hall SJ (2009) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
3. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
4. McNeil B and Harvey LM. Fermentation. A Practical Approach, IRL press, New York.
5. Robert H (2006) Microbiology and Technology of Fermented Foods. Blackwell Publishers.
6. Matthew Rimmer (2008) Intellectual Property and Biotechnology: Biological Inventions Edward Elgar. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Limited, New Delhi.
7. Frazier and Wasthoff, Food Microbiology, Tata McGraw-Hill Publishing Company Limited, New Delhi
8. Hammer B.W and Babal, Dairy Bacteriology, Prentice Hall Incorporated, London.
9. James M.J. Modern Food Microbiology, CBS Publishers and Distributers, Delhi. 2096
10. Mary E.T and Richard E. I. Microbial Food Safety Animal Agriculture: Current Topics, Iowa state University Press. 2003
11. Bibek R. Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press. 2001.
12. Adams M.R. and Moss M.O. Food Microbiology. Royal Publishing Corporation. 2000.
13. John G. Essentials of Food Microbiology. Arnold International Students Edition.
14. Frazer W.C. Food Microbiology. McGraw Hill, New York. 2079.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MMB5321					
TITLE OF THE COURSE	ENVIRONMENTAL MICROBIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		-	-	40	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. The course makes students understand distribution of microorganisms in nature, their habitat and interaction with other organisms.
2. The course enables the students to understand the importance of microorganisms in the environment, their role in the biogeochemical cycles and also their applications. The beneficial and harmful microorganisms are studied which helps them to know the impact of microbes in the environment.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will have fundamental understanding of the distribution and habitat of microorganisms in nature.	L3

C02	They can apply the knowledge in studying microbial diversity in various environmental niches.	L4
C03	Students are aware of the role of microorganisms in the environment.	L2
C04	They will have knowledge about both positive and negative aspects of microorganisms and their interaction with other organisms.	L1
C05	The course helps them to apply knowledge in employing microbes in various fields.	L4

COURSE CONTENT:

MODULE I: Soil Microbiology

10Hrs

Soil Microbiology: Soil as Dynamic system, Soil profile, Soil morphology; Biotic and abiotic interactions; Habitat and niche; Diversity and distribution (Rhizosphere, Mycorrhizosphere, Actinorhizae); Soil erosion and soil conservation; Microbial interaction in soil; Soil pathogens and soil microflora and human health. Biogeochemical cycles - Carbon cycle, Nitrogen cycle and Sulphur cycle; Hg transformation.

Diversity in anoxic eco system: Methanogens-reduction of carbon monoxide-reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of Carbon, Phosphorus, Sulphur, Nitrogen and Mercury.

MODULE II: Aquatic Biology and Sewage Treatment

10Hrs

Aquatic Microbiology: Natural waters, Microbial flora of aquatic environment, Zonation of water system, Upwelling; **Marine microbiology**; Hydrothermal vents, Nutrients in aquatic environments; **Water pollution and water borne diseases**; Eutrophication; Water purification; Ground water types and contamination; **Water quality assays and public health (SPC, MPN, MFT, ONPG and MUG).**

Sewage treatment: Primary, Secondary and Tertiary treatment. **Solid waste treatment (Landfills and Composting); Biogas production**; Role of microbes in sewage treatment; Methanogens and methylotrophs. Newer approaches to sewage treatment and Enzyme technology for treating Industrial waste water; Application of Recombinant DNA Technology in wastewater treatment.

MODULE III: Aerobiology	10Hrs
Air microflora in different layers of atmosphere, bioaerosol; Microbiology of indoor and outdoor air; Significance of microorganisms in air; Enumeration of microorganisms in air (Impingement in liquids, Impingement in solids, suction and filtration); Control of air borne microorganisms. Molecular methods of air quality assessment ; The Greenhouse effect, Ozone depletion, UV radiation and Acid rain. Aeroallergens and Allergies: Causes and tests for detection of aero allergens	
MODULE IV: Bioleaching and Biodegradation	10Hrs
Bioleaching: Principles, microorganisms and microbe-mineral interactions. Bioleaching of copper, uranium and gold; Dump, heap and bioreactor operations. Role of acidophilic microorganisms in environmental pollution. Biodegradation: Biodegradation of xenobiotic compounds and Recalcitrant compounds, Mechanism and enzymes involved in biodegradation. Role of plasmids in biodegradation. Biodegradation of cellulose, lignin, paper and plastic. Hazards from xenobiotics. Microbiology of environmental remediation- Bioremediation. Soil and water '<i>in-situ</i>' remediation- Engineering developments - Constructed wet lands; Bioremediation of oils from contaminated soils; Biosorption; Phytoremediation.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.NO
2. NO

TEXT BOOKS :

REFERENCES:

1. Bhatia A.L. Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
2. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
3. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press.
4. Baker K.H and Herson D.S. Bioremediation. Mc Graw Hill Inc., New York. 1994.
5. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
6. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science Publishers.
7. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
8. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
9. Robert L Tate, Soil Microbiology, 2nd Edition, John Wiley and Sons.
10. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
11. Grant W.D and Long P.E. Environmental Microbiology. Kluwer Academic Publishers, 1981.
12. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
13. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
14. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MMB5322					
TITLE OF THE COURSE	AGRICULTURAL MICROBIOLOGY AND PLANT PATHOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		-	-	40	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. The course aims to impart knowledge about the interaction of microorganisms with plants, mainly crop plants. The beneficiary aspects of the microbes by helping the plant growth and also increasing the plant health by avoiding diseases and disorders are studied.
2. The course also deals with the plant diseases caused by microorganisms, where microorganisms play a major role in plant health and yield. Collectively, the course helps students to gain fundamental knowledge of role of microorganisms in agriculture.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will be equipped with knowledge about the importance of microorganisms in agricultural field.	L3

C02	They can understand how to employ microorganisms to enhance agricultural productivity.	L4
C03	The knowledge of plant pathology will help students to understand microbial diseases in plants, so they understand disease predictions and the prevention measures.	L2
C04	They will have knowledge about both positive and negative aspects of microorganisms and their interaction with other organisms.	L1
C05	The course helps them to apply knowledge in employing microbes in various fields.	L4

COURSE CONTENT:	
MODULE I: Plant-Microbe Interactions	10Hrs
Distribution of microorganisms in soil, soil fertility evaluation and improvement. Role of microorganisms in soil fertility. Decomposition of organic matter by microorganisms: cellulose, hemicellulose, lignin, xylan and pectin. Biological nitrogen fixation: Symbiotic nitrogen fixation, (<i>Rhizobium</i> , <i>Frankia</i>), non-symbiotic nitrogen fixation (<i>Azotobacter</i> , <i>Azospirillum</i>). Concepts of siderophores and VAM with suitable examples. Application of nitrogen fixing genes in rDNA technology in agriculture research.	
MODULE II: Bioinoculants and Biological Control	10Hrs
Bioinoculants: Biofertilizer - types, production and quality control. Cultivation and mass production of bioinoculants- <i>Rhizobium</i>, <i>Azotobacter</i>, <i>Azospirillum</i>, Cyanobacteria, Phosphate solubilizing microorganisms and <i>Azolla</i>. Carrier-based inoculants–production, applications and limitations. Biopesticides: Types and mechanism of application of different varieties. Examples includes <i>Pseudomonas fluorescens</i>, <i>Bacillus thuringiensis</i>, <i>Trichoderma harzianum</i>, <i>Trichoderma viridae</i>, Nuclear Polyhedrosis Virus. Production, applications and limitations.	

MODULE III: Host Pathogen Interaction and Defense Mechanism	10Hrs
Host Pathogen Interaction: Infectious diseases, non-infectious diseases, Koch's postulates. Parasitism and pathogenicity, Host range of pathogens, Disease triangle, Diseases cycle/Infection cycle, Relationship between disease cycles and epidemics; Mode of entry into the host plant-mechanical forces, microbial enzymes, toxins and growth regulators. Defense Mechanisms: Plant Disease Pre-existing structural and chemical defenses. Induced structural (histological-cork layer, abscission layer, tyloses, gums) and biochemical defences (hypersensitive response), systemic acquired resistance phytoalexins, pathogenesis related (PR) proteins, PGPR and plantibodies.	
MODULE IV: Plant Diseases and Their Management	10Hrs
Plant diseases- Red rust of tea (Algae), Grain and head smut of Sorghum (Fungi), Root knot of mulberry (Nematode). Papaya ring spot (Virus), Sandal Spike Disease (Mycoplasma), Citrus canker (Bacteria). Plant disease control: Classification of plant diseases and plant diseases control. Principles and methods in disease control – Legislative methods (quarantine, crop certification), cultural methods (host eradication, crop rotation, and sanitation), soil and sand treatment (Controlling water flow, adding fertilisers, filtering water.), biological control (Suppressive soil and microbial antagonism) and chemical control (fungicides) Control through resistant varieties and quarantine. Plant disease epidemics and forecasting, plant clinic and plant doctor concept. Diagnosis of plant diseases, regulatory, farming education and awareness.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.NO
2. NO

TEXT BOOKS :

REFERENCES

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.
2. Alexopoulos C.J and Mims C.W., Introductory Mycology, New Age International, New Delhi.
3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. Plant Pathology, Fifth Edition, Elsevier Academic Press, 2005.
5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbaroa N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.
7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
8. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
9. Francis H Chapelle. Ground Water Microbiolgy and Geochemistry. 2nd Edition.
ASM press.
10. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.
11. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi
12. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised
Edition: 2006
13. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
14. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
15. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
16. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009

SEMESTER	III					
YEAR	II					
COURSE CODE	20MMB5323					
TITLE OF THE COURSE	GENETIC ENGINEERING					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		-	-	40	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5201	MOLECULAR BIOLOGY

COURSE OBJECTIVES :

1. To understand how DNA can be manipulated using different enzymes.
2. Varied vector systems to transfer DNA from one species to another, express recombinant proteins etc.
3. Diverse methods to visualise modified genetic materials.
4. Applications of genetic engineering.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	This course will enable students to learn techniques which can be used to manipulate DNA, to amplify, propagate and express proteins in different host systems.	L3

CO2	It will also teach techniques to detect the engineered DNA, RNA and protein	L4
CO3	Students will also learn various applications where genetic engineering can be used.	L2

COURSE CONTENT:	
Module I: Basic Concepts	10Hrs
DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern and Southern, Fluorescence in situ hybridization.	
Module II: Cloning and expression vectors	10Hrs
Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/baculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors.	
Module III: Cloning strategies and study of protein-DNA interactions	10Hrs
Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; electrophoretic mobility shift assay; DNase I footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.	

Module IV: Sequencing, PCR and its applications	10Hrs
Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina and 454 platform). PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Handling PCR reactions, Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: RFLP, Oligo Ligation Assay (OLA) and ASA (Allele-Specific Amplification).	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.NO
2. NO

TEXT BOOKS :

REFERENCES

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
5. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,
6. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
7. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication
8. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers

9. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
10. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MMB5324					
TITLE OF THE COURSE	AQUATIC MICROBIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		-	-	40	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. To make students understand the diversity of microorganisms in aquatic environments, ecology and biogeochemistry.
2. To know the importance of aquatic microbes and to derive their utility in various fields.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	After completion of this course, student will be able to understand microbial diversity in aquatic environments.	L2
CO2	Students understand the role of aquatic microorganisms in biogeochemical cycles.	L3

C03	Students will have a better knowledge about the application of aquatic microorganisms in various fields	L4
C04		
C05		

COURSE CONTENT:	
MODULE I: Aquatic Environment	10Hrs
Aquatic environment and distribution of microorganisms. Major environmental conditions influencing microflora in aquatic environment. Aquatic ecosystem- fresh water (ponds, lakes, stream), marine (estuaries, mangroves, deep sea, hydrothermal vents). Microbes in atmospheric water, surface water, stored water, groundwater, mineral water, spring water, well water. Nutrients in aquatic environments and food chain. Factors affecting aquatic flora (Oxygen, Temperature, pH, light, hydrostatic pressure, turbidity and nutrients).	
MODULE II: Marine Microbiology	10Hrs
Marine environment-properties of seawater, chemical and physical factors of marine environment-Ecology of coastal, shallow and deep sea microorganism - significance of marine microflora. Diversity of microorganism - Archaea, bacteria, actinobacteria, cyanobacteria, algae, fungi, viruses and protozoa in the mangroves and coral environments - Microbial endosymbionts – epiphytes - coral-microbial association, sponge-microbial association. Water zonations- upwelling and downwelling, ocean currents. Benthic microorganisms. Marine microflora and biofouling. Barophilic and Barophiles, Halophilic archaeobacteria and extremozymes. Sea food contamination. Bioluminescence.	
MODULE III: Aquatic Microflora and Water Treatment	10Hrs
Introduction to Water cycle. Techniques for the study of aquatic microorganisms. Role and importance of aquatic microbial ecosystem. Microbial consortia. Surface attachment and biofilm development. Antibacterial and bioactive compounds from aquatic microorganisms.	

Waste Water Treatment: Types (sewage and effluent), characteristics of sewage (physical, chemical and biological), BOD and COD. Role of microbes in sewage treatment. Sewage Treatment: Domestic treatment plants (septic tanks), Municipal sewage treatment Primary (coagulation and sedimentation), Secondary (Trickling filter, activated sludge, oxidation pond) and Tertiary treatment (ion exchange, reverse osmosis and dialysis). Brief account on solid waste treatment (Landfills and Composting); Biogas production; Newer approaches to sewage treatment – CETP and Enzyme technology for treating industrial waste water.	
MODULE IV: Water Pollution and Diseases	10Hrs
Water pollution, microbial changes induced by inorganic and organic pollutants. Metals as pollutants. Algal blooms. Biological and chemical control of algal blooms. Formation of biofilm. Algal toxicity. Biomagnifications. Biological indicators and Eutrophication. Water quality analysis: Collection of water samples, Standard plate count, MPN and membrane filter technique. Municipal treatment of water: Sedimentation, Filtration and Disinfection. Water borne diseases (Waterborne diseases <i>Travellers' Diarrhea, Giardia, Salmonella, Escherichia coli, Cholera</i> and <i>Hepatitis A</i>) and control measures.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.NO
2. NO

TEXT BOOKS :

REFERENCES

1. Elements of microbiology- Pelczar, Reid and Chan
2. Aquatic microbiology-Rheinheimer
3. Microbiology-Prescott, M.J, Harley, J. P. and Klein, D. A.
4. Gerhard Rheinheimer Aquatic Microbiology, John Wiley and sons, ISBN 0471718033.

5. Biodiversity and Dynamic Interactions of Microorganisms in the Aquatic Environment and Freshwater Microbiology: John Wiley, John Wiley and sons David C. Sigee ISBN-9780471485285.
6. Bhatia A.L. Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
7. Atlas R.M. Handbook of media for Environmental microbiology. CRC press.
8. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press
9. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
10. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science Publishers.
11. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
12. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
13. Grant W.D and Long P.E.Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
14. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
15. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
16. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MMB5325					
TITLE OF THE COURSE	SOIL MICROBIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		-	-	40	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. To observe importance of soil and soil microorganisms, life cycles in the nature, for plants growing.
2. Explains geochemical significant processes of the microbial activities and the soil factors controlling and limiting microbial activities.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
C01	To understand the fundamental concepts and techniques in soil microbial diversity	L2
C02	Basic and applied concepts environmental problems and available solutions towards them.	L3
C03	To make use of how microorganisms may be utilised in soil microbiology and in agriculture.	L4
C04		
C05		

COURSE CONTENT:	
MODULE I: Microbes and Soil Fertility	10Hrs
Soil profile, Soil morphology, Biotic and abiotic interactions; Habitat and niche; Soil as an environment for microorganisms. Role of microbes in soil fertility . Microbial interactions in soil - mutualism, commensalism, amensalism, synergism, parasitism, predation and competition. Soil pathogens and soil microflora and human health. Isolation of soil viruses; Genetic exchange between the communities.	
MODULE II: Diversity and Distribution of Microorganisms	10Hrs
Rhizosphere, Mycorrhizosphere, Actinorhizae, spermosphere, rhizoplane; symbiotic association in root nodules. Methods of enumeration, rhizosphere effect, factors influencing rhizosphere microbes. PGPR, Siderophores and VAM . Roles of microbes in biogeochemical cycles: Carbon, nitrogen, phosphorus, sulphur. Diversity in anoxic eco system: Methanogens-reduction of carbon monoxide, reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of Carbon, Phosphorus, Sulphur, Nitrogen and Mercury.	
MODULE III: Biofertilizer and Biopesticides	10Hrs
Biological nitrogen fixation - types (symbiotic nitrogen fixation (<i>Rhizobium</i> , <i>Frankia</i>), non-symbiotic nitrogen fixation (<i>Azotobacter</i> , <i>Azospirillum</i>); mechanism, microorganisms and factors affecting; Genetic engineering of BNF. Biofertilizer - types, production, applications and quality control. Cultivation and mass production of bioinoculants- <i>Azotobacter</i>, <i>Rhizobium</i>, <i>Azospirillum</i>, Cyanobacteria, Phosphate solubilising microorganisms, <i>Azolla</i>, <i>Frankia</i> and VAM. Biopesticides – viral, bacterial and fungal- Types and applications (<i>Pseudomonas fluroscence</i>, <i>Bacillus thuringiensis</i>, <i>Trichoderma</i> and Nuclear Polyhedrosis Virus).	
MODULE IV: Soil Pollution and Biodegradation	10Hrs
Soil pollution: Nature and sources of pollutants: Industrial, agricultural and municipal wastes, fertilizers, pesticides, radio nucleotides, fossil fuels, acid rains	

and oil spills. Heavy metals toxicity. **Soil erosion - control methods**, soil acidification, monitoring and control of soil pollution. **Biodegradation:** Decomposition of organic matter by microorganisms - **cellulose, hemicellulose, lignin, xylan and pectin**. Effect of pesticides on soil microflora. **Biodegradation of pesticides**, organic wastes and their use for **production of biogas and manures**. Preparation of farmyard manure, animal manures, rural and urban **composts and vermicompost**.

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1.NO

2. NO

TEXT BOOKS :

REFERENCES

1. Alexander M. 1977. *Introduction to Soil Microbiology*. John Wiley & Sons.
2. Burges A & Raw F. 1967. *Soil Biology*. Academic Press.
3. McLaren AD & Peterson GH. 1967. *Soil Biochemistry*. Vol. XI. Marcel Dekker.
4. Metting FB. 1993. *Soil Microbial Ecology - Applications in Agricultural and Environmental Management*. Marcel Dekker.
5. The Nature and Properties of Soil, Brady.
6. Agrios G.N. (2009), *Plant Pathology*. 5th Ed. Academic Press.
7. Paul E.A.2007. *Soil Microbiology: Ecology and Biochemistry*,3 Edn. Academic Press.
8. John L. Havlin et al., 2004. *Soil Fertility and Fertilizers: An Introduction to Nutrient Management* (7th Edition). Prentice Hall.
9. Coyne M. 1999. *Soil Microbiology* Delmar Cengage Learning
10. Rangaswami . Gand D.J. Bagyaraj. (1998) *Agricultural Microbiology*. 2nd Ed. PHI. India.
11. Subbarao, N.S. and Dommergues, Y.R. (1998) *Microbial interactions in agriculture and forestry*. Science publishers.
12. Alexander M. 1997. *Introduction to soil microbiology*, John Wiley & Sons, Inc, New York.

13. Madigan, M.T., Martinka, M., Parker, J. and Brock, T.D. 2000. Twelfth Edition, Biology Microorganisms, Prentice Hall, New Jerry.
14. Mark Wheelis, 2010. Principles of Modern Microbiology, Jones & Bartlett India Pvt. Ltd., New Delhi.
15. SubbaRao, N.S. 1995. Soil Microorganisms and Plant Growth, Third Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MMB5326					
TITLE OF THE COURSE	PHARMACEUTICAL MICROBIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		-	-	40	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. To make students understand the applications of microorganisms in production of pharmaceutically active compounds.
2. To know the importance of microbiology knowledge in maintaining the microbial standards in pharmaceutical productions.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	After completion of this course, student will be able to Identify different antimicrobial agents, antibiotics produced by them and it's mode of action.	L2
CO2	Basic and applied concepts clinical problems and available solutions towards them.	L3
CO3	Process involved in drug discovery and development and regulatory guidelines in pharmaceuticals product production.	L4

COURSE CONTENT:	
MODULE I: Antibiotics	10Hrs
Antibiotics and Synthetic antimicrobial agents: β -lactam, aminoglycosides, tetracyclines, ansamycins, macrolides. Antifungal antibiotics: Griseofulvin; Antiviral drugs: Amantidines; Nucleoside analogues, Interferons, Peptide antibiotics. Synthetic antibiotics: Sulphonamides; Chloramphenicol; Quinolone. Chemical disinfectants, antiseptics and preservatives. Therapeutic and prophylactic usage of drugs. Adverse reactions of drugs. Microbial resistance.	
MODULE II: Mechanism of Action of Antibiotics	10Hrs
Inhibition of cell wall synthesis, nucleic acid and protein synthesis. Microbial resistance to antibiotics. Molecular principles of drug targeting; Drug delivery system in gene therapy. Mode of action of non-antibiotic antimicrobial agents; Mode of action of bacterial killing by quinolinones; Bacterial resistance to quionolinones. Immobilization procedures for pharmaceutical applications (liposomes). Macromolecular, cellular and synthetic drug carriers.	
MODULE III: Microbial formulation and Applications of Microbial Enzymes	10Hrs
Biochemical and molecular basis of screening for the active ingredients from microbes. Application of microbial enzymes in therapeutics. Microbial fermentation for the production of pharmaceutical compounds (Any two). Vaccine: Synthetic peptide vaccines, Multivalent subunit vaccines, DNA vaccines. Secondary metabolites from microorganisms. Database for Drug designing; Preclinical, clinical trials and Toxicology (LD50 and ED50).	
MODULE IV: Regulatory Aspects in Pharmaceuticals	10Hrs
Design and layout of sterile product manufacturing unit. Designing of Microbiology laboratory, Biosafety levels in setting up lab and safety measures. Introduction to pharmacopoeia; FDA regulation and IP, BP, USP; Reimbursement of drugs and biological; legislative perspectives; GMP and GLP in pharmaceuticals; Quality	

control through WHO; ICH process. GCP Guidelines. Good Regulatory Practices, Clinical Research Regulations. Regulation and legislation for drugs, cosmetics, medical devices, biologicals and herbals formulation. Food & nutraceuticals in India. Intellectual property rights.

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1.NO

2. NO

TEXT BOOKS :

REFERENCES

1. Hugo, WB and Russell, AD. Pharmaceutical Microbiology, (2003). Blackwell Science, Oxford, UK.
2. Krogsgaard L, Lilijefors T. and Madsen, U. Textbook of Drug Design and Discovery, (2004). Taylor and Francis, London.
3. Geoffrey Hanlon and Norman Hodges. Essential Microbiology for pharmacy and pharmaceutical science. (2013). Wiley Blackwell.
4. S. P. Vyas & V. K. Dixit. Pharmaceutical Biotechnology. (2003) CBS Publishers & Distributors, New Delhi.
5. Bhatia R and Ichhpujani RL. Quality Assurance in Microbiology. (1995). CBS Publishers, New Delhi.
6. Gregory Gregoriadis. Drug Carriers in biology & Medicine. (2001). Academic Press New York.
7. Davis, B. D., Dulbecco, R, Eisen, H. N., Ginsberg, R. S. Microbiology. (1990). Harper and Row Publishers, Singapore.
- 8.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MMB5371					
TITLE OF THE COURSE	IMMUNOLOGY, MEDICAL AND INDUSTRIAL MICROBIOLOGY - LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	6	-	-	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents.
- To impart basic understanding of principles, and key concepts relevant to industrial microbiology.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level

C01	To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories.	L3
C02	The course will enable the student to apply the knowledge in various aspects of fermentation or industrial microbiology.	L3

List of Laboratory/Practical Experiments activities to be conducted:

1. Isolation and identification of normal microflora on simple, selective and enrichment media (throat, skin, sputum, nasal and urine sample).
2. Dental caries susceptibility assay by Snyder's agar test.
3. Serological reactions:
4. Agglutination - Blood grouping and Rh typing
5. Precipitation reactions:
i. Ouchterlony Double Diffusion,
ii. Radial Immune Diffusion.
6. Assay for susceptibility and resistance of antibiotics by Kirby Bauer method.
7. Isolation of lymphocytes from peripheral blood.
8. Identification of different types of blood cells.
9. Production and estimation of amylase from microbial sources
10. Production of organic acids (lactic acid and citric acid) from microbes.
11. Detection and quantification siderophore produced by <i>Pseudomonas spp.</i>
12. Study of different types of fermenters (Models/ Charts)
13. Immobilization technique: whole cell or enzyme- sodium alginate gel methods

REFERENCES:

REFERENCES

1. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York.

2. Mackie and McCarthy (2006) Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchill Livingstone.
3. Frank and Steven A (2002) Immunology and evolution of Infectious Diseases. Princeton University Press.
4. Wadher and Bhoosreddy (2005) Manual of Diagnostic Microbiology. Himalaya Publisher.
5. Leslic Collier, John Oxford (2000) Human virology a text book for students of medicine, dentistry and microbiology. 2nd edition. Oxford university press.
6. Jenson, Wright robinson (2007) Microbiology vol 1, Microbial Infection vol 2, Practical Medical Microbiology, Churchill living stone.
7. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
8. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
9. Stanbury PF, Whitakar A and Hall SJ (2009) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
10. Waites Michael J., Morgan Neil., Rockey John S and Gray Higton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
11. Wulf Crueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
12. Robert Mellor (2009) Entrepreneurship for Everyone: A student Textbook. SAGE Publication.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MMB5372					
TITLE OF THE COURSE	PRACTICAL BASED ELECTIVE-I					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	6	-	-	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- The course will help in making the students learn techniques to study microbial interactions and their impact in nature.
- The course imparts practical knowledge in screening the microorganisms for their employment in various fields.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students have fundamental practical knowledge of the techniques to study microbial interactions and their role in environment.	L3
CO2	Students will learn many techniques to study the impact of microorganisms in different applied microbiological studies.	L3
CO3		L4

List of Laboratory/Practical Experiments activities to be conducted:	
2.	Study of microbial interactions in soil (antagonism).
3.	Isolation of cellulose and pectin degrading microbes.
4.	Determination of Total solids, Dissolved Oxygen, Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) –(3 Units)
5.	Isolation of symbiotic and non-symbiotic nitrogen fixing microorganisms
6.	Effect of seed borne fungi on seed germination and seed vigour.
7.	Estimation of total phenols in diseased and healthy plant tissues.
8.	Isolation of Plasmid DNA
9.	Demonstration-Restriction Enzyme digestion
10.	Demonstration- Ligation of DNA fragment

REFERENCES:

1. Nicholl DST. An Introduction to Genetic Engineering. Cambridge University Press, 2002.
2. Sandhya M. Genetic Engineering: Principles and Practice. MacMillan India. 2008.
3. Primrose SB and RM Twyman. Principles of Gene Manipulation and Genomics, Blackwell Publishing MA. USA. 2006.
4. Experiments in Microbiology, Plant Pathology and Biotechnology by K.R. Aneja
5. Practical Microbiology – R.C Dubey, D.K Maheshwari, S Chand and Company, New Delhi.
6. Microbiology Laboratory Manual – Cappuccino, Sherman, Pearson Education.
7. Manual of Microbiology Kanika Sharma Ane Books Pvt. Ltd.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20MSC5401					
TITLE OF THE COURSE	PROJECT WORK					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	-	36	-	18

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	-	-

COURSE OBJECTIVES :

1. Construct a project from Plan, schedule, monitor and control students' own work and to exhibit ideas in discussions and presentations
2. Apply tools and techniques to the applied courses taught and to communicate their findings through a written report and poster presentation

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To provide a postgraduate level knowledge in Microbiology, including understanding, analysis, management, and handling of real life information technology problems in workplace.	L4
CO2	To provide graduate education that will prepare students to become thoughtful, productive members of the competing profession and community.	L4
CO3	To provide a high-quality post graduate education and training in microbiology which prepares	L5

	students for productive careers and lifelong learning.	

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT104

TITLE OF THE COURSE : BIOMOLECULES AND ENZYMOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I CHEMISTRY OF CARBOHYDRATES AND LIPIDS 13H

Chemical basis of life: Macromolecules- monomers and polymers, Acid Base balance and its maintenance, Water- properties, pH, ionization and hydrophobicity and thermodynamics. Carbohydrates: Energy storage molecules – starch, glycogen. Building blocks – cellulose, hemicellulose, and chitin. Cell surface molecules – glycolipids, proteoglycans. Lipids: Triglycerides, phospholipids, glycolipids, sphingolipids, lipoproteins. Lipid micelles, liposomes & their applications.

MODULE II CHEMISTRY OF PROTEINS AND NUCLEIC ACIDS 13H

Proteins: Amino acids and peptides. Primary, secondary, tertiary and quaternary structures, Ramachandran plot. Collagen structure, models of protein folding, experimental techniques to study protein folding (X-ray Crystallography, Fluorescence spectroscopy), roles of chaperones and chaperonins. **Concepts of protein sequencing and protease mapping.** Nucleic acids: Structure of DNA and RNA: A, B, and Z forms of DNA. Higher order structures of DNA (bends, cruciform, G-quadruplexes). **Denaturation and renaturation studies and their applications.**

MODULE III ENZYMES AND BASIC ENZYME KINETIC CONCEPTS 13H

Enzymes: Introduction to enzymes; nomenclature and classification of enzymes; chemical nature and properties of enzymes, factors affecting enzyme activities, active site, allosteric site, coenzymes and co factors. Mechanism of enzyme action: lock and key model and induced fit hypothesis. **Enzyme activity and Specific activity.** Isozymes and their significance. Enzyme Kinetics: Basic chemical kinetics, rate of reaction, order of reaction, zero order and first order reactions. Derivation of Michaelis-Menten equation, Significance of K_m , V_{max} and K_{cat} . Derivation of Lineweaver-burk plot, basic concepts of Scatchard Plot, Eadie-Hofstee Plot, Hanes-Woolf plot and their relevance.

MODULE IV ENZYME CATALYSIS AND REGULATION 13H

Mechanism of Enzyme catalysis: Mechanism of enzyme catalysis - Acid-Base catalysis, covalent catalysis, metal ion catalysis and entropy effect. Example of enzyme catalysis mechanism – chymotrypsin and transaminases. Enzyme inhibition and regulation: Basic concepts of reversible and irreversible inhibition with suitable examples, competitive, uncompetitive, non-competitive inhibitors with relevant kinetic plots. Regulation of enzyme activity: Covalent modulation, Allosteric regulation, ligand interactions, co-operative interactions, feedback regulation

REFERENCES:

1. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry 4th edition Pub: WH Freeman Co.
2. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 rd Indian edition, Pub. Oxford.
3. Stryer, L. Biochemistry 4 th Edn. W.H. Freeman and Co. NY.
4. Kuchel, P.W., Ralston Schaums, G.B. Outlines of Biochemistry 2 nd edition Pub: Tata.
5. Voet, D., Voet J.G. (2004). Biochemistry 2 nd Edn.
6. Devlin, T.M. (1997). Biochemistry with clinical correlations, John Wiley & Sons
7. Zubay, G.L. Parson, W.W., Vance, D.E. (1994). Principles of Biochemistry WmC Brown publishers. Oxford.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT171

TITLE OF THE COURSE : MOLECULAR CELL BIOLOGY AND GENETICS
L: T/A: P: C : 0: 0: 8: 4

(PRACTICALS)

1. **Micrometry**: Calibration of stage and ocular micrometer and measurement of the given biological sample
2. **Hemocytometer: Counting of cells**
3. Study of mitosis by using onion root tips
4. Study of meiosis –Grasshopper testis
5. Mounting of Barr bodies
6. Study of **Karyotyping** in onion, humans (normal and abnormal)
7. Study of **mutation in E. coli by Physical method** (UV) (2 units)
8. Study of Drosophila mutant types.
9. Mounting of polytene chromosomes – in Drosophila
10. **Study of normal and abnormal cellular cell structure and their pathological significance** (through permanent slides)
11. Isolation of nucleus/mitochondria and determination of its purity
12. Concept of Multiple Alleles in Humans (Blood group)
13. **Solving Genetics problems** (Mendelian Genetics, epistasis, Sex-linked inheritance, Lethal Gene inheritance)

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT172

TITLE OF THE COURSE : TECHNIQUES IN MICROBIOLOGY AND BIOCHEMISTRY
L: T/A: P: C: 0: 0: 8: 4

1. Determination of **pI of amino acid by titration** method.
2. Estimation of glucose by Dinitrosalicylic acid (DNSA).
3. **Estimation of protein** by Lowry's/Bradford method.
4. Estimation of inorganic phosphate by Fiske-Subbarow method
5. Determination of saponification number and acid value of the given fat samples. (2 unit)
6. **Sterilization techniques and Preparation of media**
7. **Isolation of microorganisms from Soil/Air/Water**
8. **Pure Culture Techniques – serial dilution, streaking, pour plate, spread plate**
9. Staining techniques in microbiology - simple staining, negative staining, Gram staining, spore staining, capsule staining
10. **Biochemical tests: Starch hydrolysis, Catalase, Gelatin Liquefaction, IMViC**
11. **Determination of microbial growth by turbidometric method.**
12. Identification of algae, fungi and protozoa (Permanent slides): *Spirulina*, *Nostoc*, *Aspergillus*, *Penicillium*, *Paramecium* and *Amoeba*.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT201

TITLE OF THE COURSE : BIOPHYSICAL TECHNIQUES
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I SPECTROSCOPY TECHNIQUES

13H

Theory and application of UV, Visible and Raman Spectroscopy, Circular Dichroism *and optical rotatory dispersion*; Fluorescence; Nuclear magnetic resonance, *Electron spin resonance*, Mass spectrometry (**GC-MS, LC-MS, ICP-MS, MALDI-TOF**), Atomic absorption and atomic emission spectroscopy.

MODULE II SEPARATION TECHNIQUES – CHROMATOGRAPHY AND ELECTROPHORESIS

13H

Chromatography: TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and **Affinity Chromatography; HPLC and FPLC; Dialysis, Criteria of protein purity.**

Electrophoresis: Theory and application of Polyacrylamide gel electrophoresis and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis.

MODULE III SEPARATION TECHNIQUE – CENTRIFUGATION

13H

Basic principles (RCF, Sedimentation coefficient); Types of centrifuge - Micro centrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.

MODULE IV RADIOISOTOPY, MICROSCOPY AND CELL SORTERS

13H

Radioisotope Techniques: Radioactive & stable isotopes, Pattern and rate of radioactive decay, Units of radioactivity. Measurement of radioactivity: Geiger-Muller counter, Solid & Liquid scintillation counters, autoradiography, radioimmunoassay.

Microscopy: Transmission and Scanning Electron Microscopy, Tunneling Electron Microscopy and Atomic Force Microscopy

Cell Analysis: **Florescent activated cell sorter (FACS) and Coulter counter.**

REFERENCES:

1. Essentials of Biophysics, Narayanan, P, New Age Int. Pub. New Delhi (2008).
2. Biophysical Chemistry – Theory and Principles, Upadhyay, Upadhyay and Nath, HimalayaPublishing House (2010)
3. Principles and Techniques of Biochemistry and Molecular Biology – Keith Wilson andJohn Walker, Cambridge University Press (2005).
4. Biophysics – An introduction by Ronald Glaser, Springer (2012).
5. An introduction to practical biochemistry 1987.third edition by D T Plummer. pp. 332.McGraw-Hill (UK).
6. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry, 4 edition Pub WH Freeman Co.
7. T.G. Cooper; the Tools of Biochemistry. Wiley Intersciences, 1977.
8. Protein purification techniques – A practical Approach (2001) Simon Roe, 2nd Edtion, Oxford University press

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT204

TITLE OF THE COURSE : ENVIRONMENTAL AND MEDICAL BIOTECHNOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I WASTE WATER AND SOLID WASTE MANAGEMENT 13H

Waste/Sewage water treatment: Concept of soil, air and water pollution. Waste water characteristics, Source of water pollution, Measurement of water pollution, waste water treatment-physical, chemical, biological processes. Aerobic processes; Activated sludge, oxidation ditches, trickling filter, oxidation ponds; Anaerobic processes; Anaerobic digestion, anaerobic filters, anaerobic sludge, membrane bioreactors, and enzyme immobilization technique, Reverse osmosis and ultra-filtration. Treatment of industrial effluents: dairy, distillery and tannery industries.

Solid waste management: sources and types of waste, management of solid waste (non-hazardous, hazardous medical and electronic waste), composting and vermicomposting in solid waste management, biogas, biofertilizer, biofuel, bioplastics and biopesticides.

MODULE II APPLICATION OF BIOTECHNOLOGY IN ENVIRONMENTAL MANAGEMENT 13H

Bioremediation: Concept, principles and techniques, bioremediation using microbes.

Biosorption of heavy metals and phytoremediation. Biodegradation and bioconversion of natural and xenobiotic compounds (Lignocellulose, petroleum products and heavy metals)

Biomining and Bioleaching: types and methods, microorganism in mineral recovery, advantages and disadvantages.

MODULE III BIOLOGY OF HUMAN DISEASES 13H

Evaluation of organ functions: liver, kidney, cardiac and gastric function tests. Significance of biochemical markers-amino transferases, creatine kinase, LDH, amylase and γ -glutamyl trans-peptidase

Microbial Diseases of Humans: mode of infection, symptoms, detection, epidemiology and control measures of disease caused by Viruses (AIDS, Hepatitis- B) Bacteria (Typhoid, STD) Fungi (Aspergillosis, Cryptococcosis) and Protozoa (Malaria, Amoebiasis)

Genetic Disorders of Humans: Symptoms and treatment of the Genetically inherited diseases: PKU, Alkaptonuria, Galactosemia, Von Gierke disease, Lesch-Nyhan syndrome, Gout, Sickle cell anemia, Beta Thalassemia and Diabetes

MODULE IV MOLECULAR THERAPEUTICS AND NANOBIO TECHNOLOGY 13H

Drugs, drug receptors, Relationship between drug concentration and response, agonists, drug clearance, biological half-life, drugs accumulation, basic concepts of toxic effect (methotrexate and rifampicin).

Gene therapy: overview of inherited and acquired diseases for gene therapy; barriers to gene delivery, Retro and adeno virus mediated gene transfer; Liposome mediated gene delivery, use of stem cells.

Recombinant products: Erythropoietin, Insulin and Streptokinase.

Nanobiotechnology: introduction, synthesis of nanomaterials, brief overview on mechanisms of nanomaterials synthesis, types of nanomaterials, basic concept of protein and DNA based nano structures, medical applications of nanomaterials.

REFERENCES:

1. Judit Pongracz and Mary Keen, Medical Biotechnology 1st Edition, Elsevier publications, 2008
2. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic concepts and Applications (2nd Ed) IK International Publishing House
3. Pradipta Kumar Mohapatra (2006) Textbook of Environmental Biotechnology, IK Publishing House
4. Parihar (2008) Environmental Biotechnology-Fundamentals and Application, Agrobios (India).
5. SK Agarwal (2005) Advanced Environmental Biotechnology, APH publishing corporation.
6. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
7. Devlin, Thomas M. (2001) Textbook of Biochemistry: With Clinical Correlations (5th Ed.); John Wiley & Sons, Inc.

SEMESTER/YEAR : II SEM

COURSE CODE : 17MBT205

TITLE OF THE COURSE : BIOINFORMATICS

L: T/A: P: C : 2: 0: 0: 2

TOTAL HOURS: 26

MODULE I COMPUTER NETWORK AND PROGRAMMING LANGUAGES 8H

Introduction to Computer: Computer soft wares- operating system- Windows, UNIX, Linux, Application software- word processor, spread sheet. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases - sequence, structure, non-redundant Computer Network: Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls.

MODULE II BIOLOGICAL DATABASES AND THEIR APPLICATIONS

10H

Introduction - Relational Databases Management (RDMS) - Oracle, SQL, Database generation. Data mining and applications, accessing bibliographic databases- Pubmed, Nucleic acid sequence databank – NCBI and EMBL. Protein sequence databank- NBRF- PIR, SWISSPROT Structural databases - protein data Bank (PDB) & UniProt Metabolic pathway data bank (Pub gene), Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER, Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids and protein sequences, Identification of ORFs, Identification of motifs

MODULE III PROTEIN STRUCTURE AND MOLECULAR INTERACTION

8H

Introduction to protein structure – secondary structure prediction, tertiary structure prediction, protein modeling- principles of homology and comparative modeling phylogenetics; Structure prediction methods – high-accuracy, and template based, free modeling (new folds); Secondary structure prediction; Pattern recognition – PSSMs, weight matrices; hidden Markov models Threading, structure evaluation and validation and *ab initio* Modeling Applications - Molecular docking - Autodoc

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.

5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (1998). Bioinformatics.
9. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
10. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, John
11. Programming Python by M.Lutz, O'Reilly media, 2011, 4th edition.
12. Learning Perl by R.L.Schwartz, B.D.Foy, T.Phoenix, O'Reilly media, 2011, 6th edition.
13. The C++ programming language, by B. Stroustrup, Addison-Wesley professional publishers, 2013, 4th edition.
14. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81
15. Mangan ME, et al. The UCSC Genome Browser: What Every Molecular Biologist Should Know. Curr Protoc Mol Biol. 2014 Jul 1; 107:19.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT271

TITLE OF THE COURSE : BIOPHYSICAL AND IMMUNOLOGICAL TECHNIQUES
SL: T/A: P: C : 0: 0: 8: 4

(PRACTICAL)

1. Isolation of enzyme and estimation of its activity (Urease/Amylase/Acid Phosphatase/esterase) - any one
2. Determination of kinetic properties of amylase/acid phosphatase/urease/esterase (2 units).
3. Partial purification of the enzyme by salting out/acetone and dialysis (2 units)
4. To perform SDS-PAGE and check the purity of the isolated enzyme (2 units).
5. Immobilization of the purified enzyme and its assay.
6. To separate amino acids/ lipids using paper chromatography/Thin Layer Chromatography
7. Serum Separation from whole blood and precipitation of immunoglobulins from serum.
8. Study of different cells in whole blood using Giemsa/Leishman stain.
9. Blood grouping

10. ELISA/Dot ELISA
11. Radial Immunodiffusion/Ouchterlony Double Diffusion
12. Rocket Immuno Electrophoresis
13. WIDAL/RPR Test

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT272

TITLE OF THE COURSE : MOLECULAR BIOLOGY, MEDICAL AND ENVIRONMENTAL BIOTECHNOLOGY

L: T/A: P: C : 0: 0: 8: 4

1. Estimation of DNA by colorimetric/spectrophotometric method
2. Estimation of RNA by colorimetric/spectrophotometric method
3. Isolation plant/animal genomic DNA, and analysis by agarose gel electrophoresis (2units)
4. Preparation of competent cells and transformation by calcium chloride method and calculation of transformation efficiency (2 units)
5. Study of conjugation in *E.coli*
6. Gel filtration chromatography: Sephadex/Sepharose. (Demo)
7. Estimation of SGPT/SGOT in serum samples.
8. Estimation of serum cholesterol by Zak's method.
9. Demonstration of PCR technique.
10. Determination of DO, BOD and COD of water sample (2 units)
11. Isolation and enumeration of biodegradative microorganisms (hydrocarbons/ pesticides/ heavy metals) or cellulolytic microorganisms from soil.
12. Potable water quality assessment-MPN

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT321

TITLE OF THE COURSE : METABOLISM
OF BIOMOLECULES: T/A: P: C : 4: 1: 0:
5

**Total
Hours -
52**

Module I Bioenergetics and Oxidative phosphorylation

13h Bioenergetics: laws

of thermodynamics, enthalpy, entropy, and the free energy change, standard free energy change. Biochemical energetic group transfer reactions of ATP, functions of ATP, phosphate group transfer potential of ATP and other high energy phosphate donors. Oxidative phosphorylation: Mechanism of proton pumping. Proton motive force and the Mitchell hypothesis. FoF₁-ATPase- structure and mechanism. Coupling of electron transfer to ATP synthesis. Mechanism of oxidative phosphorylation, mitochondrial specific transport systems and energy charge. Uncouplers, inhibitors and ionophores.

Module II Carbohydrate Metabolism

13h

Carbohydrate metabolism; Introduction, glycolytic pathway and regulation.

Gluconeogenesis pathway and regulation. Role of LDH. The TCA cycle and its regulation. Alternate pathways: HMP pathway, Enter – Doudoroff, Glucuronate and Glyoxylate pathway, Cori's cycle.

Glycogen and starch: degradation, synthesis and regulation, glycogen storage disorders. Pasteur effect, fermentative pathways in microorganisms. Regulation of blood glucose level, disorders of carbohydrate metabolism.

Module III: Amino acid and nucleotide metabolism

13h General metabolic reaction of amino acids– transamination, glucose – alanine cycle, oxidative deamination (glutamate dehydrogenase), minor pathways of amino acid degradation – transdeamination, amino acid oxidase, and non – oxidative deamination.

Ureacycle, its regulation and significance. Biosynthesis and degradation of essential amino acids(with emphasis on aromatic amino acids).

Disorders of amino acid metabolism (PKU,Alkaptonuria).

Biosynthesis of purine and pyrimidine nucleotides (de-novo and salvage), regulation of biosynthesis. Degradation of purine and pyrimidines, and disorders associated with their metabolism; gout, Lesch-Nyan syndrome, inhibitors of nucleotide synthesis.

**Module
Metabolism**

IV:

Lipid

13h

Oxidation of fatty acids: even and odd numbered, unsaturated and branched chain fatty acids. Alternate routes for fatty acid oxidation. Degradation of triacylglycerols and phospholipids. Energetic of β -oxidation. Metabolism of ketone bodies; their formation, oxidation and clinical significance. Biological functions of eicosanoids (prostaglandin, leucotrienes and thromboxane).

Cholesterol biosynthesis, catabolism and regulation. Transport of cholesterol -LDL receptor pathway. Lipoproteinemias, fatty liver, hypercholesterolemia. Chemical composition, biological functions and metabolic fate of VLDL, LDL and HDL.

Reference Books:

1. Biochemistry- R. Garret, Charles M Grisham, Belmont (2013)
2. Biochemistry; Geoffrey Zubey, (1998), WCB Publishers.
3. Biochemistry; David Rawn, Panima Publishers, (1989).
4. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan
5. Publications (2012).
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
7. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
8. Biochemistry; Voet , D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.
9. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
10. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGraw Hill.

COURSE CODE : 17MBT371
TITLE OF THE COURSE : GENETIC ENGINEERING-L
T/A: P: C : 0: 0: 8: 4

(PRACTICALS)

1. Isolation of DNA from microbial and plant/animal sources.
2. Isolation of total RNA and its analysis.
3. PCR amplification and analysis by agarose gel electrophoresis.
4. Preparation of plasmid DNA from *E. coli*.
5. Restriction digestion of vector and Insert
6. Vector and insert ligation
7. Preparation of competent *E. coli* cells
8. Transformation in *E. coli*.
9. Plasmid isolation and screening of recombinants
10. Induction of protein expression and analysis by SDS-PAGE
11. Purification of recombinant proteins (demo)
12. Southern hybridization using non-radioactive detection
13. cDNA synthesis by RT-PCR
14. Restriction mapping

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT372
TITLE OF THE COURSE : PLANT & ANIMAL BIOTECHNOLOGY
L: T/A: P: C : 0: 0: 8: 4

(PRACTICALS)

1. Preparation of plant tissue culture media
2. Organ culture (Shoot tip, nodal and leaf culture)
3. Callus culture: Initiation and regeneration.
4. Isolation and fusion of protoplasts
5. Isolation of plant genomic DNA from pea shoot tip/ Cauliflower by CTAB method
6. Agrobacterium culture, selection of transformants

7. Study of VAM, isolation of spores, arbuscles and vesicles from roots
8. VAM culture
9. Animal cell culture: Preparation of (serum and non-serum supplemented) media.
10. Primary culture of fibroblast cells/liver cells/testis-leydig cells
11. Assessment of viability and counting using trypan blue exclusion method
12. Determination of the concentration of viable cells in a suspension by haemocytometer counting (trypan blue)
13. Isolation of cells by explant method and Sub-culturing

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBT421

TITLE OF THE COURSE : APPLIED
BIOTECHNOLOGY: T/A: P: C : 4:1:0:5

Total hours: 52

Module I
Engineering

Bioprocess

13h

Scope and importance of bioprocess engineering technology, Bioreactors: Typical structure of Bioreactor and their working mechanism; Fermentation media and Fermentation Process: Natural and synthetic media. Types of fermentation process, Industrially important products: Ethanol, citric acid, penicillin, amylase, SCP, fermented foods

Module II
Biotechnology

Plant

13h

Basics of Plant tissue culture, initiating plant tissue culture, Aseptic techniques, Components of tissue culture media, use of growth regulators (auxins, cytokinin, gibberellins), Micro-propagation, bud and meristem tip culture, stages, factors affecting micro-propagation, applications, transgenic plants, crop improvement, Bt cotton, Bt brinjal, golden rice, edible vaccines.

Module III

Animal

Biotechnology

13h

Facilities in Animal Cell Culture, Media – natural and chemically defined, importance of serum in the media. Growth factors promoting proliferation of animal cells – EGF, FGF, PDGF and erythropoietin, Primary and Secondary Cell Culture, stem cells and tissue engineering, transgenic animals, therapeutic and pharmaceutical products,

Module IV Environmental Biotechnology

13h Air, water, soil pollution, Bio-indicators, waste water management and treatment, bioremediation and biodegradation

IPR, patenting of biotech products, Bioethics, ethical issues related to consumption of GM crops, ethical implication of Human Genome Project

References:

1. Kuby J (2007) Immunology (6th Ed), WH Freeman & Co.
2. Singh, Gautam, Chauhan, Singla (2013) Textbook of Animal Biotechnology, TERI
3. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell
4. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons
5. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
6. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic concepts and Applications (2nd Ed) IK International Publishing House
7. Pradipta Kumar Mohapatra (2006) Textbook of Environmental Biotechnology, IK Publishing House
8. Glazer and Nikaido (1995), Microbial Biotechnology, WH Freeman and Co.
9. Prescott, Harley and Klein (2002) Microbiology (5th Ed), Mc-Graw Hill Co.
10. Prescott & Dunn (2002) Industrial Microbiology, Agrobios Publishers
11. Stanbury, Whitaker and Hall (2008) Principles of Fermentation Technology, Elsevier
12. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing
13. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford Publishing.
14. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5101
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY
L: T: P: S/P: C :4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: General Chemistry 13Hrs

Types of chemical bonds in biological molecules, Hydrogen bonding & its relevance in biological systems, importance of water in biological systems, pH, pKa, pKb, pOH, preparation of buffers, Henderson-Hasselbalch equation and numerical problems associated with buffer preparation. VSEPR, Crystal field theory, Ligand field theory – explanation of coordination bonds in biomolecules - bonding of iron in haemoglobin & cytochromes, cobalt in vitamin B12, magnesium in chlorophyll.

MODULE 2: Physical Chemistry 13Hrs

Electrochemistry: Electrode potential, standard & reference electrode, calculation of biological standard potential & biological equilibrium constant, Nernst's equation.

Thermodynamics: First & second laws of thermodynamics, enthalpy, entropy, free energy, free energy change & its applications in biology, activity, chemical potential.

Chemical Kinetics: Rate of reaction, order & molecularity of reactions, effect of temperature on reaction rates, Arrhenius equation, activated complex theory, catalysis

MODULE 3: Organic Chemistry - I 13Hrs

Stereochemistry: Geometric & Optical Isomerism, Symmetry elements, R/S notation, chirality & optical activity, Stereochemistry of glucose & amino acids.

Reactive intermediates: Reactive intermediates, Ionic, radical & concerted reactions, transition state theory, kinetically & thermodynamically controlled reactions.

MODULE 4: Organic Chemistry - II 13Hrs

Reaction mechanism: S_N1 , S_N2 E1 & E2 reactions, aromatic electrophilic and aromatic nucleophilic reactions, mechanistic study of reactions important for biology, metabolic reactions, aldol condensation – collagen and elastin, esterification of acids, oxidation and reduction. Heterocyclic compounds: aromaticity, Chemistry & biological relevance of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole, chemistry of porphyrins.

REFERENCES:

14. A New Concise Inorganic Chemistry”, J. D. Lee, 5th Ed, Chapman & Hall, London(2096).
15. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Ed. Prentice Hall, India (2092)
16. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
17. Organic Mechanisms, Peter Sykes, Longman, (2077).
18. Inorganic Biochemistry. G.L. Eicharn, Elsevier
19. Physical Biochemistry. David Frifielder. 2nd Ed. W.G.Freeman and Co
20. Introduction to Biophysical Chemistry, Robert Bruce Martin, McGraw-Hill (2064).
21. Bioinorganic Chemistry Ei-Ichiro Ochiai, Elsevier (2008).
22. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
23. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (2099).
24. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
25. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
26. Basic Inorganic Chemistry”, F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (2095).

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5102
TITLE OF THE COURSE : BIOMOLECULES
L: T: P: S/P: C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: CARBOHYDRATES

13Hrs

Simple Carbohydrates: Structure and classification of carbohydrates. Configuration and conformational aspects of monosaccharides and sugar derivatives. Structural elucidation of carbohydrates through oxidation and exhaustive methylation, Glycosidic linkages in disaccharides and glycosides.

Complex Carbohydrates: Homopolysaccharides and heteropolysaccharides - starch, glycogen, cellulose chitin, glycosaminoglycans and proteoglycans; Glycoproteins and Glycolipids - O and N linked oligosaccharides, Blood group determinants, Lectins, lipopolysaccharides.

MODULE 2: AMINO ACID AND PROTEINS

13Hrs

Primary structure – structure, classification and acid-base properties of amino acids, Peptide bond, peptides, Merrifield synthesis of peptides; Primary structure –scheme of determination –amino acid composition analysis, N and C terminal analysis, cleavage of Disulfide bond, chemical and enzymatic fragmentation and sequencing through Edman's reagent.

Secondary structure: α -, PP-, 3_{10} and π -helix, β pleated sheet, β and γ bend, Peptide bond geometry and conformational map, Chou and Fasman algorithm; Super secondary structures: motifs and domains.

MODULE 3: PROTEIN CONFORMATION AND FOLDING

13Hrs

Tertiary structure: interactions stabilizing tertiary structure; denaturation of proteins, secondary and tertiary structure of fibrous proteins: α -keratin, silk fibroin and collagen.

Quaternary structure: Hemoglobin Structure and mechanism of co-operativity, molecular basis of Sickle-cell anemia; Cross linking agents to determine subunit composition.

Protein folding: Protein renaturation, significance of Anfinsen's experiment, Classical model of folding, Levinthal paradox, Landscape model of folding, accessory proteins- protein disulfide isomerases and molecular chaperones; conformational diseases: Alzheimer's and Prion diseases.

MODULE 4: LIPIDS AND NUCLEIC ACID

13Hrs

Lipids: Classification and biological importance of lipids. Structure, nomenclature, properties and functions of Simple lipids - free fatty acids, acyl glycerols& wax; Complex lipids - phospholipids, ether lipids, sphingolipids, galactolipids and Derived lipids – sterols and icosanoids including prostaglandins, thromboxanes and leukotrienes. Lipid peroxidation.

Nucleic acids: Nucleosides, nucleotides and polynucleotides; Specialized sequences: stem-loops, G-quadruplexes, palindromic and mirror repeats; denaturation and renaturation curves of nucleic acids; Oligonucleotide synthesis by phosphoramidite method.

REFERENCES:

1. Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc.(2010).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
3. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
4. Proteins Structures and Molecular Properties 2nd Ed. Thomas E. Creighton, W H Freeman and Co. (2093).
5. Principles of Protein Structure, Function, & evolution, Dickerson &Geis, 2nd Ed. Benjamin-Cummings (2083).
6. Biochemistry; David Rawn, J, Neil Patterson Publishers (2089).
7. Biochemistry 6th Ed; Jeremy M Berg, John L Tymoczko and LubertStryer, W H Freeman and Co. (2006).
8. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5103
TITLE OF THE COURSE : MOLECULAR GENETICS
L: T: P: S/P: C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: Concepts in Genetics and Genomics

13hrs

Mendelian genetics: Concepts and theories, gene interactions, Morgan's linkage analysis, chromosome theory of inheritance. Features of *E. coli*. and Human genome, C-value paradox, Fine structure of gene, Split genes and overlapping genes. Concept of Epigenetics and Genomic imprinting. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance.

Organization of Chromosomes: Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains and scaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes.

MODULE 2: Molecular Mechanisms of Recombination

13hrs

Bacterial Recombination: plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of *E. coli*.

Mechanism of Recombination: Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in *E. coli*; role of Rec A in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein in Meiotic recombination; Gene Conversion. Site-specific recombination: integration of lambda genome in *E. coli*. Topological manipulation of DNA

MODULE 3: Molecular Basis of Mutation and Transposable Genetic Elements. 13hrs

Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation:

Ames test, Mutations in mitochondrial genome and related disorders. Karyotype - normal and abnormal karyotype analysis for genetic disorders.

Transposons and Molecular mechanism of transposition: Transposable elements in prokaryotes and eukaryotes – IS elements, Composite Transposons, Tn3 elements, *Ac* and *Ds* elements, P elements, Retrotransposon and their significance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesis

Module 4: Sex Determination and Cancer Genetics

13hrs

Sex Determination: Factors affecting sex determination, Mechanism of sex determination in *Drosophila* (role of *sxl* gene) and mammals (role of *sry* gene). Secondary sex determination in mammals. Mechanism of dosage compensation in *Drosophila* (role of MSL genes) and mammals (X-chromosome inactivation, role of Xist RNA).

Medical Molecular Genetics: Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzheimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)

REFERENCES:

8. John Ringo (2004). Fundamental Genetics. Cambridge University Press.
9. Griffith et al (2011) An introduction to genetic analysis (10th Edition) W.H. Freeman and Company
10. Strachan and Read (2010) Human Molecular genetics (4th Edition) Taylor and Francis.
11. Principles of Genetics by Snustad and Simmons, 6th Edition (2011) John Wiley and Sons, Inc publisher.
12. David Freifelder (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
13. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastysdairs and Darnell, J. (2004).Molecular cell biology. Scientific American Books Inc., NY.
14. Snustad and Simmons. (2006). Principal of Genetics. 8th Edn. John Wiley & sons. Klug, W.S.,Cummings. (2003). Concepts of genetics, 7th Edn. Pearson Education.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5104
TITLE OF THE COURSE : GENERAL MICROBIOLOGY
L: T: P: S/P: C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: History and Systematics of Microorganisms **13hrs**

History and development of Microbiology: Scope and Applications of Microbiology, Discovery of microorganisms, Spontaneous generation theory, Biogenesis theory, Germ theory of diseases. Contributions of scientists to Microbiology.

Microbial Systematics - Classification systems: Criteria for classification of microorganisms, classification systems artificial and phylogenetic, Haeckel's three-kingdom classification, Whittaker's five-kingdom classification, three-domain concept of Carl Woese.

Taxonomy: Identification and nomenclature, binomial nomenclature, international code of nomenclature of prokaryotes, taxonomic ranks and hierarchical organization. Molecular methods (DNA homology, DNA-RNA homology, G+C ratio), phage typing and Serological methods in taxonomy, Numerical taxonomy. Concepts and Applications of Bergey's manual of systematic and determinative bacteriology.

MODULE 2: Microbial Techniques **13hrs**

Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM). Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective, enriched, enrichment and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic). Microbial Nutrition and kinetics: Growth curve, Macro and Micronutrients, Factors influencing the growth of microbes.

MODULE 3: Applied Microbiology-I **13hrs**

Agriculture Microbiology- Biofertilizer: Biological Nitrogen fixation- symbiotic and asymbiotic, Phosphate solubilizing microbes, Microbial antagonism in soil, PGPR, Biological control of plant diseases (*Trichoderma*, *Pseudomonas* and AM fungi). Biopesticides: *Bacillus thuringiensis* and *Beauveria bassiana*.

Medical Microbiology: pathogens, host-pathogens interaction, infection and its types. Bacterial diseases: *Staphylococcus* and *Salmonella*. Fungal diseases: Candidiasis, and

Aspergillosis. Viral Diseases- Pox virus and Hepatitis viruses. Protozoan and Helminthic diseases: Malaria and Filaria.

MODULE 4: Applied Microbiology-II

13hrs

Environmental Microbiology: Microbes in biogeochemical cycle, biodegradation of pesticides (2,4D and DDT), crude oil, oil spillage in ocean, Xenobiotic (PET), biosorption of heavy metals.

Industrial Microbiology: Fermentation, types, fermentor design, fermentation products- organic acids, vitamins, antibiotics and enzymes, fermented food- bread, cheese, Alcoholic products- wine and beer.

REFERENCES:

1. Ananthanarayanan, R. and JayaramPanicker C.K. (2004) Text book of Microbiology. Orient Longman, Hyderabad.
2. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
3. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 2009.
4. Dubey, R.C. Microbiology 1st Edition. Chand and company.
5. Edward Alcamo. Microbiology. Cliffs Notes 2006.
6. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
7. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 2009.
8. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005.
9. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.2086.
10. Prescott, L.M. Microbiology 6th edition. McGraw Hill. 2005.
11. Salle, A.J. Principles of Microbiology, 2ndedition., 2007, McGraw Hill.2097.
12. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005.
13. Tortora, Funke and Case. Microbiology, 9th Edition. Benjamin Cummings. 2009.

SEMESTER/YEAR : I SEM

COURSE CODE : 20MSC5105

TITLE OF THE COURSE : BIOINFORMATICS – I (PROTEOMICS)

L: T: P: S/P: C : 2: 0: 0: 0 : 2

Total Hours: 26

MODULE 1:

13 hrs

History, scope, definitions and basic concepts in bioinformatics and its relation with molecular biology. Basic concepts in computer and its organization. **Software & operating system** - Windows, UNIX, Linux, Java, PERL and python. Application software- word processor, spread sheet. Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group policies Fire-walls.

Data management - Relational Databases Management (RDMS) - Database generation. **Data mining and applications**, accessing bibliographic databases-Pubmed, Google Scholar, NCBI, EMBL and DDBJ. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB) & UniProt, Metabolic pathway data bank (KEGG)

MODULE 2:

13 hrs

Introduction to protein structure. Data generation; Generation of large scale molecular biology data (Through, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction and protein biochips).

Tools in proteomics: databases (GENBANK, Pubmed, PDB), Sequence analysis (FASTA, BLAST, BLAT), Structure viewer (RASMOL, PyMOL). Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and analysis tools.

Secondary structure prediction (GOR), tertiary structure prediction, protein modelling-principles of homology and comparative modelling phylogenetics; Structure prediction methods – high accuracy and template based, free modelling (new folds); Pattern recognition – PSSMs, weight matrices; hidden Markov models. Threading, structure evaluation and validation and *ab initio* Modelling, Applications - Molecular docking – Autodoc.

REFERENCES

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.

4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (2098). Bioinformatics.

SEMESTER/YEAR : I SEM

COURSE CODE : 20MSC5106

TITLE OF THE COURSE : BIOSTATISTICS

L: T: P: S/P: C : 2: 0: 0: 0 : 2

Total Hours: 26

MODULE 1: Measures of Central Tendencies, Dispersion and Correlation13hrs

Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance. Sampling methods and their significance.

MODULE 2: Probability Distributions and Testing of Hypothesis 13hrs

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions- Binomial, Poisson and Normal distributions with simple numerical. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of "p" value. Statistical package- Features of [statistical software, SPSS for various applications in Biostatistical program.](#)

REFERENCES:

1. Daniel (2099). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (2099). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (2085). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (2083). Mathematics in microbiology Academic press
5. Green, R.H. (2079). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (2074). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (2067). Statistics in Biology, Vol.1 McGraw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER/YEAR : I SEM

COURSE CODE : 20MSC5171

TITLE OF THE COURSE : ANALYSIS OF BIOMOLECULES - LAB

L: T: P: S/P: C : 0: 0: 6: 0 : 3

PRACTICALS

1. Estimation of lactose in milk by Miller's method
2. Estimation of amino acids by Ninhydrin method
3. Estimation of Iodine number of fats
4. Estimation of nucleic acids by Orcinol and DPA method
5. Potentiometric titration of amino acids
6. The study of kinetics of potassium persulphate and potassium iodide via calorimetry
7. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation
8. Estimation of percentage of iron in hematite ore using barium diphenylamine sulphonate as an internal indicator
9. Estimation of calcium in lime stone by titrimetric method
10. Determination of the percentage of available chlorine in the given sample of bleaching powder

REFERENCES:

3. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
4. An Introduction to practical Biochemistry—Plummer D. T, Tata McGraw Hill

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5172
TITLE OF THE COURSE : TECHNIQUES IN MICROBIOLOGY AND GENETICS - LAB
L: T: P: S/P: C : 0: 0: 6: 0 : 3

PRACTICALS

1. Preparation of culture media: Autotrophic, Heterotrophic, Selective, Enriched and Differential culture media.
2. Isolation of Microorganisms from different sources (Soil, water and air): Serial dilution and Pure culture techniques.
3. Staining- simple, differential - Gram's, acid fast, endospore, capsular and flagella. Motility test by Hanging-drop method.
4. Study of fungi: *Aspergillus*, *Penicillium*, *Fusarium*, *Yeast*, *Mucor*, *Rhizopus*, *Agaricus* and *Puccinia*.
5. Study of algae (permanent slides): *Spirulina*, *Nostoc*, *Spirogyra*, *Microcystis*, *Scytonema*, *Oscillatoria* and *Rivularia*.
6. Study of Protozoa (permanent slides): *Euglena*, *Plasmodium*, *Paramecium* and *Amoeba*.
7. Study of mitosis in onion root tips
8. Study of *Drosophila* mutant types.
9. Mounting of polytene chromosomes – in *Drosophila*.
10. Preparation of buccal smear to study Barr bodies.
11. Concept of Multiple Alleles in Humans (Blood group).
12. Genetics problems (Mendelian Genetics, epistasis, Sex-linked inheritance, Lethal Gene inheritance).

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata McGraw Hill

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5201
TITLE OF THE COURSE : MOLECULAR BIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: DNA Replication and Repair

13hrs

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA. Structure and functions of different types of RNA. C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson & Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication. Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes. Telomeresynthesis-telomerases. regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.

Mechanism of DNA Repair: DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

MODULE 2: Gene Expression – Transcription

13hrs

Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination-Rho dependent and Rho-independent.

Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of Enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, Elongation and Termination.

Post transcriptional modifications of mRNA (5' Cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and Processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.

MODULE 3: Gene Expression – Translation

13hrs

Protein Synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of amino Acids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Co and post translational modifications of proteins, translation control in Eukaryotes.

Protein Targeting and localization: Export of secretory proteins- signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxisomes and membrane.

MODULE 4: Regulation of Gene Expression in Prokaryotes and Eukaryotes

13hrs

Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP in the expression of lac genes and catabolite repression Regulation of tryptophan operon by Attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage.

Regulation of eukaryotic gene expression: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs of transcription factors, posttranscriptional control.

Gene Silencing: Transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

REFERENCES:

8. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition). John Wiley and Sons
9. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4th edition)
10. Principles of gene manipulation - An introduction to genetic engineering, Old R.W., Primrose S.B., Blackwell Scientific Publications, 2093.

11. David Rawn J (2089) Biochemistry, Neil Patterson Publishers.
12. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4th edition, Pub WH Freeman Co.
13. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition, Pub. Oxford.
14. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (2094). Molecular Biology of the Cell.
15. Cooper, G.M. (2097). The Cell: A molecular approach, ASM Press, USA.
16. Darnell, J. Lodish, H., Baltimore, D. (2090). Molecular Cell Biology. Scientific American Books Inc. NY.
17. Garrett, R.H. and Gresham, C.M. (2095). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
18. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.

SEMESTER/YEAR : II SEM

COURSE CODE : 20MSC5202

TITLE OF THE COURSE : ANALYTICAL TECHNIQUES

L: T: P: S/P: C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1:

13hrs

Spectroscopy: Electromagnetic radiation & its interaction with matter, Lambert- Beer's law, extinction coefficient & its importance, design of colorimeter & spectrophotometer, chemiluminescence, thermofluorescence, principles & biological applications of UV& visible spectroscopy, Principles & applications of fluorescence, nephelometry, AAS.

Structural elucidation: CD, IR, NMR, ESR, Raman spectroscopy & their applications in biology, x-ray Diffraction & their application in structural analysis of macro molecules.

MODULE 2:

13hrs

Electrophoresis: Moving boundary & zonal electrophoresis, paper & agarose gel electrophoresis, native and SDS PAGE, isoelectric focusing, 2D gel electrophoresis. Concepts and instrumentation of pulse field electrophoresis and capillary electrophoresis, Western, Northern and Southern blotting techniques.

Mass spectrometry: principles, ionization mechanisms, mass analysis TOF, ion trap quadrupole, Ionization methods: electron impact, chemical ionization, fast atom bombardment, field desorption, electron spray ionization, MALDI, protein identification using MS. Microarrays, protein biochips

MODULE 3:

13hrs

Chromatography: partition coefficient, paper & thin layer chromatography, adsorption chromatography, gel permeation & affinity chromatography, ion exchange chromatography, amino acid analyzer, gas chromatography, GCMS, HPLC, hydrophobic interaction chromatography, covalent, metal chelate & hydroxyapatite chromatography, special chromatographic techniques for nucleic acids, FPLC

Radioactivity: Disintegration of radionuclides, half-life, detection & measurement, liquid scintillation counter, isotopic tracer techniques, preparation of labeled compounds & their use in biology, autoradiography.

MODULE 4:

13hrs

Centrifugation: principle, Svedberg's constant, types of centrifuges, differential & density gradient centrifugation, preparative & analytical centrifuges, sedimentation velocity, equilibrium analysis & its applications.

Techniques in drug discovery: General protocol of classical drug discovery and clinical trials, In-Silico Drug Designing, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, QSAR, Database generation and Chemical libraries, ADMET property.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (2083)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (2090)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (2094)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR	: II SEM
COURSE CODE	: 20MSC5203
TITLE OF THE COURSE	: BIOINFORMATICS – II (GENOMICS)
L: T: P: S/P: C	: 2: 0: 0: 0 : 2

Total Hours: 26 Hours

MODULE 1:

13 hrs

Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER.

Global and Local, Similarity searching, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs

MODULE 2:

13 hrs

Translating DNA into proteins reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank files, Genbank libraries, separating sequence and annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files.

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factors binding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies and Graphical models (including Markov chain and Bayes notes). Genetic variability and connections to clinical data.

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2006.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.

4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Baxavanis (2098). Bioinformatics.
7. Fry, J.C. (2093). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5204
TITLE OF THE COURSE : EVOLUTION AND DEVELOPMENTAL BIOLOGY
L: T: P: S/P: C : 2: 0: 0: 0 : 2

Total Hours: 26 Hours

MODULE 1: Ecology and Evolution **13hrs**

Ecology: Introduction, biotic and abiotic factors, Biomes

Population ecology: Dynamics of population, Population growth-Exponential model
Logistic growth model

Community ecology: Interactions, Biogeography, Speciation, Ecological succession,
Disturbances Structure- Contrasting views

Ecosystems: Energy flow and trophic levels, Biological and geochemical processes (BC cycles, B Pyramids etc) Human impacts on ecosystems

Evolution: Introduction, Early ideas of evolution, Darwinian view of life.

Speciation and Evolutionary Rates: The nature of evolutionary units; the modern synthesis and biological speciation, rates of evolutionary change.

Natural selection: Stabilizing, directional, and disruptive selection.

Microevolutionary and Macroevolutionary phenomena: insights into genetic drift, mutation and gene flow, Ontogeny and phylogeny

MODULE 2: Developmental Biology **13hrs**

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting;

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum*

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in *Drosophila*.

REFERENCES:

10. Concepts of Ecology, Edward J. Kormondy
11. Ecology and environmental science, S.V.S. Rana
12. Cell biology, Genetics, Molecular biology, evolution and ecology
13. Minkoff, E. C. (2083). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company.
14. Sober, E. (2094). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.
15. Fundamentals of ecology by Eugene Odum, Cengage; 5 edition (2005).
16. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
17. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)
18. Development Biology by N Arumugam, Saras Publication (2014)

SEMESTER/YEAR : II SEM

COURSE CODE : 20MSC5271

TITLE OF THE COURSE : BIO-ANALYTICAL TECHNIQUES - LAB

L: T: P: S/P: C : 0: 0: 6: 0 : 3

1. Isolation of plant genomic DNA using SDS/CTAB method and its analysis.
2. **Isolation of genomic DNA from bacteria/animal tissue and its analysis.**
3. Isolation of total RNA from biological source and its analysis

4. Study of conjugation in *E. coli*.
5. Study of mutation in *E. coli* by Physical method (UV).
6. Determination of extinction coefficient of biomolecules using UV spectroscopy (Protein/DNA/RNA)
7. Separation of biomolecules (amino acids/carbohydrates) using TLC.
8. Separation of phytomolecules (secondary metabolites) using silica column chromatography
9. Separation of proteins using SDS-PAGE and molecular weight determination.
10. Separation of cell organelles using density gradient centrifugation.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)

SEMESTER/YEAR	: III SEM
COURSE CODE	: 20MSC5301
TITLE OF THE COURSE	: CLINICAL RESEARCH
L: T: P: S/P: C	: 2: 0: 0: 0 : 2

Course Objectives:

1. To introduce basic principles involved in preclinical evaluation of a drug, basic pharmacokinetics and dynamics of regulatory requirements for a clinical trial.
2. To equip students with the proper designing and planning of clinical trial.

Course Outcomes:

1. Students will acquire sufficient knowledge on the process and regulatory perspectives of preclinical evaluation studies.
2. Students will gain the concepts of designing and monitoring of clinical research studies.

Total Hours: 26 Hrs

MODULE I: Concepts of Clinical Research

13 Hrs

General introduction, routes of drugs administration, Dose, threshold dose, no observed effect level (NOEL), measurement of cumulative effects- time relationship. The *area under*

the curve (AUC) of the concentration-time profiles, absolute bioavailability, Volume of Distribution (Vd). maximum tolerated dose (MTD).Basics of pharmacokinetics, calculation of pharmacokinetic estimates. Outline of drug metabolism and elimination. Organ toxicity.Scheme of preclinical evaluation of toxicity study. Calculation of LD₅₀& ED₅₀. Acute, subacute and chronic toxicity studies. Irwin profile test. Lipinski's rule for drug like molecule.

MODULE II: Regulatory Perspectives of Clinical Research

13Hrs

Overview of Clinical Trials: Clinical evaluation of new drug, phases of clinical trial, Preparation of clinical trial. Outline of new drug development process and drugs registration.

Regulatory Perspectives of Clinical Trials: Origin and Principles of International Conference on Harmonization - Good Clinical Practice (ICH-GCP) guidelines, Ethical Committee: Institutional Review Board, Ethical Guidelines for Biomedical Research and Human Participant- Schedule Y, ICMR Informed Consent Process: Structure and content of an Informed Consent Process Ethical principles governing informed consent process. Clinical Trials: Types and Design. Experimental Study- RCT and Non RCT, Observation Study: Cohort, Case Control, Cross sectional Clinical Trial Study, Team Roles and responsibilities of Clinical Trial Personnel: Investigator, Study Coordinator, Sponsor, CRO. Clinical Trial Documentation- Trial Monitoring- Safety Monitoring in CT Adverse Drug Reactions.

REFERENCES

1. Central Drugs Standard Control Organization- Good Clinical Practices, Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health;2001.
2. International Conference on Harmonization of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonized Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 2006.
3. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi.
4. Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
5. Clinical Data Management edited by R K Rondels, S A Varley, C F Webbs. Second Edition, Jan 2000, Wiley Publications.
6. Handbook of clinical Research. Julia Lloyd and Ann Raven Ed. Churchill Livingstone.

7. Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes.
8. Essentials of medical pharmacology. TRIPATHI (K D). 6th edition, 2009, Jaypee Brothers Publihsers.
9. Textbook of modern toxicology. HODGSON (Ernest), 4th Ed. 2010, John Wiley.
10. Concepts of toxicology , OMKAR, 2014, Vishal Publishers.
11. Foyes principles of medicinal chemistry, LEMKE (Thomas L);6th edition, 2008, Wolter Klu Publishers.
12. Foyes principles of medicinal chemistry, WILLIAMS (David A); 5th edition, 2002, Wolter Klu Publishers.
13. Introduction to biochemical toxicology, HODGSON (Ernest); 3rd edition, 2001, Wiley Publishers.

SEMESTER/YEAR	: III SEM
COURSE CODE	: 20MSC5302
TITLE OF THE COURSE	: SCIENTIFIC WRITING AND IPR
L: T: P: S/P : C	: 2: 0: 0: 0 : 2

Course Objectives:

1. To acquaint students with the concepts, types and elements, formats of Report and Proposal writing.
2. To help the students get an idea about intellectual property rights, patent laws and how to file a patent.

Course Outcomes:

1. After completion of the course students will able to understand the concept and scientific writing. They will be able to draft suitable and effective reports and scientific journal papers.
2. They will also get an idea about patent laws and will know how to file a patent

Total hours: 26 Hrs

MODULE I: Scientific writing:

13 Hrs

Introduction and overview: Types of projects (Hypothesis- driven projects, Discovery-driven projects, Technology- driven projects) Outlining the proposal, Project Summary, background, Specific aims, Hypothesis, Research strategy: Significance, Innovation and Approach, Bibliography and Reference writing. Ethics in proposal writing- Plagiarism.

Writing Reports and Proposal: Objectives, Concept of report writing; Elements of report; types of reports; Dos and Don'ts of report writing; **Formats for report.** Concepts of **Proposal writing**, Characteristics of proposal, Types of proposal, Elements of proposal writing; Purpose of a research proposal.

MODULE II: Intellectual Property Rights

13 Hrs

Intellectual property rights-TRIPS, GATT-International conventions patents and methods of application of patents-Legal implications- Biodiversity and farmer rights.

Patents and Patent Laws: Concept of Patenting law - Objectives of the patent system (Basic principles and general requirements of patent law), biotechnological inventions and patent law-Legal Development-Patentable subjects and protection in biotechnology-The patenting living organisms.

REFERENCES

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2. Ganguli Prabuddha Gearing up for Patents.....The Indian Scenario” , Universities Press (2098)
3. Ganguli Prabuddha “Intellectual Property Rights--Unleashing the Knowledge Economy”, Tata McGrawHill (2001)
4. Ganguli Prabuddha and Jabade Siddharth, “Nanotechnology Intellectual Property Rights.....Research, Design, and Commercialisation”, CRC Press , Taylor and Francis Group, USA (2012)
5. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local communities Darrell A. Posey and Graham Dutfield , IDRC Books; annotated edition (June 2096).
6. Vedder, Scott. Signs of a Great Résumé: How to Write a Resume that Speaks for Itself. Veterans Edition. 2014. Print.
7. Block, Jay A. and Michael Betrus. 101 Best Resumes: Endorsed by the Professional Association of Resume Writers . New York: McGraw-Hill., 2097. Print.
8. Kulkarni, R. A. (2001). A Handbook of Communication Skills in English. Kolhapur: PhadakePrakashan.
9. Chand, S. (2073). Modern Commercial Correspondence. New Delhi: S. Chand & Company Ltd.

SEMESTER/YEAR	: IV SEM / II YEAR
COURSE CODE	: 20MSC5401
TITLE OF THE COURSE	: RESEARCH METHODOLOGY
L: T: P: S/P: C	: 3: 0: 0: 0 : 3

COURSE OBJECTIVE:

1. Students understand research terminology one that can be used to carry out different approaches to research
2. be aware of the ethical principles of research, challenge and approval processes

COURSE OUTCOME:

1. Demonstrate knowledge of research processes (reading, evaluating and developing)
2. Compare and contrast qualitative and quantitative research

TOTAL HOURS: 40

MODULE 1:

10Hrs

Meaning, Objectives and Characteristics of research. Research Methods Vs Methodology. Types of research. Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical. Research process. Criteria of good research. Developing a research plan.

MODULE 2:

10Hrs

Defining the research problem. Techniques involved in defining the problem Survey of literature. Primary and secondary sources. Reviews, treatise, monographs patents. Identifying gap areas from literature review. Development of working hypothesis.

MODULE 3:

10Hrs

Research design and methods - Basic Principle. Features of good design. Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan. Exploration, Description, Diagnosis, and Experimentation. Determining experimental and sample designs.

MODULE 4:

10Hrs

Sampling design - Steps and types in sampling design. Measurement and scaling techniques. Methods of data collection. Testing of hypotheses. Procedure for hypotheses testing flow diagram for hypotheses testing. Data analysis with Statistical Packages. Correlation and Regression. Important parametric test. Chi-square test. Analysis of variance and Covariance.

REFERENCES:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
6. Day, R.A., 1992. How to Write and Publish a Scientific Paper, Cambridge University Press.
7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MBT5201
TITLE OF THE COURSE : GENETIC ENGINEERING
L: T: P: S/P: C : 4: 0: 0: 0 : 4

Total hours: 52

MODULE I: Basic Concepts

13hrs

DNA Structure and properties; Enzymes in genetic engineering - Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Recombinases, CRISPR – cas system for gene and genome editing, Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization.

MODULE II: Cloning and expression vectors

13hrs

Plasmids; Bacteriophages; M13 mp vectors; pUC20 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/baculo& retroviral vectors; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors. Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Inclusion bodies; Methodologies to reduce formation of inclusion bodies.

MODULE III: Cloning Strategies and study of protein-DNA interactions

13hrs

Gene transfer in host cells (transformation, electroporation, transfection, microprojectile, liposome – mediated, gene gun), construction and screening of genomic and cDNA libraries; construction of microarrays –cDNA arrays and oligo arrays; techniques for DNA – protein interactions - electrophoretic mobility shift assay; DNaseI footprinting; methyl interference assay, chromatin immunoprecipitation; phage display, principle of Surface Plasmon Resonance (SPR) and its application to study protein-protein interactions.

MODULE IV: Sequencing, PCR and its applications

13hrs

Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina, 454, SOLiD sequencing).

PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), ASA (Allele-Specific Amplification).

REFERENCES:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006

4. Glick and Pasternak (2098) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
5. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,
6. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
7. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication
8. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers
9. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
10. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER/YEAR : II SEM

COURSE CODE : 20MBT5202

TITLE OF THE COURSE : ADVANCED CELL BIOLOGY

L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total hours: 52

MODULE I: Cell types, cell cycle and its control 13hrs

Cell types: Structure of prokaryotic and eukaryotic cells, ultrastructure of animal and plant cell. Cell division and control: Mitosis, meiosis and their genetic significance.

Cell cycle: Functional events of cell division and molecular mechanism of cell cycle, Control mechanisms: Role of cyclins, *Cdks* and inhibitors of cell cycle progression, Cell cycle check points, control of cell numbers in multicellular organisms, Cell death: Apoptosis and necrosis, related pathways, cell senescence.

MODULE II: Membrane transport 13hrs

Biological membranes: Structure and properties, Models of cell membrane, membrane constituents- phospholipids, glycolipid, cholesterol, membrane proteins.

Transport of nutrients- transport of ions and macromolecules, diffusion, osmosis, reverse osmosis; Types of transport mechanisms: active and passive transport, symport, antiport,

co-transport, endocytosis and exocytosis; Transport Pumps and Proteins: Ionophores, permeases, Na⁺/K⁺ Pump, Ca²⁺ Pump. ABC transporter and Multidrug resistant protein.

MODULE III: Cytoskeleton and Cell-cell interactions

13hrs

Cytoskeletal elements: Microtubules, microfilaments and intermediate filaments, microtubule polymerization dynamics, MAPs, actin polymerization dynamics, muscle contraction, Cilia and flagella of prokaryotes and eukaryotes. Cytoskeletal diseases, Extracellular matrix (ECM) and its biomolecules: Collagen, proteoglycans, fibronectin and lamins.

Cellular junctions: desmosomes, tight junctions, gap junctions and plasmodesmata.

MODULE IV: Cell Signaling and Antioxidant defense system

13hrs

Cell signaling: Principles of cell signaling, intercellular signaling: endocrine, paracrine and autocrine signaling, Extracellular Messengers & their receptors, signaling via G-protein coupled receptors, enzyme linked receptors and kinase receptors. Role of GPCRs in sensory perceptions. (Ca²⁺/Cyclic modulators –cAMP, cGMP, IP3, DAG, Nitric Oxide). Role of secondary messengers, Regulation of Glucose levels.

Antioxidant defense system: Free radicals-ROS, RNS, effect of free radicals on proteins, lipids and nucleic acids, and their clinical importance. Mechanism of antioxidant defense system (Glutathione, catalase, SOD, peroxidase).

REFERENCES:

1. Alberts et al., (2002). Molecular Biology of the Cell, Garland Publishing, Inc., 4th ed.
2. Cooper, G.M. (2007). The Cell: A molecular approach, ASM Press, USA.
3. Darnell, J., Lodish, H., Baltimore, D. (2000). Molecular Cell Biology. Scientific American Books Inc. NY. Edwards and Hassall (2000). Biochemistry and Physiology of cell, 2nd Edn. McGraw Hill Company.
4. Garrett, R.H., Gresham, C.M. (2005). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
5. Karp, G. (2006). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.
6. Lodish et al., (2007). Molecular Cell Biology, W.H. Freeman & Company, New York, 6th edition.
7. Hallwell, B., Gutteridge, J.M.C. (2002). Free Radicals Biology and Medicine. Oxford Press. UK.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MBT5271
TITLE OF THE COURSE : CELL BIOLOGY AND RECOMBINANT DNA TECHNOLOGY - LAB
L: T: P: S/P: C : 0: 0: 6: 0 : 3

1. Micrometry: Calibration of stage and ocular micrometer and measurement of the given biological sample
2. Counting of cells: Hemocytometer
3. Study of meiosis –Grasshopper testis/onion flower buds
4. Vital staining of mitochondria.
5. Preparation of competent *E. coli* cells
6. Transformation plasmid in *E. coli* and screening of transformants.
7. Isolation of plasmid DNA from *E. coli* (mini-prep) and its analysis.
8. Amplification of DNA using PCR and analysis by agarose gel electrophoresis.
9. Restriction digestion of vector/DNA and its analysis.
10. Ligation of DNA fragments and its analysis.

REFERENCES:

1. Cell biology, Genetics, Molecular biology, evolution and ecology

SEMESTER/YEAR : III SEM/2nd year
COURSE CODE : 20MBT5301
TITLE OF THE COURSE : IMMUNOLOGY
L: T: P: S/P: C : 4: 0: 0: 0 : 4

Course Objectives:

1. Impart fundamental concepts of Immune system and its workings.
2. Instill basic understanding of MHC, TCR, antibodies, antigens, T cells, specific immune response; application of antibodies as reagents.
3. To instill principles of vaccines as disease preventive agents; principles of hypersensitivity and autoimmune disorders.

Course Outcomes:

1. Students will develop a clear basic understanding of the fundamentals of mammalian immune system as our defense against pathogens as well as the concept of vaccines as protective agents.
2. Enable sufficient knowledge in application of antibodies as analytical tools.
3. Equip the students with sufficient basic knowledge necessary to understand concepts in research methodologies and in other Biotechnology courses, they study.

Total hours: 52 Hrs

MODULE I: Immune System

13 Hrs

Innate immunity Vs adaptive immunity, cell mediated and humoral immunity, immune cells (T cells B cells, NK cells, Macrophages, DCs, granulocytes, mast cells, Inflammation concept, lymphoid organs. Basic outline of negative and positive T and B cell selection, self MHC restriction during the developmental lymphoid cells. T-cell sub-sets. Complement activation, Classic, and alternative pathway and biological function.

MODULE II: Antigens and Antibodies

13 Hrs

Antigens- Immunogenicity versus Antigenicity, Factors that influence immunogenicity. Concept of epitopes.

Immunoglobulins: Basic structure of Immunoglobulins -Fine structure of Immunoglobulins - Immunoglobulin domains-variable region and constant region domains. isotopic, allotypic and idiotypic variation. Immunoglobulin classes, functions of Ig class. Organization and expression of Immunoglobulin Light and Heavy chain genes- generation of antibody diversity, scheme of T-cell receptor diversity. Class switching.

MODULE III: Immune Responses

13 Hrs.

Major histocompatibility complex (MHC); structure and organization of MHC Class I and Class II molecules. Concept of antigen specific receptor. T-cell receptor; antigen processing, antigen presentation; products and factors produced by T-cell activation; APC; cytokines. Lymphocyte migration, homing and trafficking; and chemokines; B cell activators; B-cell and helper T-cell subset interactions; cytotoxic T-cell mediated killing. Clonal selection theory, Primary and secondary immune responses. Immune response to infections, autoimmune diseases. Immune response to infectious diseases; Autoimmune diseases- Rheumatoid arthritis, multiple sclerosis; hypersensitivity reactions

MODULE IV: Immunological techniques and vaccines

13 Hrs.

Concept of polyclonal vs monoclonal antibodies. Immunofluorescence ELISA, Western blotting. Flow Cytometry. Fractionation of leukocytes under density gradient.; Hybridomas and their production. Active & Passive immunization, Role of vaccines in prevention of diseases, Types of vaccines (Heat inactivated vaccines; Attenuated vaccines; Recombinant vaccines; Subunit vaccines)

REFERENCES

1. Kindt TJ, Osborne BA, Goldsby RA. Kuby Immunology, Sixth Edition. 6th edition. New York: W. H. Freeman & Company; 2006.
2. Kuby Immunology 7th edition. Macmillan Publishers 2014.
3. Kuby Immunology, 8th Edition | Macmillan Publishers 2020.
4. Roitt IM (2001) Essentials of Immunology, Blackwell Scientific Publishers, London.
5. Murphy, K., Weaver, C., Weaver, C., 2016. Janeway's Immunobiology. W.W. Norton & Company. <https://doi.org/10.1201/9781315533247>
6. Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J., Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J., 2001. Immunobiology, 5th ed. Garland Science.
7. Abbas, Lichtman, Pillai (2011) Cellular and Molecular Immunology (7th Ed), Elsevier
8. C Vaman Rao (2007) Immunology (2nd Ed), Narosa Publishing.

SEMESTER/YEAR : III SEM/2nd Year
COURSE CODE : 20MBT5302
TITLE OF THE COURSE: : INDUSTRIAL BIOTECHNOLOGY
L: T: P: S/P: C : 4: 0: 0: 0 : 4

Course Objectives:

- To help students achieve knowledge in principles and concepts relevant to industrial biotechnology.
- To familiarize the students with upstream and downstream processing, types of fermenters and production of important microbial products.

Course Outcomes:

- Students will be updated with the current methods of fermentation process, modern fermenters and strategies for isolation of industrially important strains.
- Student will be able to apply the knowledge in their future with respect to industrial biotechnology processes.

Total hours: 52 Hrs

MODULE I: Microbial growth, development and maintenance 13 Hrs

Microbial growth and death kinetics (particularly with reference to industrially useful microorganisms). **Screening, Isolation. Identification and characterization of industrially important microbes.** Strain improvement- mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centres.

MODULE III: Bioreactors and Fermentation 13 Hrs

Scope and importance of fermentation in industrial Biotechnology, Basic components, design and scale-up of fermenters – Typical fermenter. Types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. **Conditions regulating fermentation - pH, temperature, dissolved oxygen, foaming and aeration.** Types of fermentation - batch fermentation and chemostat, submerged and solid substrate fermentation.

MODULE IV: Upstream Processing and downstream processing 13Hrs

Formulation of fermentation media. Rheology of fermentation media. Nutrients: growth factors, carbon, nitrogen, energy and mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization; culturing techniques of microbial strains; inoculum preparation and inoculum development. Steps in recovery and purification of fermented products. Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid- Liquid extraction, Solvent recovery, Supercritical fluid extraction, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing, Effluent treatment.

Module V: Industrial Bioprocessing**13Hrs**

Industrial alcohol production and organic acids (citric acid), Non-alcoholic beverages (coffee, tea), food additives, biopolymers (dextran, alginate), biosurfactants, lipids & oils. Enzymes: Production of Amylases-Fungal and Bacterial Amylase. Amino acid production- L- Glutamic acid and L-lysine. Industrial production of health care product: Vaccines (Hepatitis B) and hormones (human insulin), antibiotic (Penicillin and Streptomycin).

REFERENCES:

1. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 2091.
2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
3. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon Press, Oxford, 2097.
4. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, (2nd Ed). Taylor & Francis Ltd, UK, 2007.
5. Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology (2nd Ed.) Cambridge University Press. 2002.
6. Prescott, Sc and Dunn, C. Industrial Microbiology, McGraw Hill, New York. 2084
7. Michael, L. Shulers and Fikret Kargi. Bioprocess Engineering: Basic concepts (2nd Ed.) Prientice Hall Publishers. 2001
8. Paulins, M. D. Bioprocess Engineering Principles. John Wiley Publishers.2003

SEMESTER/YEAR : III SEM**COURSE CODE : 20MBT5371****TITLE OF THE COURSE : BIOPROCESS TECHNOLOGY AND IMMUNOTECHNIQUES-LAB****L: T: P: S/P: C : 0: 0: 6: 0 : 3****Course Objectives:**

1. To equip students with techniques for industrial production.
2. To learn immune techniques used as diagnostic tools.

Course Outcomes:

1. This course will enable students to learn techniques which can be used in industrial production.

2. It will also teach diagnostic immune techniques routinely used in medical laboratories

PRACTICALS

1. ELISA/Dot ELISA
2. Radial Immunodiffusion/Ouchterlony Double Diffusion
3. Rocket Immuno Electrophoresis
4. Demonstration of a fermenter and its types.
5. Preservation techniques of industrially important microorganisms – soil, glycerol, mineral oil and lyophilization.
6. Production of organic acids (citric acid) from microbes
7. Immobilization technique: whole cell or enzyme- sodium alginate gel method and demonstration of its significance.
8. Production of antibiotic (penicillin) by submerged and solid substrate fermentation.
9. Laboratory scale production of wine/beer.
10. Estimation of alcohol by specific gravity method and determination of total acidity and non-reducing sugars (2 units)
11. Sterility tests for pharmaceutical products
12. Production of amylase by solid substrate fermentation.
13. Production of yoghurt and estimation of lactic acid at different time intervals.

REFERENCES:

1. Kuby J, Judy Owen, Jenni Punt, Sharon Stranford (2013). Immunology. 7th Edition. W.H. Freeman and Company.
2. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Springer, 2008. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt (2011). 12th edition, Essential Immunology, ELBS, Blackwell Scientific Publishers, London
3. William E Paul (2012). Fundamentals in Immunology. 7th edition, Raven Press.

SEMESTER/YEAR : III SEM

COURSE CODE : 20MBT5372

TITLE OF THE COURSE : ELECTIVE BASED PRACTICAL- II

L: T: P: S/P: C : 0: 0: 6: 0 : 3

Course Objectives

1. The course will help in making the students learn basic techniques for understanding genetic concepts and detecting human genetic diseases.
2. The course imparts practical knowledge on methods and tests useful in water quality assessment and determination of medical risks.

Course Outcome:

1. Students will have fundamental practical knowledge of the techniques for understanding genetic diseases
3. Students will acquire practical knowledge on methods and tests useful in water quality assessment and determination of medical risks.

PRACTICALS

1. Karyotyping of normal/abnormal chromosome set
2. Restriction digestion and Restriction mapping
3. Identification of inactivated X- chromosome as Barr body.
4. Demonstration of PCR technique.
5. Estimation of SGPT/SGOT in serum samples.
6. Estimation of serum cholesterol by Zak's method.
7. Determination of Dissolved Oxygen, Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) (3 units)
8. Isolation and enumeration of biodegradative microorganisms (hydrocarbons/ pesticides/ heavy metals) or cellulolytic microorganisms from soil.
9. Potable water quality assessment-MPN

REFERENCES

1. S.B. Primrose, R.M. Twyman and R.W. Old; Principles of Gene Manipulation. 6th Edition, S.B. University Press, 2001.
2. J. Sambrook and D.W. Russell; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Glick and Pasternak (2008) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
4. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

5. Ronald L Dooste- Theory and Practical of water and waste water treatment.

SEMESTER/YEAR: III SEM
COURSE CODE: 20MBT5321
TITLE OF THE COURSE: PLANT BIOTECHNOLOGY
L: T: P: S/P: C : 3: 0: 0: 0 : 3

Course Objectives:

- To equip the students with fundamentals of culturing plant cells and tissues, culture environment, cell proliferation, differentiation, and media formulation.
- To familiarize the students with knowledge on various recombinant DNA techniques to produce genetically modified organisms with novel traits.

Course Outcomes:

- The students will learn the fundamentals of culturing plant cells and tissues, culture environment, cell proliferation, differentiation, and media formulation.
- The students will acquire knowledge on various recombinant DNA techniques to produce genetically modified organisms with novel traits.

Total hours: 40 Hrs

MODULE I: Plant Tissue Culture **10 Hrs**

Scope and Importance of plant tissue culture; Totipotency; Media composition and types, hormones and growth regulators, **Organogenesis; Micropropagation; Somatic embryogenesis** and its applications; Somaclonal variation; Anther culture for haploid production and its applications in plant breeding; Protoplast isolation; Culture and usage; Somatic hybridization - methods and applications; Cybrids. Cell cultures for secondary metabolite production

MODULE II: Genetic Transformation Techniques for plants **10Hrs**

Agrobacterium-plant interaction; organization of Ti and Ri plasmids; T-DNA transfer; Disarming the Ti plasmid.

Agrobacterium-mediated transformation; Cointegrate and binary vectors and their utility; viral based vectors. Direct gene transfer PEG-mediated, electroporation, particle bombardment and alternative methods; Screenable and selectable markers; stability of transgene; Transplastomic technology; Marker-free methodologies; Gene editing by TALEN and Crispr techniques

MODULE III: GM Technology and Plant Trait improvement **10 Hrs**

GM Strategies for Biotic and Abiotic Stress Resistance/Tolerance, Herbicide, bacterial and fungal resistance crops

Concept of bio factories; Production of pharmaceutical proteins Plantibodies, vaccines and industrial enzymes in plants. Metabolic engineering for oil improvement, Crop improvement and fortification of agricultural crops–Bt cotton, Bt brinjal, transgenic sweet potato and Golden rice. Ethical, regulatory and environmental issues associated with GM crops and GM food;

MODULE IV: Molecular Breeding: Molecular Mapping & Marker Assisted Selection

10 Hrs

Molecular markers: RFLP, RAPD, SCAR, STS, AFLP, and SNP markers; Construction of genetic and physical map; Quantitative and qualitative characters. MAS for genes of agronomic importance, e.g. insect resistance, grain quality and grain yield; QTL mapping and cloning. Application of Molecular Markers: Genotyping tools as plant variety protection, hybrid purity tests.

REFERENCES

1. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing
2. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
3. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford Publishing.
4. Santosh Nagar and MadhavAadhi (2010) Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications
5. B D Singh (2014) Biotechnology: Expanding horizons, Kalyani Publishers.
6. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.
7. Halford N.G. Plant biotechnology: current and future applications of genetically modified crops. John Wiley Publishers.2006

SEMESTER/YEAR	: III SEM
COURSE CODE	: 20MBT5322
TITLE OF THE COURSE	: ANIMAL BIOTECHNOLOGY
L: T: P: S/P: C	: 3: 0: 0: 0 : 3

Course Objectives:

1. To acquaint the students with the basic concepts of animal cell culture set up and conditions.
2. To Equip the students with fundamentals of gene transfer methods for mammalian cells and animal transgenics followed by important applications of animal biotechnology

Course Outcome:

1. Will learn about basic animal cell culture conditions and its uses.
2. Be able to describe techniques and problems both technical and ethical in animal cloning.
3. Will be equipped with the wide area of applications of biotechnology in modern world.

Total hours: **40 Hrs**

MODULE I: Basics of Animal Tissue Culture **10 Hrs**

Introduction, cell culture laboratory-design and layout. Equipment and Instrumentation. Methods of sterilization, **Detection of Mycoplasma and viral contaminants**, types of culture **media, composition, preparation**. Serum and protein free defined media. Role of CO₂, Serum, supplements, Culture and maintenance of primary and established cell lines. Biology of cultured cells: Culture environment, cell adhesion, cell proliferation and differentiation. Characterization of cultured cells, viability, cytotoxicity.

Module II: Stem Cells **10 Hrs**

Stem cells – Adult, embryonic, Induced pluripotent stem cells. Stem cells from adult organs- Characteristics, isolation, culture and characterization protocol, long-term maintenance and characterization. **Tissue engineering**, biomaterials used in tissue engineering, three-dimensional culture and transplantation of engineered cells

Module III: Transgenic animals

10 Hrs

Methods involved in the production of transgenic animals, importance and applications of transgenic animals. Gene knock out and mice models for tackling human diseases. IVF-technology for livestock and humans. Bioethics associated with developing transgenic animals - Use of cell cultures as alternative for animal models for research. Animal and human cloning- ethical and social issues.

Module IV Applications of Animal Biotechnology

10 Hrs

Disease resistant, recombinant vaccines for poultry, livestock pharming products. **Pharmaceutical products produced by mammalian cells** - plasminogen activator, erythropoietin, blood clotting factors, interleukins, interferons, **Cell culture-based vaccines**.

Biosafety: The Cartagena protocol on biosafety. Good manufacturing practice and Good lab practices (GMP and GLP).

REFERENCES:

1. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell.
2. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons
3. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
4. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA
5. Ernst-L Winnacker, From Genes to Clones: Introduction to Gene Technology. WILEYVCH Verlag GmbH, Weinheim, Germany Reprinted by Panima Publishing Corporation, New Delhi. 2003
6. Brown, T. A. (2006). Gene cloning and DNA analysis: An introduction. Oxford: Blackwell Pub

SEMESTER/YEAR	: III SEM
COURSE CODE	: 20MBT5323
TITLE OF THE COURSE	:PRINCIPLES OF ENZYMOLOGY AND METABOLISM
L: T: P: S/P: C	: 3: 0: 0: 0 : 3

Course Objectives

1. To impart basic concepts of metabolisms of carbohydrates, amino acids, nucleotides and lipids, Oxidative phosphorylation and generation of ATP.
2. To equip students with basic understandings of concept of enzymology.

Course Outcomes

1. Students will be equipped with the basic concepts of metabolism of biological fuels in biological systems and oxidative phosphorylation process involved in ATP synthesis.
2. Gain sufficient knowledge on the role of enzymes and the nature of their action in metabolism.

Total hours: 40 Hrs

MODULE I: Enzymes and basic enzyme kinetic concepts

10 Hrs

Basic Concepts of Enzymes: factors affecting enzyme activities, active site, allosteric site, coenzymes and co factors. Mechanism of enzyme action: lock and key model and induced fit hypothesis. Enzyme activity and Specific activity. Isozymes and their significance.

Enzyme Kinetics: Basic chemical kinetics, rate of reaction, Significance of K_m , V_{max} and K_{cat} , basic concepts of Lineweaver-burk plot and its relevance.

Enzyme inhibition and regulation: Basic concepts of reversible and irreversible inhibition with suitable examples, competitive, uncompetitive, non-competitive inhibitors with relevant kinetic plots. Regulation of enzyme activity: Covalent modulation, Allosteric regulation, ligand interactions, co-operative interactions, feedback regulation

MODULE II: Carbohydrate and amino acid metabolism

10 Hrs

Carbohydrate metabolism; Introduction, glycolytic pathway. Gluconeogenesis pathway. Role of LDH. TCA cycle. HMP pathway, Cori's cycle. Brief scheme of glycogen metabolism. Pasteur

effect, fermentative pathways in microorganisms. Amino acid metabolism: General metabolic reaction of amino acids– transamination, glucose – alanine cycle, oxidative deamination (glutamate dehydrogenase), minor pathways of amino acid degradation – trans deamination, amino acid oxidase, and non – oxidative deamination. Urea cycle, Biosynthesis and degradation of essential amino acids. Disorders of amino acid metabolism (PKU, Alkaptonuria).

MODULE III: Nucleotide and Lipid metabolism

10 Hrs

Nucleotide metabolism: biosynthesis of purine and pyrimidine nucleotides (de-novo and salvage). Degradation of purine and pyrimidines, and disorders associated with their metabolism.

Lipid Metabolism: Oxidation of fatty acids: beta oxidation. Cholesterol biosynthesis. Scheme of transport of cholesterol -LDL receptor pathway. Lipoproteinemia, fatty liver, hypercholesterolemia. Biological functions, and metabolic fate of VLDL, LDL and HDL.

MODULE IV: Oxidative phosphorylation

10 Hrs

Oxidative phosphorylation: Mechanism of proton pumping. Proton motive force and the Mitchell hypothesis. FoF1- ATPase- structure and mechanism. Coupling of electron transfer to ATP synthesis. Mechanism of oxidative phosphorylation, Uncouplers, inhibitors, and ionophores.

REFERENCES

1. Enzymes - Biochemistry, Biotechnology, Clinical Chemistry, Palmer and Bonner, Elsevier Press (2007).
2. Enzymes-Biochemistry, Biotechnology, Clinical Chemistry, Trevor Palmer, 2nd edition, 2008, East-West Press Edition, Horwood Publishing limited.
3. Enzyme kinetics and mechanisms. TAYLOR (Kenneth B). 2009, Kluwer Academic Press
4. Fundamentals of Enzymology, Price and Stevens, Oxford University Press (1999).
5. Fundamentals of Enzyme Kinetics, Bowden, Portland Press (2004).

6. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland, Wiley-VCH Publishers (2000).
7. Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, Blackwell Science (2000).
8. Biochemical Calculations, 2nd Ed. Irwin H. Segel, John Wiley and Sons (1976).
9. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry 4th edition Pub: WH. Freeman Co.
10. Stryer, L. Biochemistry 4th Edn. W.H. Freeman and Co. NY.
11. Devlin, T.M. (1997). Biochemistry with clinical correlations, John Wiley & Sons
12. Zubay, G.L. Parson, W.W., Vance, D.E. (1994). Principles of Biochemistry WmC Brown publishers. Oxford.
13. Biochemistry, Voet and Voet, 4th Ed, Wiley (2010).

SEMESTER/YEAR	: III SEM
COURSE CODE	: 20MBT5324
TITLE OF THE COURSE	: HEALTH AND ENVIRONMENTAL BIOTECHNOLOGY
L: T: P: S/P: C	: 3: 0: 0: 0 : 3

Course Objectives:

1. To impart basic knowledge in environmental science, issues and biotechnological applications in waste management.
2. To familiarize students with basic concepts involving health and disease, infectious disease.
3. To give conceptual knowledge of the principles behind molecular therapeutics and nanobiotechnology.

Course outcomes:

1. Students will be equipped with basic foundation of Biotechnological applications to environmental and medical problems.
2. Students will gain basic knowledge in application of nanobiotechnology to molecular therapeutics

Total Hours: 40 Hrs

MODULE I: Waste Water and Solid Waste Management

10 Hrs

Waste/Sewage water treatment: Concept of soil, air and water pollution. Waste water characteristics, Source of water pollution, Measurement of water pollution, waste water treatment-physical, chemical, biological processes. Aerobic processes; Activated sludge, oxidation ditches, trickling filter, oxidation ponds; Anaerobic processes; Anaerobic digestion, anaerobic filters, anaerobic sludge, membrane bioreactors, and enzyme immobilization technique, Reverse osmosis and ultra-filtration. Treatment of industrial effluents: dairy, distillery and tannery industries.

Solid waste management: sources and types of waste, management of solid waste (non-hazardous, hazardous medical and electronic waste), composting and vermicomposting in solid waste management, biogas, biofertilizer, biofuel, bioplastics and biopesticides.

MODULE II: Application of Biotechnology in Environmental Management 10 Hrs

Bioremediation: Concept, principles and techniques, bioremediation using microbes.

Biosorption of heavy metals and phytoremediation. Biodegradation and bioconversion of natural and xenobiotic compounds (Lignocellulose, petroleum products and heavy metals)

Biomining and Bioleaching: types and methods, microorganism in mineral recovery, advantages and disadvantages.

MODULE III: Biology of Human Diseases 10 Hrs

Evaluation of organ functions: liver, kidney, cardiac function tests with the significant serum biomarkers. Infectious (communicable) diseases: Cause, Symptoms and treatment/prevention- Bacterial infections (Typhoid), Viral infections(H1N1), STDs. Pregnancy and infections. Genetic Disorders of Humans: Symptoms and treatment of the Genetically inherited diseases: PKU, Alkaptonuria, Galactosemia, Lesch- Nyhan syndrome, Gout, , Beta Thalassemia and Diabetes.

MODULE IV: Molecular Therapeutics and Nanobiotechnology 10 Hrs

Drugs, drug receptors, Relationship between drug concentration and response, agonists, drug clearance, biological half-life, drugs accumulation, basic concepts of toxic effect (methotrexate and rifampicin).

Gene therapy: overview of inherited and acquired diseases for gene therapy; barriers to gene delivery, Retro and adeno virus mediated gene transfer; Liposome mediated gene delivery, use of stem cells.

Recombinant products: Erythropoietin, Insulin and Streptokinase.

Nanobiotechnology: introduction, synthesis of nanomaterials, brief overview on mechanisms of nanomaterials synthesis, types of nanomaterials, basic concept of protein and DNA based nano structures, medical applications of nanomaterials

REFERENCES

1. Judit Pongracz and Mary Keen, Medical Biotechnology 1st Edition, Elsevier publications, 2008
2. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic concepts and Applications (2nd Ed) IK International Publishing House
3. Pradipta Kumar Mohapatra (2006) Textbook of Environmental Biotechnology, IK Publishing House
4. Parihar (2008) Environmental Biotechnology-Fundamentals and Application, Agrobios (India).
5. SK Agarwal (2005) Advanced Environmental Biotechnology, APH publishing corporation.
6. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

SEMESTER/YEAR	: III SEM
COURSE CODE	: 20MBT5325
TITLE OF THE COURSE	: GENOMICS AND PROTEOMICS
L: T: P: S/P: C	: 3: 0: 0: 0 : 3

Course Objectives:

1. The course aims to appraise the students to basic and high throughput techniques in Genomics and Proteomics and their applications.

2. To aware students the concepts to make them capable to propose appropriate methods for analysis of given sample type with respect to purpose of analysis

Course Outcomes:

1. Students will be equipped to infer the basic concepts of genomics, transcriptomics and proteomics.
2. List and discuss the use of genomics and proteomics in human health.
3. Suggest and outline solution to theoretical and experimental problems in Genomics and Proteomics fields.

Total hours: 40 Hrs

MODULE I: Genome Organization, structure and mapping 10 Hrs

Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast. Recognition of coding and non-coding sequences and gene annotation. Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques.

Module II: Genome sequencing and analysis 10 Hrs

Genome sequencing. Clone contig method, Next Gen Sequencing, Genome sequencing projects of E. coli., yeast, and human genome project. Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; Genome sequence data bases, expressed sequenced tags (ESTs), Genome sequence analysis. determining gene location in genome sequence, Promoter prediction methods

Module III: Proteomics 10 Hrs

Protein analysis (includes measurement of concentration, amino-acid composition, N terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectric focusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; Mass Spectroscopy, Concept of MudPIT (Multidimensional Protein Identification Technology), Protein-protein interactions, proteome databases.

Module IV: Functional and comparative Genomics 10 Hrs

Transcriptome analysis-transcripts of a tissue; Massively parallel signature sequencing (MPSS), Expression profiling in human diseases. Orthologs, homologs, paralogs, gene evolution, protein evolution by exon shuffling, comparative genomics of closely related bacteria. Introduction to metabolomics, lipidomics, metagenomics, systems biology, Pharmacogenetics and drug development

REFERENCES

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry
2. 2nd Edition. Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
4. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.

SEMESTER/YEAR : III SEM
COURSE CODE : 20MBT5326
TITLE OF THE COURSE : Human Genetic Diseases
L: T: P: S/P: C : 3: 0: 0: 0 : 3

Course Objectives:

1. To help students in understanding the genetic basis of different diseases.
2. To familiarise students with basics of cytogenetic analysis

Course Outcomes:

1. Students will grasp the concepts of genetic basis of different diseases.
2. Students will understand the basics of cytogenetic analysis.

Total hours: 40 Hrs

Module I: Genetic factors in common diseases **10 Hrs**

Genetic susceptibility to common diseases. Genetic approaches to common diseases. Diabetes mellitus, Hypertension, Coronary artery, diseases, Alzheimer's disease, Congenital abnormalities, Huntington's disorder, Neurofibromatosis, Cystic fibrosis, Duchenne Muscular Dystrophy (DMD), Becker muscular dystrophy, Hemophilia A and B. Trinucleotide Repeat Expansion mutations and their remediation.

Module II: Biochemical genetics and pharmacogenetics **10 Hrs**

Biochemical genetics: Inborn errors of metabolism, molecular and biochemical pathways and their basis of Phenylketonuria, Alkaptonuria, Maple syrup urine disease, Mucopolysaccharide and Galactosemia, Albinism

Pharmacogenetics: Definition, drug metabolism, Genetic variation revealed solely by the effect of drugs, Hereditary disorders with altered drug response, Evolutionary origin of

variation in drug responses, Pharmacogenomics, Molecular detection of diseases after human genome project, Drug discovery.

Module III: Cellular and molecular cytogenetic technologies

10 Hrs

Cell lines, Cell and tissue culture practices, harvesting of cells for chromosomal analysis, Conventional and specialized staining protocols, Imaging in cytogenetic practices, Chromosome jumping and walking, Chromosome instability and fragile sites.

Module IV: Diagnosis of prenatal and haematopoietic disorders

10 Hrs

Prenatal diagnosis: Amniocentesis, Chorionic villi biopsy, Cytogenetics of prenatal chromosomal abnormalities with clinical citations, Genetic counselling, Chromosomal diagnostics in hematopoietic disorders: Myeloid disorders, AML, CML and lymphoid leukaemia, lymphoblastic lymphoma and their chromosomal changes, Chromosome changes in benign and malignant tumors, Cytogenetics of breast cancer.

REFERENCES

1. Peter Sudbery 2002. Human Molecular Genetics (Second Edition), Prentice Hall.
2. Tom Strachan & Andrew P. Read 1999. Human Molecular Genetics (2nd Edition), John Wiley & Sons
3. M.A. Jobling, M.E. Hurles & C. Tyler-Smith, 2004. Human Evolutionary Genetics-Origins, Peoples & Disease, Garland Science.
4. Jorge J. Yunis, 1977. Molecular Structure of Human Chromosomes, Academic Press.
5. Elaine Johansen Mange & Arthur P. Mange, 1995. Basic Human Genetics (Second Edition), Sinauer Associates, Inc.
6. Ricki Lewis, 1998. Human Genetics-Concepts & Applications (3rd Edition), McGraw-Hill.
7. Margarlet J. Barch, Turid Knutsen & Jack L. Spurbeck, 1997. The AGT Cytogenetics Laboratory Manual (3rd Edition), Lippincott-Raven.
8. K.C. Sawant 2003. Concise Encyclopedia of Human Genetics, Dominant Pub. & Distributors
9. Amita Sarkar, 2001. Human Genetics, Dominant publishers and Distributors.
10. Michael Baraitser & Robin Winter, 1983. A Colour Atlas of Clinical Genetics, Wolfe Medical Publications Ltd.

SEMESTER	I					
YEAR	I					
COURSE CODE	20MSC5103					
TITLE OF THE COURSE	MOLECULAR GENETICS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
	-	-	-

COURSE OBJECTIVES :

- To understand the functions and structures of nucleic acids and proteins.
- To understand the concepts of transcription, translation, control of gene expression, mutations, DNA repair and DNA recombination

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	In-depth knowledge of biological and/or medicinal processes through the investigation of the underlying molecular mechanisms	L3

CO2	At the end student will gain an understanding of chemical and molecular processes that occur in and between cells	L3
CO3	Discuss the molecular mechanisms by which DNA controls development, growth or morphological characteristics of organisms	L4
CO4	Explain the principles of cloning and genetic manipulation and their application in genetic analysis	L3
CO5	Discuss the molecular mechanisms by which DNA controls development, growth or morphological characteristics of organisms	L2

COURSE CONTENT:

MODULE 1	13Hrs
Mendelian genetics: Concepts and theories, gene interactions, Morgan's linkage analysis, chromosome theory of inheritance. Features of <i>E. coli</i>. and Human genome, C-value paradox, Fine structure of gene, Split genes and overlapping genes. Concept of Epigenetics and Genomic imprinting. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance. Organization of Chromosomes: Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains and scaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes	
MODULE 2	13Hrs
Bacterial Recombination: plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of <i>E. coli</i>. Mechanism of Recombination: Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in <i>E. coli</i>; role of Rec A in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein	

in Meiotic recombination; Gene Conversion. Site-specific recombination: integration of lambda genome in <i>E. coli</i> . Topological manipulation of DN	
MODULE 3	13Hrs
Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation: Ames test, Mutations in mitochondrial genome and related disorders. Karyotype - normal and abnormal karyotype analysis for genetic disorders. Transposons and Molecular mechanism of transposition: Transposable elements in prokaryotes and eukaryotes – IS elements, Composite Transposons, Tn3 elements, <i>Ac</i> and <i>Ds</i> elements, P elements, Retrotransposon and their significance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesis	
MODULE 4	13Hrs
Sex Determination: Factors affecting sex determination, Mechanism of sex determination in <i>Drosophila</i> (role of <i>sex</i> gene) and mammals (role of <i>sry</i> gene). Secondary sex determination in mammals. Mechanism of dosage compensation in <i>Drosophila</i> (role of MSL genes) and mammals (X-chromosome inactivation, role of Xist RNA). Medical Molecular Genetics: Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzheimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.NO
2. NO

TEXT BOOKS :

1. John Ringo (2004). Fundamental Genetics. Cambridge University Press.
2. Griffith et al (2011) An introduction to genetic analysis (10th Edition) W.H. Freeman and Comp
3. Strachan and Read (2010) Human Molecular genetics (4th Edition) Taylor and Francis.
4. Principles of Genetics by Snustad and Simmons, 6th Edition (2011) John Wiley and Sons, Inc p
5. David Freifelder (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
6. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastysdairs and Darnell, J. (2004).Molecular
7. Snustad and Simmons. (2006). Principal of Genetics. 8th Edn. John Wiley & sons. Klug, W.S.,Cu Pearson Education.

SEMESTER	II					
YEAR	I					
COURSE CODE	20MHG5201					
TITLE OF THE COURSE	FUNDAMENTALS OF HUMAN GENETICS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To be updated with the knowledge on the basics of human genetics and genetic causes for human diseases.
- To study the genetic techniques as to gain the knowledge in the field of basic human genetics.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The fundamentals of human genetics will help to students in obtaining basic knowledge of human genetics and its importance.	L3

CO2	Students will have an idea on identifying the pattern of inheritance and genetic cause for the disease	L3

COURSE CONTENT:		
MODULE 1		13Hrs
Introduction to Genetics: Mendel and his experiments, Law of segregation and independent assortment; Chromosomal basis of segregation and independent assortment. Allelic variation and gene function, Dominance relationships, basis of dominant and recessive mutations; Multiple allelism, allelic series.		
MODULE 2		13Hrs
History and Scope of Human Genetics: Origin of Human Genetics, Present and future prospectus of Human Genetics, Pedigrees-gathering family history, pedigree symbols, construction of pedigrees; Monogenic traits-Autosomal inheritance-dominant and recessive; Sex-linked inheritance-dominant and recessive; Sex-limited and sex-influenced traits; Y-linked; Mitochondrial inheritance, Errors in transmission (Mutation), Classification of Genetic Disorders, Medical Applications of Chromosomes, Drawing of a pedigree, Consanguinity.		
MODULE 3		13Hrs
Human Cytogenetics: Review of cellular division mitosis and meiosis, Human Chromosomes, Chromosomal aberrations, Techniques in human chromosome analysis, Human karyotype: banding, nomenclature of banding, Pathology of human chromosomes, Nomenclature of aberrant karyotypes, Common chromosomal disorders and Mendelian disorders: Down syndrome, Edwards syndrome, Patau's syndrome and other trisomies, disorders of structural aberrations.		

MODULE 4	13Hrs
Complex traits: Characteristics and structure of genes, Single gene disorders, Multifactorial disorders. Polygenic inheritance of continuous (quantitative) traits, Dismorphology, Polygenic inheritance of discontinuous (dichotomous) traits-threshold model, liability and recurrence risk, Genetic susceptibility in multifactorial disorders (alcoholism, diabetes mellitus, obesity), Estimation of genetic components of multifactorial traits: empiric risk, heritability, coefficient of relationship.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.NO
2. NO

TEXT BOOKS :

1. Principle of Genetics, 8th Edition, Gardner, Simmons, Snustad.
2. Human Molecular Genetics, 2nd edition, Tom Strachan and Andrew P. Read.
3. Human Genetics, Lewis, 1999.
4. Basic human Genetics, Mange and Mange, 1999.
5. Human Molecular genetics, Strachan and Read, 2003.
6. Cummings, M.R. 1997. Human Heredity: Principles and Issues. International Thomson Publishing Co., New York.
7. Mckinlay Gardner, R.J. 2000. Chromosome Abnormalities and Genetic Counseling.

Oxford University Press, Oxford.

8. Ricki Lewis. 2009. Human Genetics-Concepts and Application. Ninth Edition. McGraw-Hill College Publishers.

9. Stern. C. 1973. Principles of Human Genetics, 3rd ed. W.H. Freeman and Company, San Francisco.

10. Turpin, R. and Lejeune, J. 1969. Human Afflictions and Chromosomal Aberrations. Pergamon Press, Oxford.

R	II					
YEAR	I					
COURSE CODE	20MHG5202					
TITLE OF THE COURSE	HUMAN BIOCHEMICAL AND IMMUNOGENETICS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To understand the genetics of biochemical disorders especially inborn errors of metabolism.

- To study the genetics of immune system and immunodeficiency diseases.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will get an idea of how genetically inherited diseases are associated with biochemical pathways.	L3
CO2	This course will help to understand the importance of genes in gaining immunity	L3

COURSE CONTENT:	
MODULE 1	13Hrs
The concept of Biochemical Polymorphism: Concept of enzyme and protein polymorphism; Effects of multiple gene loci on protein structure; Molecular structure, biosynthesis and genetics of the ABH antigens, Rh antigens and MN antigens. Quantitative and qualitative variation of enzymes; Haemoglobin variants; Hemoglobin and Hemoglobinopathies, Effects of Single Amino Acid Substitutions: Sickle cell Anaemia, Genetics of steroid and insulin receptors.	
MODULE 2	13Hrs
Inborn errors of metabolism: Disorders of aminoacid metabolism (Alkaptonuria, Phenylketonuria, Maple Syrup Urine Disease), Disorders of Carbohydrate Metabolism (Galactosemia, Hereditary Fructose Intolerance), Glycogen storage diseases (affecting liver and muscle), Lysosomal Storage Disorders (Tay-Sachs Disease), Disorders of Lipoprotein and lipid metabolism-Hyper Lipoproteinemia, FH; Disorders of Purine metabolism Lesch Nyhan syndrome; Disorders of Pyrimidine metabolism-Orotic Aciduria, Disorders of copper metabolism (Menkes and Wilson diseases).	

MODULE 3	13Hrs
Introduction to immune system: Innate and adaptive immunity, Phagocytes, the complement system, natural killer cells; The adaptive immune system: Cellular immune system, humoral immune system; Genetic basis of structure and diversity; Immunoglobulin molecules and genetic basis of antibody diversity. Organization of immunoglobulin genes, mechanism of gene rearrangements, class switching, regulation of immunoglobulin genes.	
MODULE 4	13Hrs
Regulatory mechanisms of immune system: The Major Histocompatibility complex (MHC), Organization of HLA complex , Structure of class I and II HLA molecules, Expression of HLA genes, HLA polymorphism. Immunodeficiency diseases-Agammaglobulinemia, Severe combined immuno-deficiency, Ataxia telangiectasia, Wiskott-Aldrich syndrome. Hypersensitive reactions, Cytokine-related diseases, Immunesystem in human health, Immune response to infectious diseases and malignancy, Concept of immunotherapy, Vaccines, Transplantation immunology.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.NO
2. NO

TEXT BOOKS :

1. Principle of Genetics, 8th Edition, Gardner, Simmons, Snustad.
2. Human Molecular Genetics, 2nd edition, Tom Strachan and Andrew P. Read.
3. Human Genetics, Lewis, 1999.
4. Basic human Genetics, Mange and Mange, 1999.
5. Human Molecular genetics, Strachan and Read, 2003.
6. Cummings, M.R. 1997. Human Heredity: Principles and Issues. International Thomson Publishing Co., New York.
7. Mckinlay Gardner, R.J. 2000. Chromosome Abnormalities and Genetic Counseling. Oxford University Press, Oxford.
8. Ricki Lewis. 2009. Human Genetics-Concepts and Application. Ninth Edition. McGraw-Hill Collge Publishers.
9. Stern. C. 1973. Principles of Human Genetics, 3rd ed. W.H. Freeman and Company, San Francisco.
10. Turpin, R. and Lejeune, J. 1969. Human Afflictions and Chromosomal Aberrations. Pergamon Press, Oxford.

SEMESTER	II					
YEAR	I					
COURSE CODE	20MHG5271					
TITLE OF THE COURSE	PRACTICALS IN HUMAN CYTOGENETICS, BIOCHEMICAL AND IMMUNOGENETICS					
	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits

SCHEME OF Instruction	0	0	6	-	42	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To increase students learning ability by conducting practicals of human cytogenetics, on biochemical genetics including errors in metabolism.
- To familiarize students with the various immunological techniques including antigen-antibody interactions, quantitation of antigens or antibody, agglutination reactions etc.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	After this course students would have practical knowledge of various human cytogenetic, biochemical and immunological techniques.	L4
CO2	Completion of this practical course, student will have the hands on training experience, which will help to carry out such practical experiments as well as research in future	L2

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Barr body identification from buccal cells

2. Karyotyping:

- a) Setting up of Human leukocyte culture
- b) Harvesting and metaphase plate preparations
- c) Preparation of G-banded chromosomes and observation

3. Problems on patterns of Inheritance in Human: Pedigree analysis; Autosomal patterns, X and Y linked patterns.

4. Hemoglobin estimation from Blood/Urine.

5. Sickling test to identify sickle shaped RBC's.

6. Determination of Red Blood Cell (RBC) and White Blood Cell (WBC) count by using hemocytometer.

7. Blood smear preparation and differential leukocyte count.

8. ABO-Blood grouping and Rh typing.

9. Single/Double Immunodiffusion assay for quantitation of antigens/antibody.

10. Determination of lymphocyte viability by Trypan blue dye exclusion test.

TEXT BOOKS :

1. 1 Wilson & Walker (2000). Practical biochemistry. Principle and techniques, Cambridge.
2. Griffith's et al. (2004). An introduction to genetic analysis, Freeman
3. Rooney, D.E. and Czepulkowski, B.H. (1992). Human Cytogenetics: A Practical Approach. IRL Press, Vol. 1&2, 2nded.
4. Stoddart, M.J. (2011). Mammalian Cell Viability: Methods and Protocols. Humana Press, New York.
5. Gersen, S.L. and Keagle, M.B. (2005). The Principles of Clinical Cytogenetics. Humana Press, 2nded.
6. Freshney, R.I. (2010). Animal Cell Culture: A Practical Approach. IRL Press, Oxford, 2nded.
7. Hay FC and Westwood OMR (2003) Practical Immunology, 4th Ed., Blackwell Publishing.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MHG5301					
TITLE OF THE COURSE	MEDICAL AND CANCER GENETICS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- This course will provide up-to-date information about various applications of genetics to human health.
- The objective of the course is to understand how genetics contributes to predisposition and progression of cancer.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will have an idea on different types of genetic disorders, mapping of disease genes to specific locations on chromosomes, analyses of the molecular mechanisms through which genes cause disease.	L1

CO2	This course will familiarize the students with current concepts in cancer genetics and genomics.	L3

COURSE CONTENT:	
MODULE 1	13Hrs
INTRODUCTION TO MEDICAL GENETICS Scope of Medical Genetics: Practical applications of medical genetics, Impact of genetics condition on families, Types of human genetic diseases. Nomenclature of mutations, from genotype to phenotype: loss of function mutations, gain of function mutations. Identifying Human Disease Genes, monogenic and polygenic disorders.	
MODULE 2	13Hrs
GENETIC DISORDERS OF HUMAN Genetic disorders of Skin: Psoriasis, hereditary hemorrhagic telangiectasia, multiple neurofibromatosis, blooms syndrome. Skeletal system: Marfan's syndrome, brachydactyly, syndactyly, polydactyly, spina bifida and anencephaly, Rheumatoid arthritis, Osteogenesis imperfecta. Muscle: muscular dystrophies, Myotonia. Eye: Glaucoma, retinoblastoma. Jaws: Hare lip and palate. Ears: Deafness. Alimentary system: Hypertrophic pyloric stenosis. Respiratory system: Cystic fibrosis. Cardio vascular system: congenital heart disease, coronary heart diseases and Hypertension. Central nervous system: The ataxias and familial spastic paraplegia. Kidney and urinogenital tract: Cystinosis, polycystic kidney disease. Endocrine system: diabetes.	
MODULE 3	13Hrs
AN OVERVIEW OF CANCER GENETICS The genetic basis of cancer, Characteristics of cancer cells, Difference between normal and cancer cells, Contact inhibition, Malignancy as a loss of normal cellular affinities,	

Differential gene expression in normal vs transformed cells, Molecular changes in proto-oncogenes, tumor suppressor genes-Knudson's Hypothesis.

MODULE 4

13Hrs

TYPES OF HUMAN CANCER

Inherited versus sporadic cancers. Retinoblastoma, Lung cancer, Colon cancer, Brain cancer, Breast cancer, Prostate cancer, cervical and esophageal cancers. Epstein Barr virus and its relationship to Burkett's lymphoma, Papilloma virus and cervical carcinoma. Genetic predisposition to sporadic cancer. Cancer prevention, diagnosis and treatment

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1.NO

2. NO

TEXT BOOKS :

1. Peter Turnpenny and Sian Ellard (Eds) (2012) Emery's Elements of Medical Genetics, Elsevier, 14th Edition.
2. RA Weinberg (2012) Biology of Cancer, Garland, Taylor and Francis Group Publication, 2nd Edition.
3. Peter Turnpenny and Sian Ellard (Eds) (2012) Emery's Elements of Medical Genetics, Elsevier, 14th Edition.
4. LB Jorde, JC Carey and MJ Bamshad (2009) Medical Genetics, Elsevier Publication.
5. S Heim, F Mitelman (2011) Cancer Cytogenetics: Chromosomal and Molecular Genetic Aberrations of Tumor Cells, John Willey and Sons Publications.
6. Gardner, A. and Davies, T. (2009) Human Genetics-Scion Publishing, 2nd edition.
7. Tobias, E.S. , Connor, J.M. and Ferguson-Smith, M. (2011) Essential Medical Genetics, Wiley-Blackwell publications, 6th edition.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MHG5302					
TITLE OF THE COURSE	GENETIC SCREENING, COUNSELING AND DISEASE MANAGEMENT					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	-	-	52	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- The primary objective of the course is to educate students in the fundamental concepts of medical genetics and counselling in order to become competent, insightful, knowledgeable, sensitive and passionate genetic counsellors.
- To provide intensive practical knowledge of Genetic Counseling, screening and disease management.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	This course will prepare the student with in-depth knowledge of genetic counseling, diverse fieldwork and innovative learning	L2

	experiences to develop motivated genetic counselors to meet the needs of an expanding landscape in genetics and genomics.	
CO2	Student will understand the genetic mechanisms play a fundamental role in the pathogenesis and treatment of diseases and in the maintenance of health.	L3

COURSE CONTENT:	
MODULE 1	13Hrs
INTRODUCTION TO GENETIC COUNSELING Scope of genetic counseling, methods of genetic counseling , educating the counselee, presenting the risks and options and guiding. Information gathering and construction of pedigrees; Medical Genetic evaluation (Basic components of Medical History, Past medical history, social & family history). Components of Genetic Counselling: Physical examination (General and dysmorphology examination, Documentation), Legal and ethical considerations; Patterns of inheritance, risk assessment and counselling in common Mendelian and multifactor syndromes. Reproductive failures, consanguinity.	
MODULE 2	13Hrs
METHODS IN GENETIC SCREENING Scope of genetic screening, Prenatal and Post natal screening. Population screening for genetic diseases, family screening. Prenatal screening methods -Noninvasive methods (Ultrasound, Endoscopy, MRI, Maternal Serum Screening for Down's syndrome & Neural tube defect, Fetal Blood Sampling, etc.) Invasive methods; Amniocentesis, Chorionic Villi Sampling. Ethical issues in prenatal screening & diagnosis. Post-natal screening- chromosomal abnormalities, cytogenetic and molecular methods.	
MODULE 3	13Hrs
POPULATION SCREENING	

Newborn screening: PKU, Galactosemia, SCA & Congenital Hypothyroidism. Population carrier screening: Alzheimer's, HD & FHCL, Disease susceptibility for complex diseases – CAD & T2DM, Thalassemia's, Cystic Fibrosis, DMD, Fragile– X syndrome, Hemophilia. Presymptomatic and predispositional testing. Markers for disease diagnosis and prognosis: Genetic markers; Protein/enzyme markers and antibodies	
MODULE 4	13Hrs
MANAGEMENT OF GENETIC DISORDERS 13 HRS Conventional methods for treatment of genetic diseases: Diet replacement, dietary avoidance, protein/enzyme substitution- Enzyme replacement therapy; substrate reduction therapy, Recombinant gene products for therapy. Gene therapy; Somatic cell gene therapy vs Germ line gene therapy; Gene transfer methods for therapy, Viral vectors, physical and chemical methods; Limitations of gene therapy Surgical interventions- Organ transplantation, bone marrow transplant. Immunotherapy: Approaches in immune therapy -use of Monoclonal antibodies, NK cells, Dendritic cells, B-lymphocytes and vaccines. Genomic medicine: Pharmacogenetics: G6PD & CYP2D6, benefits of Pharmacogenomics- personalized medicine.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.NO
2. NO

TEXT BOOKS :

1. Snustad, D P., and Michael J. Simmons. (2012) Principles of genetics. Hoboken, NJ: Wiley.
2. K Park (2011) Park's Textbook of Preventive and Social Medicine, Banarsidas Bhanot Publication, 21st Edition.
3. Peter Turnpenny and Sian Ellard (Eds) (2012) Emery's Elements of Medical Genetics, Elsevier, 14th Edition.

4. R.J. McKinlay Gardner, Grant R Sutherland, and Lisa G. Shaffer (2011), Chromosome abnormalities and Genetic counselling, Oxford University Press, 4th Edition.
5. Jean-Marie Saudubray, Georges van den Berghe, John H. Walter, (Eds.) (2012), Inborn Metabolic Diseases: Diagnosis and Treatment, Springer, 5th Edition.
6. DL Rimoin, RE Pyeritz, B Korf (2013), Emery and Rimoin's Principles and Practice of Medical Genetics, Elsevier Science Publication, 6th Edition.
7. P George, GP Patrinos and WJ Ansorge (2010) Molecular Diagnostics, Academic Press, Elsevier Publication, 2nd Edition.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MHG5321					
TITLE OF THE COURSE	HUMAN POPULATION GENETICS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	0	-	-	40	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To make student understand the forces that have an impact on levels of genetic variations in natural and/or experimental populations for both qualitative and quantitative traits.
- To make the students familiar with different types of DNA markers and the range of tools for their detection to enable advanced studies on molecular population genetics.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	This course will give students exposure towards understanding population health and disease susceptibility.	L3
CO2	This course will be helpful to the students to conceptualize the existence of genetic variation and speciation.	L2

COURSE CONTENT:

MODULE 1	10Hrs
INTRODUCTION TO POPULATION GENETICS Mendelian Population and scope of population genetics. Gene and genotype frequencies , mating patterns, Hardy-Weinberg principle, heterozygotes, extension of H-W principle to multiple alleles, sex-linked alleles. Non-random matings, inbreeding and assortative matings, inbreeding coefficient. Factors that change allelic frequencies.	
MODULE 2	10Hrs
GENETIC MAPPING OF MENDELIAN TRAITS Identifying recombinants and non-recombinants in pedigrees. Genetic and physical map distances , Basics of genetic variation, Genetic markers-SNP, CNV, Indels, VNTR, STR, Microsatellite, Two-point mapping- LOD score analysis, Multipoint mapping, Homozygosity map.	
MODULE 3	10Hrs
GENETIC VARIATION AND INHERITANCE OF COMPLEX TRAITS: Tag markers and Haplotypes , Linkage disequilibrium, Fixation index; Quantitative Genetic analysis; Broad-Sense Heritability and Narrow-Sense Heritability. Testing gene mutations for alleles: complementation test, intragenic complementation Genotypes &	

phenotypes: Effect of the environment on phenotype development, Penetrance and expressivity, Visible, sterile and lethal mutations, Gene interactions and modifying genes, Pleiotropy.	
MODULE 4	10Hrs
GENETIC POLYMORPHISMS AMONG POPULATIONS Genetic polymorphism, transient and stable and factors responsible for stable polymorphism. DNA markers and populations differences . Application of population genetics. Role of population genetics in genetic counselling. Genetic origin and evolution of human races. Genetic Demography, age and gender specific death and birth rates, intrinsic rate of natural increase. Index of opportunity for natural selection.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.NO
2. NO

TEXT BOOKS :

1. Hamilton M.B. (2009). Population Genetics. Wiley-Blackwell, UK.
2. Hedrick P.W.(2011). Genetics of Populations. Jones and Bartlett Publishers, Massachusetts.
3. Jobling, M., Hollox, E., Hurles, M., Kivisild, T. and Tyler-Smith, C. (2013). Human Evolutionary Genetics. Garland Science.
4. Nielsen, R. and Slatkin, M. (2013). An Introduction to Population Genetics: Theory and Applications. Sinauer Associates, Inc.
5. Relethford, J.H. (2012). Human Population Genetics. John Wiley & Sons.
6. Snusted, D.P., Simmons, M. J. (2010). Principles of Genetics. John Wiley & Sons, New York.
7. Knight, J.C. (2009). Human Genetic Diversity –Functional consequences for Health and Disease. Oxford University Press, USA.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MHG5322					
TITLE OF THE COURSE	DEVELOPMENTAL AND REPRODUCTIVE GENETICS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	0	-	-	40	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- The goal of the course is to explore how genetic differences between individuals lead to behavioral differences between individuals.
- Provide an overview of reproductive disorders, types of infertility, and genetic causes for infertility.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	After completing the course students will be able to develop knowledge on hereditary mechanisms and processes relevant for the nervous system and behavior.	L3

CO2	Students will learn about genetic causes behind infertility, methods available for genetic testing, diagnosis, and reproductive options.	L2

COURSE CONTENT:	
MODULE 1	10Hrs
EARLY DEVELOPMENT Gametogenesis and differentiation: Oogenesis and spermatogenesis, Hormonal regulations. Fertilization and development: Molecular events of fertilization, activation of sperm motility, gamete fusion, Role of calcium during egg activation, Genetics of multicellularity cleavage, Molecular events.	
MODULE 2	10Hrs
BASIC CONCEPTS OF DEVELOPMENT Potency, commitment, specification, induction, competence, determination and differentiation; Morphogenetic gradients, pattern formation, cell fate and cell lineages; Mosaic versus regulative development; Genomic imprinting. Genomic imprinting; later phases of embryonic development; phenocopies and malformations; the development of structure and birth defects in humans; sex differentiation and its errors.	
MODULE 3	10Hrs
REPRODUCTIVE SYSTEMS AND DISORDERS Male and female reproductive systems: Gonads and differentiation of sexual characters; hormonal regulation of sexual differentiation; Reproductive Disorders: Genetic and environmental susceptibility for reproductive disorders, endometriosis, polycystic ovarian disorder, pseudohermaphroditism; true hermaphroditism; gonadal dysgenesis, testicular feminization.	

MODULE 4	10Hrs
GENETICS OF INFERTILITY AND ASSISTED REPRODUCTIVE TECHNIQUES Genetic basis of male infertility, genetic basis of female infertility; Abnormal gametes and infertility, Spontaneous abortions and still birth (etiology, pathogenesis, genetic characteristics, diagnosis and management), Reproductive technologies; Assisted reproductive techniques (ARTs), IVF, artificial insemination, cryo-preservation of oocyte, sperm & embryo, in vitro fertilization, embryo transfer, intra-cytoplasm sperm injection, ethical issues, prenatal diagnosis, pre-implantation genetic diagnosis (PGD), Genetic technologies used in PGD,	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.NO
2. NO

TEXT BOOKS :

1. Plomin, R., DeFries, J.C., McClearn, G.E. & McGuffin, P. (2008). Behavioral Genetics (5th Ed.). Worth Publishers, NY.
2. Knopik, Neiderhiser, DeFries and Plomin. Behavioral Genetics. Worth, 2017, 7th Ed.
3. Mazzocco, M.M. & Ross, J.L (2007; Eds). Neurogenetic Developmental Disorders. MIT Press, Boston, MA.
4. Kim, YK (2009; Ed). Handbook of Behavioral Genetics. Springer, NY, NY.
5. Anholt, R. & MacKay, T. (2010). Principles of Behavioral Genetics. Elsevier Press, San Diego, CA.
6. Moody (2007). Principles of developmental biology, Elsevier.
7. Singh and Pal (2007). Human Embryology, 8th Edition, McMillan.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MHG5323					
TITLE OF THE COURSE	CLINICAL GENETICS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	0	-	-	40	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To provide students with increased knowledge about the genetic causes and inheritance of genetic disorders.
- This course is designed to provide an overview of human genetic diseases associated with blood, muscle, brain and Eye.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	After completing the course students will have acquired knowledge about the cause and inheritance of genetic disorders in humans.	L1

CO2	Students will have knowledge of genetic disorders, congenital anomalies and malformations and molecular mechanisms underlying these diseases.	L4

COURSE CONTENT:	
MODULE 1	10Hrs
GENETIC BASIS OF SYNDROMES AND DISORDERS	
Monogenic diseases: Cystic fibrosis, Tay-Sachs syndrome, Marfan syndrome. Polygenic diseases: Hyperlipidemia, Atherosclerosis, Diabetes mellitus. Genomic syndrome: Neurofibromatosis I syndrome. Genomic imprinting Syndromes: Prader-Willi & Angelman syndromes, Beckwith-Wiedeman Syndrome	
MODULE 2	10Hrs
CONGENITAL ABNORMALITIES AND DYSMORPHIC SYNDROMES	
Numerical (Down's Syndrome, Fragile-X syndrome, Edward's syndrome), Microdeletions (DiGeorge Syndrome, Prader Willi and Angelman Syndrome, Retinoblastoma), Breakage syndromes (Ataxia Telangiectasia, Fanconi Anemia)	
MODULE 3	10Hrs
DISORDERS OF BLOOD, MUSCLE AND EYE	
Disorders of Haemopoietic systems. Overview of Blood cell types and haemoglobin. Hemoglobinopathies, Thalassemias, Hemophilias. Disorders of muscle: Dystrophies (Duchenne Muscular dystrophy and Becker Muscular Dystrophy), Myotonias, Myopathies. Disorders of eye: Retinitis pigmentosa, Cataracts, Colour blindness.	
MODULE 4	10Hrs
MITOCHONDRIAL AND NEUROGENETIC DISORDERS	

Mitochondrial disorders: Kearns-Sayre syndrome, Pearson's syndrome, and progressive external ophthalmoplegia, MELAS syndrome, Leber's hereditary optic neuropathy, Defects in nuclear genes leading to dysfunction of mitochondrial proteins (Friedreich's ataxia). Neurogenetic disorders: Charcot-Marie tooth syndrome, Spino-muscular atrophy, Alzheimer's disease.

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1.NO

2. NO

TEXT BOOKS :

1. Cassidy, S.B. and Allanson, J.E. (2010). Management of Genetic Syndromes. Wiley-Blackwell, 3rd ed.
2. Gardner, R.J.M., Sutherland, G.R. and Shaffer, L.G. (2011). Chromosome Abnormalities and Genetic Counselling. Oxford University Press, 4th ed.
3. Gunder, L.M. and Sudbury, S.A.M. (2011). Essentials of Medical Genetics for Health Professionals. Jones and Bartlett Learning.
4. Hudgins, L., Toriello, H.V. Enns, G.M. and Hoyme, H.E. (Eds.) (2014). Signs and Symptoms of Genetic Conditions: A Handbook. Oxford University Press, London, 1st ed., p.560.
5. Jorde, L.B., Carey, J.C. and Bamshad, M.J. (2010). Medical Genetics. Mosby, 4th ed.
6. Korf, B.R. and Irons, H.B. (2013). Human Genetics and Genomics. John Wiley and Sons, Hoboken, 4th ed.
7. Roderick R. McInnes and Huntington F. Willard (2007). Thompson & Thompson Genetics in Medicine

SEMESTER	III					
YEAR	II					
COURSE CODE	20MHG5324					
TITLE OF THE COURSE	APPLIED HUMAN GENETICS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	0	-	-	40	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To understand applications of human genetics in drug therapy optimization and patient care.
- To enrich the current knowledge with nutritional genomics and genomic medicine.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will have the knowledge of recent trends in human genetics and its applications.	L1
CO2	This course will enhance the in-depth understanding of genomic medicine and Nutrigenomics concepts and cultivating empathy towards patients with genetic conditions	L4

COURSE CONTENT:	
MODULE 1	10Hrs
APPLICATIONS OF HUMAN GENETICS Production of recombinant Insulin , Interferon and Human Growth hormone (HGH). Vaccines-Hepatitis B vaccine. Preparation of DNA probes, Monoclonal antibodies and Diagnostic kits (Typhoid, Syphilis). DNA Fingerprinting: Methodology of DNA fingerprinting. Molecular markers-RFLP & RAPD, Micro satellite, SNPs, STR. Applications with examples in forensic science, medico legal aspects.	
MODULE 2	10Hrs
PHARMACOGENOMICS Introduction to pharmacogenomics. Genetic polymorphism of CYP isoenzymes and drug transporters. New pharmacological classes of drugs (antibodies, antisense RNAs, siRNAs, aptamers). Personalized medicine and drug prescription. Development of new innovative molecularly-targeted cancer therapeutics ; Examples of drugs related to the pharmacogenomics application in clinical practice: a) Pharmacodynamics- and pharmacogenomics-guided warfarin dosing in individual patients; b) Pharmacological assessment of tamoxifen-paroxetine interaction and pharmacogenomics of tamoxifen in oncology; c) Thiopurine drugs and pharmacogenomics of TPMT enzyme in guiding dosage schemes; d) Pharmacogenomics of antidepressant and psychotropic drugs.	
MODULE 3	10Hrs
NEUTRIGENOMICS Introduction to nutrigenomics and personalized nutrition. 'Omics' technologies used in nutrition . Nutritional Epidemiology and Study Design. Genetic variation and nutrient response. Food Intolerances. Consumer genetics and personalized nutrition- Keeping genetic information safe. Genetic determinants of eating behaviours. Functional food, functional food science, food technology and its impact on functional food development; markers for development of functional foods; key issues in Indian functional food industry and nutraceutical. Relation of functional foods and nutraceutical (FFN) to foods and drugs.	
MODULE 4	10Hrs

CHARACTERIZATION OF COMPLEX DISEASE TRAITS

Scaling the human genome: UCSC genome browser, RegulomeDB database, ENCODE-ChIA-PET database, Dual Luciferase Reporter (DLR) assay. Estimating DNA-protein interactions: Chromatin Immunoprecipitation (ChIP) assay, Electrophoretic mobility Shift Assay (EMSA) and affinity pull down assays, 3D view of the Genome: Chromatin Conformation Capture (3C) and Hi-ChIP assays.

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1.NO

2. NO

TEXT BOOKS :

1. QI L. Gene-Diet Interactions in Complex Disease (2012): Current Findings and Relevance for Public Health, Curr Nutr Rep: 1: 222-227
2. TUCKER K.L., SMITH C.E., LAI C.Q., ORDOVAS J.M (2013). Quantifying diet for nutrigenomic studies, Annual review of nutrition: 33: 349-371.
3. PETERS L.L., ROBLEDOR F., BULT C.J., CHURCHILL G.A., PAIGEN B.J., SVENSON K.L. (2007). The mouse as a model for human biology: a resource guide for complex trait analysis, Nature reviews Genetics 8: 58-69.
4. FRAZER K.A., MURRAY S.S., SCHORK N.J., TOPOL E.J. (2009). Human genetic variation and its contribution to complex traits, Nature reviews Genetics: 10: 241-251.
5. DAVID L.A., MAURICE C.F., CARMODY R.N., GOOTENBERG D.B., BUTTON J.E., WOLFE B.E. et al. (2013) Diet rapidly and reproducibly alters the human gut microbiome, Nature
6. LUCA F., PERRY G.H., DI RIENZO A. (2010) Evolutionary adaptations to dietary changes, Annual review of nutrition: 30: 291-314.
7. Raffaele DE Caterina, J. Alfredo Martinez and Martin Kohlmeier (2020). Principles of Nutrigenetics and Nutrigenomics, Elsevier.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MHG5325					
TITLE OF THE COURSE	GENETICS IN TOXICOLOGY AND FORENSIC SCIENCE					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	0	-	-	40	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To Lay foundation in forensic genetics that can be applied to assess problems concerning various types of DNA markers and analyses.
- Study and understand different experiments employed in forensic genetics and Toxicology.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	At the end of the course student will able to understand genetic toxicology and methods applied in forensic genetics.	L1
CO2	Student will have the current knowledge of genetics in forensic applications.	L4

COURSE CONTENT:	
MODULE 1	10Hrs
INTRODUCTION TO GENETIC TOXICOLOGY Origin of genetic toxicology; historical prospective of genetic toxicology; fundamentals of genetic toxicity; mechanism of induction of chromosomal alterations and sister chromatid exchanges; mutagens-chemical, physical, biological, environmental and food; antimutagens. Mechanisms of gene mutations; germinal mutations and human genetic diseases; mutations and cancers; genetic toxicology and congenital malformations; consequences of genotoxic effects in humans.	
MODULE 2	10Hrs
EVALUATION OF GENO TOXICITY 10 HRS Functional genomics: cDNA/gene, cloning; site-directed mutagenesis; Mammalian tissue culture, Methods for generation of transgenic animals/ knock-in, knockout models (microinjection, ES cell transformation); E Numutagenesis; PFGE, Automated DNA sequencing. In vitro gene mutation – bacterial reverse mutation assay (Ames test), mammalian cell Hprt mutation; In vivo gene mutation - Rodent lymphocyte Hprt mutation assay.	
MODULE 3	10Hrs
INTRODUCTION TO FORENSIC GENETICS Forensic Biology: Definition and scope Importance, nature, location, collection and preservation of biological exhibits and crime scene investigation of biological evidence. DNA Profiling: Introduction, History of DNA Typing, DNA variations, DNA typing systems- RFLP analysis, PCR amplifications, sequence polymorphism. Analysis of SNP, Y-STR, Mitochondrial DNA, Ancient DNA typing. DNA Statistics: frequency estimate calculations, interpretations, allele frequency determination, Paternity/Maternity index, Sibling index, Probability of match. Human Genome Project, DNA Forensic Databases.	
MODULE 4	10Hrs

FORENSIC SIGNIFICANCE OF DNA PROFILING

Applications in disputed paternity cases, child swapping, missing person's identity- civil immigration, legal perspectives- legal standards for admissibility of DNA profiling, procedural and ethical concerns, status of development of DNA profiling in India and abroad. New and future technologies: DNA chips, SNPs and limitations of DNA profiling.

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1.NO

2. NO

TEXT BOOKS :

1. Goodwin, Linacre, and Hadi (2010) An Introduction to Forensic Genetics, 2nd Edition, Wiley [Paperback]
2. Butler, J.M. (2005) Forensic DNA Typing, 2nd Edition, Elsevier.
3. Baird, M.L. Analysis of Forensic DNA Samples by Single Locus VNTR ProbesForensic DNA TechnologyMark Farley, James Harrington, editorsLewis, 1991.
4. Principles of Genetic Toxicology (2013) by D. Brusick Second Edition, Springer2. Genetic Toxicology Testing - A Laboratory Manual edited (2016) by Ray Proudlock Elsevier-Academic Press3. Genetic Toxicology: An Agricultural Perspective edited by Raymond F. Fleck, Plenum Press4.
5. Transgenic plants as sensors of environmental pollution genotoxicity (2008) Kovachuk and Kovalchuk. Sensors 8(3), 1539-15585.
6. Toxicology of Herbal Products edited by Olavi Pelkonen, Pierre Duez, Pia Maarit Vuorela, Heikki Vuorela.
7. Rudin N, Inman K (2001). An Introduction to Forensic DNA Analysis, CRC Press.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MHG5371					
TITLE OF THE COURSE	LABORATORY EXERCISE IN MEDICAL AND CANCER GENETICS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	6	-	42	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To increase students learning ability by conducting practical's including isolation of DNA/RNA from blood sample, amplification of gene through PCR, Sequencing of PCR products and analysis.
- To familiarize students with the various methods involved in mutation analysis, genotype-phenotype correlation and disease pathway analysis.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	After this course students would have practical knowledge of genotyping/genome analysis methods.	L4
CO2	On completion of this practical course, student will have the hands on training experience in the field of Molecular genetic testing.	L2

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Isolation of DNA from peripheral Blood.
2. Isolation of RNA from whole blood.
3. Quantity and Quality check for Genomic DNA and RNA by using agarose gel electrophoresis and spectrophotometric method.
4. Applications and usage of databases like, OMIM, NCBI, Ensemble, UCSC Genome browser, Emboss, PDB.
5. Primer designing by using bioinformatics tools for genes to be amplified through PCR.
6. PCR amplification of gene fragments by using specific primers.
7. Agarose gel electrophoresis to resolve PCR products and purification of PCR products.
8. Demonstration of sanger method of sequencing and analysis of mutations by using exon sequences of the gene.
9. Use of databases and bioinformatics tools for protein-structures, gene ontologies, protein-interactions and disease pathway analysis.

TEXT BOOKS :

1. Kary B Mullis, Francois Ferre (1994), PCR-The Polymerase Chain Reaction, Birkhauser Boston Edn.
2. LB Jorde, JC Carey and MJ Bamshad (2009) Medical Genetics, Elsevier Publication
3. R. Durbin (1998) Biological sequence analysis; Cambridge University Press, 1998.
4. T Strachan and AP Read (2011), Human Molecular Genetics, Garland Science/Taylor and Francis Group Publication, 4th Edition.
5. P George, GP Patrinos and WJ Ansorge (2010) Molecular Diagnostics, Academic Press, Elsevier Publication, 2nd Edition.
6. L Buckingham (2011) Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, FA Davis Company Publication, 2nd Edition.
7. P George, GP Patrinos and WJ Ansorge (2010) Molecular Diagnostics, Academic Press, Elsevier Publication, 2nd Edition.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MHG5372					
TITLE OF THE COURSE	LABORATORY EXERCISES IN GENETIC SCREENING AND ANALYSIS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	6	-	42	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- Students will Explore knowledge in genetic counseling, screening and genetic testing methods by having case studies.
- Train the student to understand how to gather family history by pedigree construction, analysis and prediction of genetic risk.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	At the end of the course Students will be able to perform genetic counseling effectively.	L4
CO2	Students will get case based practical knowledge to understand genetic counseling screening and genome analysis methods.	L2

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Preparation of pedigree on case based study.
2. Case based genetic counseling, problems on Genetic counseling and risk assessment.
3. Demonstration of comet Assay to detect DNA damage.
4. Applications and usage of databases like, OMIM, NCBI, Ensemble, UCSC Genome browser, Emboss, PDB.
4. Genotyping by using RFLP markers.
5. Genotyping using VNTR markers.
6. Quantitative PCR (qPCR) for estimation of gene copy or transcript expression level.
7. Demonstration of data analysis in genomics, transcriptomics (mRNA and miRNA analysis), and metagenomics.
8. Case studies in clinically relevant databases and SNP databases.
9. Maternal serum testing for prenatal diagnosis.
10. Identification of chromosomal abnormalities in relation to cancers using banding technique.

TEXT BOOKS :

1. Peter S Harper (2010), Practical Genetic Counselling Elsevier, 7th Edition.
2. R.J. McKinlay Gardner, Grant R Sutherland, and Lisa G. Shaffer (2011), Chromosome abnormalities and Genetic counselling, Oxford University Press, 4th Edition.
3. Jones KL and Smith DW : Smith's Recognizable patterns of Human malformations (7th Edition, 2013): Elsevier Health Sciences
4. Young I: Introduction to Risk Calculation in Genetic Counseling (3rd Edition, 2006) Oxford University Press.
5. Knowles, Richard V. (2001) Solving problems in genetics, New York: Springer
6. S Heim, F Mitelman (2011) Cancer Cytogenetics: Chromosomal and Molecular Genetic Aberrations of Tumor Cells, John Willey and Sons Publications.
7. Griffiths, Anthony J., et al. (2015) Introduction to genetic analysis, New York, NY: W.H. Freeman & Company.

DAYANANDA SAGAR UNIVERSITY
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SCHOOL OF BASIC & APPLIED SCIENCES



SCHEME & SYLLABUS
FOR
BACHELOR OF SCIENCE (B.Sc.) – 2022

WITH HONOURS & MINORS

B.SC. HONS IN BIOCHEMISTRY
B.SC. HONS IN BIOTECHNOLOGY
B.SC. HONS IN GENETICS
B.SC. HONS IN MICROBIOLOGY
B.SC. HONS IN CHEMISTRY

(With effect from 2022-23)

SCHEME - B.Sc. - 2022-23 ONWARDS

I SEM - Common to All

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22BS1101	ESSENTIALS OF BIOCHEMISTRY	CR	4	-	4	-	6	*	***
2	139	22BS1102	BASIC MICROBIOLOGY	CR	4	-	4	-	6	*	***
3	139	22BS1103	CHEMISTRY-I	CR	4	-	4	-	6	*	***
4	139	22BS1104	ENVIRONMENT AND PUBLIC HEALTH	CR	3	-	-	-	3	*	***
5	139	22BS1105	ENGLISH - 1	CR	2	-	-	-	2	*	***
6	139	22BS1106	KANNADA - 1	CR	2	-	-	-	2	*	***
					19	-	12	-	25		

II SEM - Common to All

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22BS1201	CELL BIOLOGY	CR	4	-	4	-	6	*	***
2	139	22BS1202	BASIC GENETICS	CR	4	-	4	-	6	*	***
3	139	22BS1203	MICROBIAL DIVERSITY AND KINETICS	CR	4	-	4	-	6	*	***
4	139	22BS1204	BIOSTATISTICS	CR	3	-	-	-	3	*	***
5	139	22BS1205	ENGLISH - II	CR	2	-	-	-	2	*	***
6	139	22BS1206	KANNADA - II	CR	2	-	-	-	2	*	***
					19	-	12	-	25		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SCHEME - B.Sc. - 2022-23 ONWARDS

III SEM - Common to All

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22BS2301	BIOPHYSICS AND INSTRUMENTATION	CR	4	-	4	-	6	*	***
2	139	22BS2302	MOLECULAR BIOLOGY	CR	4	-	4	-	6	*	***
3	139	22BS2303	EVOLUTIONARY GENETICS	CR	4	-	4	-	6	*	***
4	139	22BS2304	CHEMISTRY - II	CR	3	-	-	-	3	*	***
5	139	22BS2305	COMPUTER APPLICATIONS	CR	2	-	-	-	2	*	***
6	139	22BS2306	CONSTITUTION OF INDIA	CR	2	-	-	-	2	*	***
					19	-	12	-	25		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SCHEME - B.Sc. HONS - BIOCHEMISTRY - 2022-23 ONWARDS

IV SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22BY2401	HUMAN ANATOMY & PATHOLOGY	CR	4	-	4	-	6	*	***
2	139	22BY2402	METABOLISM I	CR	4	-	4	-	6	*	***
3	139	22BY2403	NUTRITION	CR	2	-	-	-	2	*	***
4	139	22BS2401	BIOSAFETY AND GOOD LABORATORY PRACTICE	CR	2	-	-	-	2	*	***
					12	-	08	-	16		

V SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22BY3501	HUMAN PHYSIOLOGY	CR	4	-	4	-	6	*	***
2	139	22BY3502	METABOLISM II	CR	4	-	4	-	6	*	***
3	139	22BS3501	BIOETHICS AND IPR	CR	2	-	-	-	2	*	***
4	139	22BS3502	BIOINFORMATICS	CR	2	-	-	-	2	*	***
					12	-	08	-	16		

VI SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22BY3601	ENZYMOLOGY	CR	4	-	4	-	6	*	***
2	139	22BY3602	IMMUNOLOGY	CR	4	-	4	-	6	*	***
3	139	22BS3601	PRINCIPLES OF 'MULTI-OMICS'	CR	2	-	-	-	2	*	***
4	139	22BS3602	TOXICOLOGY	CR	2	-	-	-	2	*	***
					12	-	08	-	16		

SCHEME - B.Sc. HONS - BIOCHEMISTRY - 2022-23 ONWARDS

VII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22BY4701	GENETIC ENGINEERING	CR	4	-	4	-	6	*	***
2	139	22BY4702	SIGNAL TRANSDUCTION	CR	4	-	4	-	6	*	***
3	139	22BY4703	PLANT PHYSIOLOGY BIOCHEMISTRY	CR	4	-	4	-	6	*	***
4	139	22BS4701	RESEARCH METHODOLOGY	CR	3	-	-	-	3	*	***
					15	-	12	-	21		

VIII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22BS4801	RESEARCH PROJECT	CR	-	-	-	-	12	*	***
2	139	22BS4802	MOOC / SWAYAM / NPTEL / ANY SIMILAR	CR	2	-	-	-	2	*	***
					02	-	-	-	14		

SCHEME - B.Sc. HONS - BIOTECHNOLOGY - 2022-23 ONWARDS

IV SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22BT2401	PLANT BIOTECHNOLOGY	CR	4	-	4	-	6	*	***
2	139	22BT2402	GENETIC ENGINEERING	CR	4	-	4	-	6	*	***
3	139	22BT2403	FUNDAMENTALS OF PLANT PHYSIOLOGY AND PATHOLOGY	CR	2	-	-	-	2	*	***
4	139	22BS2401	BIOSAFETY AND GOOD LABORATORY PRACTICE	CR	2	-	-	-	2	*	***
					12	-	08	-	16		

V SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22BT3501	IMMUNOLOGY	CR	4	-	4	-	6	*	***
2	139	22BT3502	ANIMAL BIOTECHNOLOGY	CR	4	-	4	-	6	*	***
3	139	22BS3501	BIOETHICS AND IPR	CR	2	-	-	-	2	*	***
4	139	22BS3502	BIOINFORMATICS	CR	2	-	-	-	2	*	***
					12	-	08	-	16		

VI SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22BT3601	BIO-PROCESS TECHNOLOGY	CR	4	-	4	-	6	*	***
2	139	22BT3602	ENVIRONMENTAL BIOTECHNOLOGY	CR	4	-	4	-	6	*	***
3	139	22BS3601	PRINCIPLES OF 'MULTI-OMICS'	CR	2	-	-	-	2	*	***
4	139	22BS3602	TOXICOLOGY	CR	2	-	-	-	2	*	***
					12	-	08	-	16		

SCHEME - B.Sc. HONS - BIOTECHNOLOGY - 2022-23 ONWARDS

VII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22BT4701	FOOD TECHNOLOGY	CR	4	-	4	-	6	*	***
2	139	22BT4702	MEDICAL BIOTECHNOLOGY	CR	4	-	4	-	6	*	***
3	139	22BT4703	AGRICULTURAL BIOTECHNOLOGY	CR	4	-	4	-	6	*	***
4	139	22BS4701	RESEARCH METHODOLOGY	CR	3	-	-	-	3	*	***
					15	-	12	-	21		

VIII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22BS4801	RESEARCH PROJECT	CR	-	-	-	-	12	*	***
2	139	22BS4802	MOOC / SWAYAM / NPTL / ANY SIMILAR	CR	2	-	-	-	2	*	***
					02	-	-	-	14		

SCHEME - B.Sc. HONS - GENETICS - 2022-23 ONWARDS

IV SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22GS2401	CYTOGENETICS	CR	4	-	4	-	6	*	***
2	139	22GS2402	DEVELOPMENTAL BIOLOGY	CR	4	-	4	-	6	*	***
3	139	22GS2403	QUANTITATIVE GENETICS	CR	2	-	-	-	2	*	***
4	139	22BS2401	BIOSAFETY AND GOOD LABORATORY PRACTICE	CR	2	-	-	-	2	*	***
					12	-	08	-	16		

V SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22GS3501	MICROBIAL GENETICS	CR	4	-	4	-	6	*	***
2	139	22GS3502	MOLECULAR GENETICS & GENOMICS	CR	4	-	4	-	6	*	***
3	139	22BS3501	BIOETHICS AND IPR	CR	2	-	-	-	2	*	***
4	139	22BS3502	BIOINFORMATICS	CR	2	-	-	-	2	*	***
					12	-	08	-	16		

VI SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22GS3601	HUMAN GENETICS	CR	4	-	4	-	6	*	***
2	139	22GS3602	POPULATION GENETICS	CR	4	-	4	-	6	*	***
3	139	22BS3601	PRINCIPLES OF 'MULTI-OMICS'	CR	2	-	-	-	2	*	***
4	139	22BS3602	TOXICOLOGY	CR	2	-	-	-	2	*	***
					12	-	08	-	16		

SCHEME - B.Sc. HONS - GENETICS - 2022-23 ONWARDS

VII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22GS4701	ANIMAL GENETICS	CR	4	-	4	-	6	*	***
2	139	22GS4702	PLANT GENETICS	CR	4	-	4	-	6	*	***
3	139	22GS4703	BEHAVIORAL GENETICS	CR	4	-	4	-	6	*	***
4	139	22BS4701	RESEARCH METHODOLOGY	CR	3	-	-	-	3	*	***
					15	-	12	-	21		

VIII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22BS4801	RESEARCH PROJECT	CR	-	-	-	-	12	*	***
2	139	22BS4802	MOOC / SWAYAM / NPTEL / ANY SIMILAR	CR	2	-	-	-	2	*	***
					02	-	-	-	14		

SCHEME – B.Sc. HONS – MICROBIOLOGY– 2022-23 ONWARDS

IV SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22MY2401	MICROBIAL PHYSIOLOGY	CR	4	-	4	-	6	*	***
2	139	22MY2402	IMMUNOLOGY AND IMMUNO-TECHNIQUES	CR	4	-	4	-	6	*	***
3	139	22MY2403	PHARMACEUTICAL MICROBIOLOGY	CR	2	-	-	-	2	*	***
4	139	22BS2401	BIOSAFETY AND GOOD LABORATORY PRACTICE	CR	2	-	-	-	2	*	***
					12	-	08	-	16		

V SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22MY3501	MEDICAL AND CLINICAL MICROBIOLOGY	CR	4	-	4	-	6	*	***
2	139	22MY3502	MICROBIAL GENETICS AND GENETIC ENGINEERING	CR	4	-	4	-	6	*	***
3	139	22BS3501	BIOETHICS AND IPR	CR	2	-	-	-	2	*	***
4	139	22BS3502	BIOINFORMATICS	CR	2	-	-	-	2	*	***
					12	-	08	-	16		

VI SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22MY3601	INDUSTRIAL MICROBIOLOGY	CR	4	-	4	-	6	*	***
2	139	22MY3602	NANO MICROBIOLOGY AND EXTREMOPHILES	CR	4	-	4	-	6	*	***
3	139	22BS3601	PRINCIPLES OF 'MULTI-OMICS'	CR	2	-	-	-	2	*	***
4	139	22BS3602	TOXICOLOGY	CR	2	-	-	-	2	*	***
					12	-	08	-	16		

SCHEME - B.Sc. HONS - MICROBIOLOGY - 2022-23 ONWARDS

VII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22MY4701	FOOD AND DIARY MICROBIOLOGY	CR	4	-	4	-	6	*	***
2	139	22MY4702	ENVIRONMENTAL MICROBIOLOGY	CR	4	-	4	-	6	*	***
3	139	22MY4703	MICROBIAL-PLANT INTERACTIONS	CR	4	-	4	-	6	*	***
4	139	22BS4701	RESEARCH METHODOLOGY	CR	3	-	-	-	3	*	***
					15	-	12	-	21		

VIII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22BS4801	RESEARCH PROJECT	CR	-	-	-	-	12	*	***
2	139	22BS4802	MOOC / SWAYAM / NPTEL / ANY SIMILAR	CR	2	-	-	-	2	*	***
					02	-	-	-	14		

SCHEME – B.Sc. HONS – CHEMISTRY– 2022-23 ONWARDS

IV SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22CY2401	INORGANIC CHEMISTRY	CR	4	-	4	-	6	*	***
2	139	22CY2402	PHYSICAL CHEMISTRY - I	CR	4	-	4	-	6	*	***
3	139	22CY2403	PHARMACEUTICAL CHEMISTRY	CR	2	-	-	-	2	*	***
4	139	22BS2401	BIOSAFETY AND GOOD LABORATORY PRACTICE	CR	2	-	-	-	2	*	***
					12	-	08	-	16		

V SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22CY3501	ORGANIC CHEMISTRY - I	CR	4	-	4	-	6	*	***
2	139	22CY3502	PHYSICAL CHEMISTRY - II	CR	4	-	4	-	6	*	***
3	139	22BS3501	BIOETHICS AND IPR	CR	2	-	-	-	2	*	***
4	139	22BS3502	BIOINFORMATICS	CR	2	-	-	-	2	*	***
					12	-	08	-	16		

VI

VI SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22CY3601	ORGANIC CHEMISTRY - II	CR	4	-	4	-	6	*	***
2	139	22CY3602	SPECTROSCOPY	CR	4	-	4	-	6	*	***
3	139	22BS3601	PRINCIPLES OF 'MULTI-OMICS'	CR	2	-	-	-	2	*	***
4	139	22BS3602	TOXICOLOGY	CR	2	-	-	-	2	*	***
					12	-	08	-	16		

SCHEME - B.Sc. HONS - CHEMISTRY - 2022-23 ONWARDS

VII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22CY4701	POLYMER CHEMISTRY	CR	4	-	4	-	6	*	***
2	139	22CY4702	INORGANIC CHEMISTRY - II	CR	4	-	4	-	6	*	***
3	139	22CY4703	NANOSCIENCE AND MATERIAL CHEMISTRY	CR	4	-	4	-	6	*	***
4	139	22BS4701	RESEARCH METHODOLOGY	CR	3	-	-	-	3	*	***
					15	-	12	-	21		

VIII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	139	22BS4801	RESEARCH PROJECT	CR	-	-	-	-	12	*	***
2	139	22BS4802	MOOC / SWAYAM / NPTEL / ANY SIMILAR	CR	2	-	-	-	2	*	***
					02	-	-	-	14		

SCHEME – B.Sc. HONS –2022-23 ONWARDS

MINOR COURSES OFFERED FROM IV SEM TO VI SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE-REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
BIOCHEMISTRY											
1	139	22BY2404	ANATOMY AND PHYSIOLOGY	CR	4	–	4	–	6	*	***
2	139	22BY3503	METABOLISM	CR	4	–	4	–	6	*	***
3	139	22BY3603	ENZYME & PROTEIN CHEMISTRY	CR	4	–	4	–	6	*	***
BIOTECHNOLOGY											
1	139	22BT2404	PLANT BIOTECHNOLOGY	CR	4	–	4	–	6	*	***
2	139	22BT3503	ANIMAL BIOTECHNOLOGY	CR	4	–	4	–	6	*	***
3	139	22BT3603	INDUSTRIAL BIOTECHNOLOGY	CR	4	–	4	–	6	*	***
GENETICS											
1	139	22GS2404	GENOMICS	CR	4	–	4	–	6	*	***
2	139	22GS3503	GENETIC TESTING	CR	4	–	4	–	6	*	***
3	139	22GS3603	COMPLEX TRAITS AND GENE NETWORKS	CR	4	–	4	–	6	*	***
MICROBIOLOGY											
1	139	22MY2404	MICROBIAL FERMENTATION	CR	4	–	4	–	6	*	***
2	139	22MY3503	MEDICAL MICROBIOLOGY AND DIAGNOSTICS	CR	4	–	4	–	6	*	***
3	139	22MY3603	MICROBIOME AND EXTREMOPHILES	CR	4	–	4	–	6	*	***
CHEMISTRY											
1	139	22CY2404	COORDINATION COMPOUNDS	CR	4	–	4	–	6	*	***
2	139	22CY3503	PHYSICAL CHEMISTRY FOR BIOLOGICAL SCIENCES	CR	4	–	4	–	6	*	***
3	139	22CY3603	ORGANIC CHEMISTRY FOR BIOLOGICAL SCIENCES	CR	4	–	4	–	6	*	***

SEMESTER	I					
YEAR	I					
COURSE CODE	22BS1101					
TITLE OF THE COURSE	ESSENTIALS OF BIOCHEMISTRY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To create in depth understanding about fundamentals of biomolecules, their structure and significance. - To know about the structural and functional classification of biomolecules

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Will be able to demonstrate the composition and structure of various bio-molecules molecules in the living systems	L1
CO2	Should be able to correlate the structure and functions of bio-molecules, like carbohydrates, lipids, proteins and nucleic acids in biological systems	L2
CO3	Should be able to demonstrate the mechanism of interaction and functions various bio-molecules in living systems.	L3
CO4	Should be able to demonstrate the normal and abnormal structure of various bio-molecules in the context of various medical conditions	L3

COURSE CONTENT:	
MODULE 1	15Hrs
BIOCHEMICAL CALCULATIONS Solutions, Stock Solutions- preparation and dilution of stock solutions. Avogadro Number Molarity, Molality, mole fraction and Normality. Density and Relative Density. Ionic Strength - pKa, pKb and pI. Equilibrium Constants, Dissociation constant, Henderson-Hasselbalch equation and buffer preparations. Electrochemical series, Nernst equation, standard electrode potential. pH, pOH. Law of Rational indices and Miller indices with numerical. Calculation of molecular weight of proteins and nucleic acids.	
MODULE 2	15Hrs
CARBOHYDRATES Simple Carbohydrates: Structure and classification of carbohydrates. Configuration and conformational aspects of monosaccharides and sugar derivatives. Brief structural elucidation by permethylation (MALDI), Glycosidic linkages in disaccharides and glycosides (GC-MS). Complex Carbohydrates: Homopolysachharides and heteropolysachharides - starch, glycogen, cellulose chitin, glycosaminoglycans and proteoglycans; Glycoproteins and Glycolipids.	

MODULE 3	15Hrs
AMINO ACID AND PROTEINS Primary structure – Structure, classification and acid-base properties of amino acids, Peptide bond, Primary structure –scheme of determination –amino acid composition analysis, N and C terminal analysis, cleavage of Disulfide bond, chemical and enzymatic fragmentation and sequencing through Edman's reagent. Secondary structure: α -, PP-, 310 and π -helix, β pleated sheet, β bend, Peptide bond geometry and Ramchandran plot, motifs and domains. Tertiary structure: Interactions stabilizing tertiary structure; denaturation of proteins, secondary and tertiary structure of fibrous proteins: α -keratin, silk fibroin and collagen. Quaternary structure: Hemoglobin Structure, molecular basis of Sickle-cell anemia; Cross linking agents to determine subunit composition. Introduction to protein folding Protein folding: Protein renaturation and denaturation, significance of Anfinsen's experiment, Landscape model of folding, accessory proteins- protein molecular chaperones;	
MODULE 4	15Hrs
LIPIDS AND NUCLEIC ACID 15Hrs Lipids: Classification, Nomenclature and biological functions of lipids. Complex lipids - phospholipids, sphingolipids, galactolipids and Eicosanoids and sterols–prostaglandins, thromboxanes and leukotrienes. Nucleic acids: Nucleosides, nucleotides and polynucleotides; Primary and secondary structure, properties and types of DNA; structure and function of RNA's; Specialized sequences: G-quadruplexes, palindromic and mirror repeats; denaturation and renaturation curves of nucleic acids;	

TEXT BOOKS/REFERANCES: 1. Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc.(2010). 2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012). 3. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012). 4. Proteins Structures and Molecular Properties 2nd Ed. Thomas E. Creighton, W H Freeman and Co. (1993). 5. Principles of Protein Structure, Function, & evolution, Dickerson & Geis, 2nd Ed. Benjamin-Cummings (1983). 6. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989). 7. Biochemistry 6th Ed; Jeremy M Berg, John L Tymoczko and Lubert Stryer, W H Freeman and Co. (2006). 8. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

ESSENTIALS OF BIOCHEMISTRY-PRACTICALS
EXPERIMENTS
1. Qualitative analysis of carbohydrates - Monosaccharides (Glucose, Fructose), Disaccharides (Lactose, Maltose, Sucrose), Polysaccharides (Starch).
2. Qualitative analysis of amino acids (tryptophan, tyrosine, cysteine, methionine, arginine, proline and histidine).
3. Estimation of protein by Lowry method
4. Estimation of sugar by Miller method.
5. Estimation of DNA by DPA method.
6. Determination of free amino acid content in germinating seeds.
7. Determination of Vitamin C content in lemon juice

TEXT BOOKS/ REFERENCES

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER	I					
YEAR	I					
COURSE CODE	22BS1102					
TITLE OF THE COURSE	BASIC MICROBIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To equip the students about the importance of microorganisms in our global society. - To create in-depth knowledge of the structural and functional characteristics of prokaryotic and eukaryotic cells and their classification. - To make students to learn basic microbiological techniques employed for isolation, culturing and identification of prokaryotic and eukaryotic microorganisms.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will be acquainted with fundamental aspects of basic microbiology & isolation techniques	L1
CO2	Enable the students to understand the diversity of microbial, structure, function and their environment	L2
CO3	Students will be able to understand the importance of microorganisms	L3
CO4	Students will be equipped with fundamental knowledge of microbial growth patterns and kinetic studies enabling them to apply the same in various allied fields.	L2

COURSE CONTENT:	
MODULE 1	15Hrs
HISTORY AND SCOPE OF MICROBIOLOGY Development of microbiology as a discipline, spontaneous generation and biogenesis. Scope, disciplines and Applications of microbiology. Contributions of Antony von Leeuwenhoek, Joseph Lister, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Sumbunath Dey, Ananda Chakroborty, Paul Ehrlich, Selman A. Waksman, Lazaro Spallanzani, Dmitri Iwanovsky, Martinus Beijerinck, Sergei Winogradsky, Elie Metchnikoff and Sir Ronald Ross in the field of Microbiology. Difference between prokaryotic and eukaryotic microorganisms. General structure and characteristics of viruses, bacteria, fungi, algae and Protozoa. General account of microbiome.	
MODULE 2	15Hrs

MICROSCOPY	
Principles of microscopy - resolving power, numerical aperture, working distance and magnification. Types- optical and electron microcopy – Basic principle, sample preparation, applications and limitations of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope (Toppling & sliding mode), Fluorescence and Electron Microscope - TEM and SEM. Staining techniques: Nature of dyes, Physical and chemical theories of staining, Principles and applications of a) Simple, negative staining b) Differential Staining- Gram's and Acid-fast staining c) Structural staining –cell wall, endospore, flagella, capsular staining, fungal staining.	
MODULE 3	15Hrs
MICROBIAL TECHNIQUES	
Sterilization and Disinfection: Definition, Principles, construction, and applications for physical and chemical methods of sterilization. Physical: Boiling, Pasteurization, Fractional sterilization -Tyndallization and Moist heat under pressure autoclave. Dry heat sterilization - Incineration and hot air oven. Filtration – seitz filter, membrane filter and laminar air flows. Radiation Ionizing radiation and non-ionizing radiation. Chemical methods: Alcohol, aldehydes, phenols, halogen, metallic salts, Quaternary ammonium compounds and sterilizing gases as antimicrobial agents. Culture media and its types: Components, Types - Simple, Selective, Transport, Enriched, Differential media. Pure culture techniques: Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic).	
MODULE 4	15Hrs
GROWTH KINETICS	
Definition of microbial growth, factors affecting microbial growth (pH, temperature, oxygen concentration, pressure and radiations). Cell division, Growth curve of bacteria, kinetics of growth. Mathematics of growth- generation time and growth rate constant. Measurement of growth: Measurement of cell numbers- Counting chambers, electronic counters, viable counting techniques, membrane filter technique. Measurement of cell mass- dry weight and turbidity measurement. Measurement of cell activity, Batch culture, Continuous culture - Chemostat and Turbidostat. Synchronous culture.	

TEXT BOOKS/REFERANCES:	
- Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2007. Introductory Mycology; Fourth edition, Wiley India Private Limited - Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec - Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York. - Benson, H. J. 1994. Microbiological Application. WCB McGraw-Hill of India Private Limited. - Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J. - Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999. - Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005 - Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1986. - Pommerville, J.C. 2007. Alcamo's Fundamentals of Microbiology. Eighth Edition. Jones and Bartlett Publishers, USA. - Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005. - Salle, A. J. 1984. Fundamental Principles of Bacteriology. Tata McGraw-Hill Publishing Company Limited, New Delhi. - Salle, A.J. Principles of Microbiology, 2nd edition., 1997, Mc Graw Hill.1997. - Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005.	

14. Tortora, Funke and Case. Microbiology, 9th Edition. Benjamin Cummings. 2009.

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1) Study of instruments a) Autoclave b) Hot air oven c) Incubator d) pH meter e) High speed centrifuge f) Colorimeter g) UV-Vis Spectrophotometer h) Laminar air flow	(2 Units)
2) Media Preparation: a) Basal media (Nutrient agar and broth, PDA media and MRBA) b) Selective media (EMB agar and McConkey agar), c) Enriched media (Blood agar).	
3) Isolation of bacteria and fungi by serial dilution technique from soil, water and air.	
4) Methods of pure culture techniques a) Pour plate technique b) Spread plate technique c) Streak plate technique	
5) Transfer of media and inoculum a) Slant culture technique b) Broth culture technique c) Stab culture technique	
6) Microscopic examination of bacterial smear a) Simple staining b) Gram's staining c) Capsule staining d) Endospore staining	
7) Microscopic observation of temporary slides a. Algae: Chlamydomonas and Spirulina b. Fungi: Rhizopus, Aspergillus, Penicillium, Yeast. c. Protozoa: Amoeba, Paramecium and Euglena.	

REFERENCES

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
3. Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
4. Pelczar, M. J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.
5. Prescott, L.M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, NY.

SEMESTER	I					
YEAR	I					
COURSE CODE	22BS1103					
TITLE OF THE COURSE	CHEMISTRY I					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To make the students to understand basic facts and concepts in chemistry while retaining the exciting aspects of chemistry so as to develop interest in the study of chemistry as a discipline. - To make the students to familiarize with the basic concepts related to modern atomic theory, quantum chemistry, titrations, periodic table and gaseous state of matter.	

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will learn about handling of data and basics of different titrations	L1
CO2	Students will learn about advanced principles of atomic structure	L2
CO3	Students will get the knowledge periodic table and classification elements in the periodic table	L3
CO4	Students will learn about various aspects of gaseous state of matter	L2

COURSE CONTENT:	
MODULE 1	15Hrs
ANALYTICAL CHEMISTRY Handling of analytical data: SI and CGS units of measurements and physical constants and their inter conversion; Significant figures and calculations, accuracy, precision and errors in quantitative analysis. Stoichiometry: atomic weights, molecular weights, mole concept, molarity, molality, normality, mole fraction, ppt, ppb and ppm. Numerical problems related to the above concepts. Titrimetric analysis: Basic principle of titrimetric analysis. Classification, preparation and dilution of reagents/solutions. Use of $N_1V_1 = N_2V_2$ formula, Preparation of ppm level solutions from source materials (salts), conversion factors. Acid-base titrimetry: Titration curves, Quantitative applications – selecting and standardizing a titrant, inorganic analysis -alkalinity, acidity. Complexometric titrimetry: Indicators for EDTA titrations, titration methods employing EDTA -direct, back, displacement and indirect determinations, Application-determination of hardness of water. Redox titrimetry: Balancing redox equations, titration curves, Theory of redox indicators. Precipitation titrimetry: Titration curves, indicators for precipitation titrations involving silver nitrate Gravimetric Analysis: Requisites of precipitation, mechanism of precipitation, Factors influencing precipitation, Co-precipitation, post-precipitation.	
MODULE 2	15Hrs

ATOMIC STRUCTURE	
Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's equation-derivation, Heisenberg's uncertainty principle. Hydrogen atomic spectra. Need of a new approach to Atomic structure. Elements of Quantum chemistry- Schrodinger wave equation and meaning of various terms in it. Significance of ψ and ψ^2 , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Quantum numbers and their Significance. Shapes of s, p and d atomic orbitals, nodal planes. Rules for filling up of electrons in various orbitals (Aufbau principle, Pauli's exclusion principle, Hund's rule of maximum multiplicity and n+l rule), Electronic configuration of the elements (up to Z=30) and anomalous electronic configurations. Stability of half-filled and completely filled orbitals- concept of pairing and exchange energy.	
MODULE 3	15Hrs
PERIODICITY OF ELEMENTS	
Classification of elements into s, p, d, and f-blocks, cause of periodicity. Brief discussion of the following properties of the elements, with reference to s- & p-block and the trends shown: Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. Atomic and ionic radii, ionization enthalpy, Successive ionization enthalpies and factors affecting ionization enthalpy and trends in groups and periods. Electron gain enthalpy and trends in groups and periods. Electronegativity, Pauling's/ Allred Rochow's scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.	
MODULE 4	15Hrs
BASIC ORGANIC CHEMISTRY	
Representation of structural formula of organic compounds: condensed formula and bond line formula of organic compounds, classification of organic compounds based on functional groups with examples. Delocalisation of electrons: Inductive effect, electrometric effect, resonance (mesomeric effect, EWG and EDG, +M and -M effects) and hyper conjugation. Reactive intermediates: Types of bond cleavage, curly arrow rules in representation of mechanistic steps; electrophiles, nucleophiles, carbocations, carbanions, free radicals and carbenes- generation, structures, stability and examples. Types of organic reactions: Types of organic reactions with examples (electrophilic/ nucleophilic substitution/addition/free radical reaction with examples. Aromaticity: Kekule structure of benzene - molecular orbital picture of benzene - resonance energy and stability of benzene - Huckel's rule (aromatic, non-aromatic, and antiaromatic molecules) - aromaticity of benzene and benzenoid compounds - aromaticity of three, four, five, six, seven and eight-membered systems - annulenes.	

TEXT BOOKS/REFERENCES:
1. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London (1996).
2. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992)
3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
4. Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
5. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002.
6. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi.

EXPERIMENTS

- | |
|--|
| 1. Calibration of glassware, pipette, burette and volumetric flask. |
| 2. Determination of sodium carbonate and sodium bicarbonate in a mixture. |
| 3. Determination of iron (II) using potassium dichromate. |
| 4. Determination of chlorine in bleaching powder using iodometric method. |
| 5. Standardization of EDTA solution and determination of hardness of water. |
| 6. Determination of Ba^{2+} as BaSO_4 BY gravimetric method. |
| 7. Determination of Fe^{2+} as Fe_2O_3 by gravimetric method. |

TEXT BOOKS/ REFERENCES

- | |
|--|
| 1. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford, A.R. Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication. |
| 2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication. |
| 3. Experimental Organic Chemistry Laboratory Manual, J.I. Garcia, J.A. Dobado, G. Francisco, Elsevier Publication. |
| 4. Chemistry Practical Inorganic Qualitative Analysis For Under Graduate Students, M.J. Mamtara, S.C. Karad, J.S. Makasana, Lap Lambert Academic Publishing. |
| 5. Advanced Practical Chemistry, K. Chelladurai, K. Subbian, Lap Lambert Academic Publishing. |

SEMESTER	I					
YEAR	I					
COURSE CODE	22BS1104					
TITLE OF THE COURSE	ENVIRONMENT AND PUBLIC HEALTH					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- Develop strong foundations in epidemiology with special focus on infectious diseases, their environmental transmission, and treatment strategies. - Understand recent advances made in combating or preventing the spread of infectious diseases. - Understand the effects of human interventions on the dynamics and functioning of ecosystems

COURSE OUTCOMES:		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to deliberate on the possible solutions for: global health challenges, improving diseases and overall health status, in economically poor countries.	L1
CO2	Student will be able to propose prudent solution for integrated management of water and food supplies.	L2
CO3	Develop critical thinking and communication skills for the design and executions of research projects.	L3

COURSE CONTENT:	
MODULE 1	7 Hrs
Introduction. Infectious diseases: clinical symptoms, epidemiology, treatment, global surveillance and challenges in eradicating major diseases. Interpreting graphic and tabular data; trends, controls, variation, and uncertainty in measurements.	
MODULE 2	15 Hrs
INTRODUCTION TO MICROBIAL PATHOGENS Communicable diseases. Complexity of ecosystems and microbial habitats: Cholera and Malaria- clinical symptoms, epidemiology and mechanisms of disease transmission. Pathogen dynamics in the environment. Mode of waterborne disease transmission. Chemical, microbial control practiced in agriculture and human health.	
MODULE 3	15 Hrs
HUMAN MICROBIOME AND PUBLIC HEALTH Health status of populations, modelling the dynamics of infection. Modes of disease transmission, major stages in disease process, surveillance, and immunization. Biological, social & economic factors in public health.	

Earth and Human microbiome project. Policies and practices with respect to wild life protection, water and air quality, industrial and household waste disposal.

MODULE 4

8 Hrs

PERSPECTIVES AND INTERVENTIONS IN PUBLIC HEALTH

Epidemiological perspectives. Disease burden and surveillance; Alternative systems of medicine. Ayurveda, Yoga, Unani, Siddha and Homeopathy (AYUSH); Universal Immunization Programme (UIP); Reproductive Health-Youth Unite for Victory on AIDS.

REFERENCES:

1. Park, K. (2011). Preventive and Social Medicine. Benarsi Das Publications. (pp. 16- 19, 24-27)
2. Sadgopal, M., & Sagar, A. (2007, July-September). Can Public Health open up to the AYUSH System and give space for People's Views of Health and Disease? mfc bulletin, 45-50.
3. Sekhsaria, P. (2007). Conservation in India and the Need to Think Beyond 'Tiger vs. Tribal'. Biotropica, 39(5), 575-577.
4. UNDP. (2013). The Human Development Report, The Rise of the South: Human Progress in Diverse World. New York: UNDP. (also available in Hindi)

SEMESTER	I					
YEAR	I					
COURSE CODE	22BS1105					
TITLE OF THE COURSE	ENGLISH – I					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To encourage the students to speak English confidently and enable them to communicate for day-to-day needs. - To build up their confidence in the usage of English and to enhance their written communicative competence also helping them for competitive exams.

COURSE OUTCOME:		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students are confident in oral and written communication	L1
CO2	Have enhanced competence for competitive exams	L2

COURSE CONTENT:	
MODULE 1	7 Hrs
COMMUNICATION SKILLS Definition, importance of communication, communication process – source, message, encoding, channel, decoding, receiver, feedback, context, levels of communication, Flow of Communication, Verbal and Non-Verbal Communication, Barriers to Communication - physiological, physical, cultural, language, gender, interpersonal, psychological, emotional. Perspective in communication/ Communication styles: introduction, visual perception, language, other factors affecting our perspective – past experiences, prejudices, feelings, environment	
MODULE 2	7 Hrs
Elements of communication – introduction, face to face communication – tone of voice, body language (non-verbal communication), verbal communication, physical communication; Basic listening skills: introduction, self-awareness, active listening, becoming an active listener, listening in difficult situations; Interview skills: purpose of an interview, do's and don't's of an interview; Giving presentations: dealing with fears, planning your presentation, structuring your presentation, delivering your presentation, techniques of delivery; Group discussion: introduction, communication skills in group discussion, do's and don't's of group discussion;	

Phonetics: The Organs of Speech, The Description and Classification of Speech Sounds, The Description and Classification of Vowels, The Description and Classification of Consonants, Phonetic symbols and the IPA, Phonemic and Phonetic Transcription Phonology, Phoneme sequences and Consonant Cluster, The Syllable, Word Accent, Accent and Rhythm in Connected Speech, Intonation, Varieties of English Pronunciation.	
MODULE 3	6Hrs
EFFECTIVE WRITING SKILLS	
Effective written communication: introduction, when and when not to use written communication – complexity of the topic, amount of discussion required, shades of meaning, formal communication	
Writing effectively: subject lines, put the main point first, and know your audience, organisation of the message, Paragraph Writing, Letter Writing, Report Writing, Book Review, Scientific writing, Making a message – Transitivity/ intransitivity – complementation – talking about closely linked action – using two verbs together (eg: She started laughing), Transforming messages – Making statements, questions, orders and suggestions – denying – rejecting – disagreeing – possibility – ability, permission, obligation etc.	
MODULE 4	10 Hrs
GRAMMAR	
Word Classes: Open Word Classes: - Nouns, Verbs, Adjectives, Adverbs, Pronouns; Closed Word Classes: - Pre-determiners, Determiners, Numerals, Enumerators, Prepositions, Conjunctions, Auxiliary Verbs, Interjection;	
Morphology: Bound and Free Morphemes; Affixes, Stems and Roots; Morphological Analysis; Phrases: Noun Phrase, Verb Phrase, Genitive Phrase, Adjective Phrase, Adverb Phrase, Prepositional Phrase, Phrases and its types, Clauses and its types, Sentences and its types, Common errors, phonetics;	
Clauses: Clause Elements, Clause Types, Kinds, Concord;	
Sentences: Simple Sentences, Compound Sentences, Complex Sentences;	
Sub Ordination: Sub-Clauses, Finite and Non-Finite Sub-Clauses;	
Co-ordination: Linked and Unlinked Coordination, Synthesis;	
Ambiguity: Types of Ambiguity, Structural and Lexical Ambiguity;	
Common Errors: Nouns and Pronouns, Articles, Verbs, Concord, Adjectives, Adverbs, Prepositions, Vocabulary, Expressing time, Referring to present, past and future time - use of adjuncts - frequency and duration, Talking about manner and place, Information about place, manner - position of adjuncts - types of adverbs (time, frequency, duration etc), Reporting what people say/think, Reporting verbs - reporting someone's actual words - reporting in one's own words, The structure of information, Focusing on the thing affected (passive voice) - selecting focus (left structure) taking the focus off the subject (impersonal 'it' etc.) – Introducing something new (with 'there') - focusing on information using adjuncts.	

TEXT BOOKS:
1. Crystal, David. 1985, Rediscover Grammar with David Crystal. Longman 2. Bakshi, R. N. A Course in English Grammar. Orient Longman 3. Close, R. A. Reference Grammar for Students of English. Orient Longman 4. Krishnaswamy, N. Modern English – A Book of Grammar, Usage & Composition. Macmillan India Ltd. 5. Aroor, Usha (Ed.) WordMaster Learner's Dictionary of Modern English. Orient Longman 17 6. Hewings, M. 1999, Advanced English Grammar. Cambridge University Press 7. Basic communication skills for technology, Andreja J. Ruther Ford, 2nd Edition, Pearson Education, 2011. 8. Communication Skills, Sanjay Kumar, Pushpalata, 1st Edition, Oxford Press, 2011. 9. Brilliant – Communication Skills, Gill Hasson, 1st Edition, Pearson Life, 2011. 10. Soft Skill and Professional Communication, Francis Peters SJ, 1st Edition, Mc GrawHill Education, 2011.

SEMESTER	I					
YEAR	I					
COURSE CODE	22BS1106					
TITLE OF THE COURSE	KANNADA KALI – I					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	0	0	0	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To enable students read and write in Kannada - To make students to communicate in Kannada helping them to interact with local people for their daily needs

COURSE OUTCOME		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students should be able to read, write and communicate in Kannada	L3

COURSE CONTENT:

1. ALPHABETS – AKSHARAMAALE - ಅಕ್ಷರಮಾಲೆ
2. SIGNS OF VOWELS AND CONJUNCT CONSONANTS – KAAGUNITHA MATTHU OTTHAKSHARAGALU
ಕಾಗುಣಿತ ಮತ್ತು ಒತ್ತಕ್ಷರಗಳು
3. DAILY USING WORDS PART – 1
DINANITHYADAPADAGALUBHAAGA – 1
ದಿನನಿತ್ಯದ ಪದಗಳು ಭಾಗ – 1
4. WEEKDAY AND MONTH NAMES –
VAARADAMATTHU THINGALAHESARUGALU
ವಾರದ ಮತ್ತು ತಿಂಗಳ ಹೆಸರುಗಳು
5. TASTE – RUCHI – ರುಚಿ
6. COLOURS – BANNAGALU – ಬಣ್ಣಗಳು
7. NUMBERS – SANKYEGALU – ಸಂಖ್ಯೆಗಳು
8. DAILY USING WORDS PART – 2
DINANITHYADAPADAGALUBHAAGA – 2
ದಿನನಿತ್ಯದ ಪದಗಳು ಭಾಗ – 2
9. QUESTION PATTERNS – PRASHNEYA VIDHAANAGALU
ಪ್ರಶ್ನೆಯ ವಿಧಾನಗಳು
10. MEASUREMENTS – ALATHEGALU – ಅಳತೆಗಳು
11. EDUCATION WORDS – SHAIKSHANIKAPADAGALU
ಶೈಕ್ಷಣಿಕ ಪದಗಳು
12. FRUITS – HANNUGALU – ಹಣ್ಣುಗಳು

13. VEGETABLES – THARAKAARIGALU – ತರಕಾರಿಗಳು

14. FOOD ITEMS – AAHAARA PADAARTHAGALU

ಆಹಾರ ಪದಾರ್ಥಗಳು

15. DAILY USING WORDS PART -3 –

DINANITHYADA PADAGALU BHAAGA-3

ದಿನನಿತ್ಯದ ಪದಗಳು ಭಾಗ -3

16. METALS – LOHAGALU – ಲೋಹಗಳು

17. RELATIVES – SAMBANDHIKARU – ಸಂಬಂಧಿಕರು

18. SEASONS AND CLOTHES –

KAALAGALU MATTHU BATTEGALU

ಕಾಲಗಳು ಮತ್ತು ಬಟ್ಟೆಗಳು

19. HOUSE AND FURNITURE –

MANE MATTHU PEETOPAKARANAGALU

ಮನೆ ಮತ್ತು ಪೀಠೋಪಕರಣಗಳು

20. VERBS - KRIYAA PADAGALU – ಕ್ರಿಯಾ ಪದಗಳು

SEMESTER	II					
YEAR	I					
COURSE CODE	22BS1201					
TITLE OF THE COURSE	CELL BIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To familiarize the students with the basic components of prokaryotic and eukaryotic cells with special focus on the physiological processes of the cell organelles and cell. - To introduce the students to the cell membrane and cell wall and to the very basics of cell cycle and cell death pathways.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Should be able to identify different organelles of the cell	L1
CO2	Should be able to demonstrate/identify the different parts of cell cycle and their function	L2
CO3	Should be able to identify the regulatory steps of the cell cycle	L3
CO4	Should be able to demonstrate the essential importance of cell death pathways	L2

COURSE CONTENT:	
MODULE 1	15Hrs
MODULE 1 ULTRA STRUCTURE OF CELL Prokaryotic (Bacteria) and Eukaryotic cells (Animal and Plant) - Characteristics and differences. Cell Wall: Ultrastructure, chemical composition and function. Plasma membrane: Chemical composition (Lipids, Proteins, Carbohydrates), Structure (Fluid mosaic model). Mode of transport across membrane: Active Transport (Pumps) and Passive transport (Osmosis, Diffusion).	
MODULE 2	15Hrs
CELL ORGANELLES -I Structure and general functions: Chloroplast (Envelope, Stroma, Thylakoids); Endoplasmic Reticulum (Smooth and Rough); Golgi complex (Cisternae, Tubules, Vesicles); Mitochondria; Ribosomes; Lysosomes (Primary and Secondary); Microsomes.	
MODULE 3	15Hrs
CELL ORGANELLES -II Structure and general functions: Cytoskeleton (Microtubules, Microfilaments and Intermediate Filaments); Cilia and Flagella. Structure and general functions of Nucleus (Nuclear envelope, Nucleoplasm and Nucleolus). Chromosomes- Discovery, Structure and functions (Centromere,	

Secondary constrictions, Telomere). Types of Chromatin (Euchromatin and Heterochromatin); Dosage Compensation. Organization of Chromatin: Nucleosomes and Solenoid Model; Giant Chromosomes (Polytene and Lampbrush).

MODULE 4

15Hrs

CELL GROWTH AND CELL DIVISION

Cell cycle: Introduction to cell cycle stages (Interphase and M phase); Introduction to Cell cycle control (Cyclins and Cyclin dependent kinases). Mitosis: Mitotic phases; Cytokinesis; Significance of Mitosis. Meiosis: First meiotic division; Second meiotic division, Synaptonemal complex; Significance of meiosis. Introduction to programmed cell death (Apoptosis & Necrosis).

TEXT BOOKS/REFERANCES:

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Gerald Karp. Cell and Molecular Biology. 6th Edition (2009) Wiley Publications.
3. Bruce Alberts et al. Molecular Biology of the cell - (2002) Garland Publications. Ambrose and Esty D. M. Cell Biology - (1997) ELBS Publications.
4. Robertis E. D. F. and Robertis E. M. F. Genetics and Molecular Biology - (2001) Saunders College.

EXPERIMENTS

1. Introduction to Microscopy (Bright Field, Dark Field, Phase Contrast Microscopy)
2. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.
3. Cell division: Study of mitosis using onion root tips.
4. Chloroplast isolation and their microscopic examination
5. Vital Staining of mitochondria (yeast).
6. Meiosis demonstration using grass hopper testis/onion flower buds
7. Study of model organisms - -Tobacco Mosaic Virus, Lambda Phage, *Neurospora crassa*, *Caenorhabditis elegans*, *Arabidopsis thaliana*, *Drosophila*.

TEXT BOOKS/ REFERENCES

1. Dr. Renu Gupta , Dr. Seema Makhija , Dr. Ravi Toteja. Cell Biology : Practical Manual. Prestige Publishers, 2018.
2. Amit Gupta and Bipin Kumar Sati . Practical laboratory manual- CELL BIOLOGY.LAP Lambert Academic Publishing, 2019.
3. Alberts et al., (2002). Molecular Biology of the Cell, Garland Publishing, Inc., 4th ed.

SEMESTER	II					
YEAR	I					
COURSE CODE	22BS1202					
TITLE OF THE COURSE	BASIC GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	4	0	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To gain insight on the historical perspective of the evolution of genetics. - To comprehend and identify the different types of mendelian and non-mendelian inheritance.

COURSE OUTCOMES:		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will have clarity to the background of genetics before getting into details in the forthcoming semesters	L3
CO2	They will be capable differentiate between mendelian and non mendelian inheritance sources along with associated intricacies.	L3
CO3	Student will gain the ability to analyse and relate phenotype to genotype and potential factors influencing the interaction.	L3

COURSE CONTENT:		
MODULE 1	HISTORY OF GENETICS AND MENDELIAN PRINCIPLES	15Hrs
Pre- formation, History and scope of Genetics, Pre- Mendelian genetic concepts epigenesis, pangenesis, germplasm theory. Mendel- Life and his experiments on pea plants. Principle of Dominance (Dominance and Recessiveness); Laws of Inheritance and their applications. Monohybrid Cross, Dihybrid Cross, Back Cross, Test Cross		
MODULE 2	EXTENSIONS OF MENDELISM AND GENE INTERACTIONS	15Hrs
Co-dominance and incomplete dominance - definition, examples. Multiple allelism- definition, Eye color in Drosophila, Blood groups and Rh factor in Human; Allelic series; Lethal alleles; Multi-factorial inheritance- Skin colour in Humans; Penetrance and Expressivity; Plieotropy. Epistasis- dominant, recessive. Supplementary and Complementary gene interactions; Non epistatic inter allelic gene interaction, Position effect.		
MODULE 3	SEX DETERMINATION AND EXTRA CHROMOSOMAL INHERITANCE	15Hrs
Chromosomal theory of Inheritance - Concepts and evidences. Mechanism of sex determination- XX-XY; XX-		

XO; ZZ-ZW; Bridges genetic balance theory. Environmental and hormonal control of sex determination Gynandromorphs / Intersexes, Super sexes in *Drosophila*. Sex differentiation and dosage compensation (*Drosophila* and Man). Sex linked and sex-limited traits in Humans. Hemophilia, Hypertrichosis. Extra Chromosomal inheritance, flower colour in *Mirabilis jalapa*, kappa particle in *Paramecium*, sigma factor in *Drosophila*, Cytoplasmic Male Sterility (CMS) in maize.

MODULE 4 MODEL ORGANISMS IN GENETICS	15Hrs
Bacteria - <i>E. coli</i> ; Viruses - Tobacco Mosaic Virus; Bacteriophage - Lambda Phage; Fungi- <i>Neurospora</i> species, <i>N. crassa</i> , <i>Saccharomyces cerevisiae</i> ; Nematode - <i>Caenorhabditis elegans</i> , Plant - <i>Arabidopsis thaliana</i> , Fly - <i>Drosophila melanogaster</i> , Fish - Zebra fish (<i>Danio rerio</i>), Mammal - Mice (<i>Mus musculus</i>) and Rat (<i>Rattus rattus</i>).	

TEXT BOOK/ REFERENCES:

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Strickberger M. W., Genetics. (1968) Macmillan Publishers.
Mathew Hamilton, (2009) Population Genetics, Wiley-Blackwell
3. Snustad D. P., Simmons M. J., Principles of Genetics. 5th Edition (2008) John Wiley & Sons.
4. Brooker R. B., Genetics Analysis and Principles. Fourth Edition (2009) McGraw-Hill.
5. Tamarin R. H., Principle of Genetics. Seventh Edition. (2002) Tata-McGraw Hill.
6. Hart D and Jones E.W., Genetics Principles and Analysis. 4th Edition (1998) Jones and Bartlett Publication.
7. Atherly A. G., Girton J. R. and Donald M. C. J. F. The Science of Genetics (1999) Sounders College Publication / Harcourt Brace.
8. Sturtevant A. H., A History of Genetics (1965). Harper and Row New York. Mendel G. The First Geneticist by Orel V. (1996) Oxford University Press, New York.
9. Ross S. A first course in Probability. 4th Edition (1994). McMillan, New York.
10. Stansfield W. D., Theory and problems of Genetics (Schaum's Outline Series). (2002) McGraw Hill.
11. Stubbe H., History of Genetics (1972). Harper and Row New York.
12. Prasad S. Fundamentals of Biostatistics (1993). Emkay publications, New Delhi.
13. Khan and Khanum. Fundamentals of Biostatistics. II Revised Edition. (2004). Ukaaz Publication.

EXPERIMENTS

1. Temporary squash preparation of : Grasshopper Testes, Onion flower bud
2. Observation of meiotic stages in permanent slides
3. Blood Typing
4. Sex differentiation in *Drosophila*
5. Preparation of Barr bodies from buccal smear.
6. Problem solving on : (a) Probability (b) multiple alleles (c) Gene interactions (d) Sex Linkage
7. Studies on mendelian traits: (a) Flower color in *Mirabilis jalapa* (b) Coat color in Mice (c) Comb pattern in fowl.

REFERENCES

1. Brooker, R. J. 1999. Genetics: Analysis and Principles. Benjamin Cummings, Longman, INC.
2. Gardner E. J. M. J. Simmons and D.P. Snustad 1991 Principles of Genetics. John Wiley & Sons. INC. New York.
3. Klug, W. S. and M. R. Cummings 1994 Concepts of Genetics MacMillan Colley Publishing and Company NY.
4. Strickberger M. W. 1996. Genetics. Mac Millan Publishing Co. New York
5. Tamarin, R H. 1999. Principles of Genetics. McGraw-Hill.

SEMESTER	II					
YEAR	I					
COURSE CODE	22BS1203					
TITLE OF THE COURSE	MICROBIAL DIVERSITY AND KINETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To understand microbial diversity, classification, structure of different groups of microbes and their functions - To strengthen the knowledge on cell and cellular organisation of prokaryotic and eukaryotic systems. - To know about the economic importance of the microbes.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Enable students to relate the principles in classifying microbes	L1
CO2	Apply the knowledge in identifying different microorganisms and to study their life cycles	L2
CO3	Elucidate the role of beneficial and harmful effects	L3

COURSE CONTENT:
MODULE 1 15Hrs MICROBIAL DIVERSITY AND SYSTEMATICS Microbial Systematics: Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems. Brief account of Bergey's manual of systematic and determinative bacteriology. Criteria for classification of bacteria. Molecular methods (DNA homology, DNA-RNA homology, G+C ratio), phage typing and Serological methods in taxonomy, Numerical taxonomy.
MODULE 2 15Hrs PROKARYOTIC MICROBIOLOGY Bacteriology: Ultra structure of Bacteria: Classification, Structure external to the cell wall- Slime layer, Capsule, Flagella, Pilus/ Fimbriae. Cell wall, Cytoplasmic membrane; Cytoplasmic inclusion bodies. Bacterial Chromosome, Plasmids and Episomes, Ribosomes, Exospores, Endospore and Cysts. General account of Archaeobacteria, Actinomycetes. Virology: Classification, General structure, characteristics, cultivation and replication of viruses. Type study: classification, structure, replication, cultivation and application of - TMV and Lambda phage. Viroids and Prions.

MODULE 3	15Hrs
PHYCOLOGY Classification, General characteristics of algae including occurrence, thallus organization. Algal Ultrastructure, pigments, flagella, eyespot food reserves. Reproduction: vegetative, asexual and sexual. Types of life cycles: Haplontic, Diplontic, Haplobiontic and Diplobiontic. Type study of Cyanophyta (<i>Spirulina</i>), Chlorophyta (<i>Spirogyra</i>), Rhodophyta (<i>Gracillaria</i>). Economic importance of algae.	
MODULE 4	15Hrs
MYCOLOGY AND PROTOZOOLOGY Fungi: Classification, General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra-structure, thallus organization and aggregation, fungal cell wall structure and synthesis. Reproduction asexual and sexual. Type study of Zygomycetes (<i>Rhizopus</i>), Ascomycetes (<i>Aspergillus</i>), Basidiomycetes (<i>Agaricus</i>) and Deuteromycetes (<i>Fusarium</i>). Economic importance of fungi. Protozoa: General characteristics of protozoa. Type study - <i>Amoeba</i> , <i>Paramecium</i> , <i>Plasmodium</i> .	

TEXT BOOKS:
- Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2007. Introductory Mycology. ; Fourth edition, Wiley India Private Limited - Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec - Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York. - Benson, H. J. 1994. Microbiological Application. WCB McGraw-Hill of India Private Limited. - Brock, T. D. and Madigan, M.T. 1996. Biology of Microorganisms. Prentice Hall of India Private Limited. - Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England. - Pelczar, M. J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York. - Pommerville, J.C. 2007. Alcamo's Fundamentals of Microbiology. Eighth Edition. Jones and Bartlett Publishers, USA. - Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York. - Salle, A. J. 1984. Fundamental Principles of Bacteriology. Tata McGraw-Hill Publishing Company Limited, New Delhi. - Sharma, O. P. 1986. Text Book of Algae. Tata McGraw-Hill Education. - Stanier R.Y., and Ingraham J.L. 1991. General Microbiology. Prentice Hall of India Private Limited, New Delhi. - Vashishta, B.R. 2010. Botany for Degree Students – Algae. S. Chand and Co.

EXPERIMENTS
1. Isolation and identification of fungi (Lactophenol cotton blue mount).
2. Isolation and Identification of algae.
3. Study of Protozoa by using permanent slides: <i>Amoeba</i> , <i>Paramecium</i> , <i>Giardia</i> , <i>Plasmodium</i> .
4. Study of bacterial growth curve by turbidometric method.
5. Study of growth curve of fungi by colony diameter method
6. Cultivation and propagation of bacteriophage.
7. Cultivation of Algae / Algal growth.

REFERENCES:

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
3. Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
4. Pelczar, M. J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.
5. Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York.

SEMESTER	II					
YEAR	I					
COURSE CODE	22BS1204					
TITLE OF THE COURSE	BIOSTATISTICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To familiarize the students with basic concepts and principles of statistics - To understand the applications of statistics in biological sciences.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Student will be aware of various applied and allied domains like statistics and will be able to think creatively	L2
CO2	Students will be empowered for better prospects leading to project design and execution.	L3

COURSE CONTENT:	
MODULE 1	5 Hrs
Measures of Central Tendencies Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median.	
MODULE 2	15Hrs
Dispersion And Correlation Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance. Sampling methods and their significance.	
MODULE 3	7 Hrs
Probability Distributions Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions- Binomial, Poisson and Normal distributions with simple numerical	
MODULE 4	8 Hrs
Testing of hypothesis: Basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of “p” value. Statistical package- Features of statistical software, SPSS	

for various applications in Biostatistical program.

TEXT BOOKS/REFERANCES:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (1983). Mathematics in microbiology Academic press
5. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER	I I					
YEAR	I					
COURSE CODE	22BS1205					
TITLE OF THE COURSE	English II					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- The students will draw inferences relying on the context.
- The students will analyze and synthesize information presented in different sources.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students should be able to identify words or phrase related to the topic	L1
CO2	Students should be able to distinguish between more important ideas from less important ones.	L2
CO3	Students should be able to identify the figures of speech used	L3
CO4	Students should be able to write effectively concluding paragraphs that include a summary of the main points, repetition of the thesis-argument sentence, and/or their own comments	L2

COURSE CONTENT:	
MODULE 1	
6 Hrs	
Reading Skills Comprehension passage, classification and process analysis, Data interpretation,skimming and scanning,Types of reading, Techniques to improve reading.	
MODULE 2	
6 Hrs	
Writing skills Referencing skills, Brochure, Advertisements, graphic representation, Data interpretation, letter of appreciation, scientific writing, types of writing, travelogue writing	
MODULE 3	
6 Hrs	
Listening skills Listening Vs Hearing, Non verbal and Verbal signs of active listening, Barriers of listening skills, principles of listening skills, Types of listening, Techniques to improve listening skills	
MODULE 4	
6 Hrs	
Speaking skills Phonetics: basic concepts in phonetics, elocution, interviews, types of speaking, Debate, Group discussion. Narrating a story	

MODULE 5	6 hrs
Grammar Linkers, Types of sentence, Gerunds, Question tags, WH questions, Tenses, Common errors, antonyms and synonyms, affix.	

TEXT BOOKS: 1. Crystal, David. 1985, Rediscover Grammar with David Crystal. Longman 2. Bakshi, R. N. A Course in English Grammar. Orient Longman 3. Close, R. A. Reference Grammar for Students of English. Orient Longman 4. Krishnaswamy, N. Modern English – A Book of Grammar, Usage & Composition. Macmillan India Ltd. 5. Aroor, Usha (Ed.) WordMaster Learner's Dictionary of Modern English. Orient Longman 17

SEMESTER	II					
YEAR	I					
COURSE CODE	22BS1206					
TITLE OF THE COURSE	KANNADA KALI – II					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	0	0	0	30	2
Perquisite Courses (if any)						
#	Sem/Year	Course Code	Title of the Course			
-	-	-	-			

COURSE OBJECTIVES:
- To enable students read and write in Kannada - To make students to communicate in Kannada helping them to interact with local people for their daily needs

COURSE OUTCOME		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students should be able to read, write and communicate in Kannada	L3

COURSE CONTENT:

- BODY PARTS – DEHADA ANGAANGAGALU**
ದೇಹದ ಅಂಗಾಂಗಗಳು
- HEALTH INFORMATION (HISTORY TAKING) – AAROGYADA MAAHITHI** – ಆರೋಗ್ಯದ ಮಾಹಿತಿ
- MEDICAL WORDS AND DISEASES – VAIDYAKEEYA PADAGALU MATTHU KAAVILEGALU**
ವೈದ್ಯಕೀಯ ಪದಗಳು ಮತ್ತು ಖಾಯಿಲೆಗಳು
- PATIENT CASE RECORD – ROGIYADAAKHALEYA VIVARA**
ರೋಗಿಯ ದಾಖಲೆಯ ವಿವರ
- COMMON PHYSIOTHERAPY WORDS – PHYSIOTHERAPY YA SAAMAANYA PADAGALU**
ಫಿಜಿಯೋಥೆರಪಿಯ ಸಾಮಾನ್ಯ ಪದಗಳು
- DOCTOR & PATIENT CONVERSATION – VAIDHYA & ROGIYA SAMBAASHANE**
ವೈದ್ಯ & ರೋಗಿಯ ಸಂಭಾಷಣೆ
- DENTAL RELATED WORDS – HALLIGE SAMBANDHISIDA PADAGALU**
ಹಲ್ಲಿಗೆ ಸಂಬಂಧಿಸಿದ ಪದಗಳು
- DENTAL TREATMENT INSTRUCTIONS – DANTHA CHIKITHSEYA SUCHANEGALU**
ದಂತ ಚಿಕಿತ್ಸೆಯ ಸೂಚನೆಗಳು
- GENERAL CHECK UP – SAAMAANYA CHIKITHSE**
ಸಾಮಾನ್ಯ ಚಿಕಿತ್ಸೆ
- HEALTH EXAMINATIONS – AAROGYADA PAREEKSHEGALU**
ಆರೋಗ್ಯದ ಪರೀಕ್ಷೆಗಳು

11. OPPOSITE WORDS – VIRUDDHA PADAGALU

ವಿರುದ್ಧ ಪದಗಳು

12. VERBS - KRIYAA PADAGALU – ಕ್ರಿಯಾ ಪದಗಳು

13. LIQUID ITEMS – NEERINAAMSHADA PADAGALU

ನೀರಿನಾಂಶದ ಪದಗಳು

14. FEELINGS – BHAAVANE GALU – ಭಾವನೆಗಳು

15. TENSES – KAALASOOCHAKAGALU – ಕಾಲಸೂಚಕಗಳು

**16. COMMUNICATION WORDS –
SAMBHAASHANEYA PADAGALU**

ಸಂಭಾಷಣೆಯ ಪದಗಳು

SEMESTER	III					
YEAR	II					
COURSE CODE	22BS2301					
TITLE OF THE COURSE	BIOPHYSICS AND INSTRUMENTATION					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To create general understanding about theoretical concepts of techniques used to detect and assay biomolecules. - To familiarize the students with basic concepts and principles of biophysical and biochemical techniques used in biological sciences. - To give holistic view for understanding the screening, isolation, separation and characterization of molecules	

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Student will be scientifically equipped with understanding of the about the different biomolecules and their important functions.	L1
CO2	Student will be aware of the analytical tools and their instrumentation used in biotechnology/biological sciences.	L2
CO3	Students will have a basic understanding of biomedical equipments	L3
CO4	Students will be empowered for better prospects leading to project design and execution.	L2

COURSE CONTENT:	
MODULE 1	15Hrs
Spectroscopy: Beer-Lambert's law, application and its limitations. Extinction coefficient, Principle, schematics and applications of Colorimeter and UV-Vis Spectroscopy. Structural elucidation: CD, IR, NMR, x-ray Diffraction & their application in structural analysis of macro molecules, Mass spectroscopy (LC-MS and MALDI).	
MODULE 2	15Hrs
Chromatography: Principle of Chromatography. Distribution/partition coefficient, Absorption and Adsorption phenomenon, Retention factor (R _f & R _t concepts). Types: Planar and columnar. Paper and thin layer chromatography, types and their application in separation of biomolecules. Types of matrices used, separation of biomolecules using gel permeation, ion exchange, affinity and adsorption chromatography with applications. Brief idea about High Performance Liquid Chromatography (HPLC) and Gas Chromatography (GC).	

MODULE 3	15Hrs
Electrophoresis: Migration of ions in electric field, Factors affecting electrophoretic mobility. Paper electrophoresis, High voltage electrophoresis and their Applications. Principle, schematics and application of Agarose gel electrophoresis, SDS-PAGE, Isoelectric focusing (IEF) ,2D-PAGE and Capillary electrophoresis	
MODULE 4	15Hrs
Isotopic tracer techniques: Radioactive & stable isotopes, Pattern and rate of radioactive decay. Measurement of radioactivity: Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique), Autoradiography their advantages and limitations. Centrifugation: Basic principles, RCF, Svedberg constant and Sedimentation coefficient. Preparative centrifugation: Differential & density gradient centrifugation, Applications. Analytical centrifugation: Determination of molecular weight of biomolecules.	

TEXT BOOKS/REFERANCES:

1. Principles and Techniques of Practical Biochemistry – Keith Wilson and John Walker. Cambridge low price edition. 2. Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications 3. Analytical Techniques in Biochemistry and Molecular biology – Katoch. Springer. 4. Fundamentals of Analytical Chemistry - Skoog, Holler and West. Saunders 5. Handbook of Analytical Techniques – Gunzler and Williams. Wiley & Sons 6. Immunology – Kuby. Freeman Publishers 7. A Textbook of Practical Biochemistry- Joshi and Saraswat. Jain Publishers.

EXPERIMENTS
1. pH metric titrations of HCl-NaOH / Acetic acid-NaOH.
2. Determination of pI of amino acid (glycine).
3. Determination of extinction coefficient using colorimetry.
4. Determination of lambda maximum of biomolecules using UV spectroscopy.
5. Estimation of pKa of amino acid (glycine).
6. Determination of density & viscosity of given unknown solution.
7. Separation of amino acid by Thin Layer Chromatography (TLC).
8. Column chromatography of phyto-pigments on adsorbent (silica/alumina).

TEXT BOOKS/ REFERENCES

1. Principles and Techniques of Practical Biochemistry – Keith Wilson and John Walker. Cambridge low price edition. 2. Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications.

SEMESTER	III					
YEAR	II					
COURSE CODE	22BS2302					
TITLE OF THE COURSE	MOLECULAR BIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- Understand the general principles of central dogma, DNA and RNA types structure and their role in cells. - Explain the mechanisms of DNA replication, RNA synthesis and repair, various levels of gene expression, regulation and protein function.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	To demonstrate the fundamental understanding of central dogma of molecular biology	L1
CO2	To compile the steps involved in DNA replication and display experimental evidence that indicates that it is semi conservative in nature	L2
CO3	To demonstrate the fundamentals of steps involved in transcription and translation	L3

COURSE CONTENT:
MODULE 1 15Hrs THE MOLECULAR BASIS OF LIFE Central dogma, DNA and RNA as genetic material – experimental proof. Evidences for DNA as the genetic material- Griffith's transformation experiment, Hershey and Chase experiment, evidence for RNA as the genetic material of viruses (TMV, Retroviruses). Nucleic acids: DNA structure and types (A, B and Z model), Denaturation and renaturation kinetics of DNA, Types of RNA – mRNA, tRNA and rRNA, mi RNA.
MODULE 2 15Hrs DNA REPLICATION AND ITS COMPONENTS Replication of DNA (Conservative, Dispersive and Semi Conservative DNA replication, Meselson and Stahl experiment), theta and rolling circle model of replication. Prokaryotic and Eukaryotic – Enzymes and proteins involved in replication. DNA repair.
MODULE 3 15Hrs DNA TRANSCRIPTION AND ITS COMPONENTS RNA polymerases, Mechanism of transcription – initiation, elongation and termination in prokaryotes and eukaryotes. Post-transcriptional modifications of Eukaryotic mRNA (Poly A tailing, 5' capping and splicing mechanisms)

MODULE 4	15Hrs
TRANSLATION AND REGULATION OF GENE EXPRESSION Genetic code, wobble hypothesis, Mechanism of translation in prokaryotes and eukaryotes, Post translational modification of Proteins. Regulation of Gene expression in Prokaryotes – Operon concepts, induction, repression, attenuation, examples of Lac and Trp operons. Regulation of Gene expression in Eukaryotes –galactose metabolism in yeast.	

TEXT BOOKS/REFERENCES: 1. Cell & Molecular Biology by Gerald Karp, 3rd Edition, John Wiley & Sons (2009) 2. Molecular Biology of the Gene by James Watson et al, Pearson Education (2013) 3. Molecular Biology of the Cell, Bruce Alberts et al, Garland Science Publication (2007) 4. Principles of Biochemistry by Nelson and Cox, WH Freeman Publications (2008) 5. Textbook of Cell and Molecular Biology by Ajoy Paul, Books and Allied Ltd (2011). 6. Molecular Biology and Genetic Engineering by P K Gupta, Deep and Deep Publications (2008). 7. Cell Biology, Genetics, Molecular Biology, evolution and Ecology by PS Verma and VK Agarwal, S. Chand Publications (2006).

EXPERIMENTS
1. Extraction of DNA from plant/bacteria and animal sources (2 Units)
2. Separation of DNA on agarose gel electrophoresis, Visualization of DNA (2 units)
3. Quantification of DNA by spectrophotometry

TEXT BOOKS/ REFERENCES 1. Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz. Scientific American books. USA. 1983. 2. Biotechnology A Laboratory Course by Becker JM, Caldwell GA, Zachgo EA. Second edition. Elsevier. 1996. 3. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer 2011 4. Lab Manual in Biochemistry, Immunology and Biotechnology by Arti Nigam and Archana Ayyagari. TATA McGraw Hill publishers, 2008.

SEMESTER	III					
YEAR	II					
COURSE CODE	22BS2303					
TITLE OF THE COURSE	EVOLUTIONARY GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To make student understand the forces that have an impact on levels of genetic variations in natural and/or experimental populations for both qualitative and quantitative traits. - To enable students to choose, apply and evaluate several methods for studying genetic variation in and between species.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	This course will be helpful to the students to conceptualize the existence of genetic variation and speciation.	L1
CO2	Students will be able to describe the basic mechanisms behind evolution of DNA sequences and gene structure	L2
CO3	Student will gain the ability to analyze and relate phenotype to genotype and potential factors influencing the interaction.	L3

COURSE CONTENT:	
MODULE 1	15Hrs
CLASSICAL EVOLUTIONARY GENETICS Darwinism, Neo Darwinism and Synthetic Theory. Evolution of Sexual Reproduction. Sex Ratio and Sex Determination. Competition Among Levels of Organization. Speciation and Phylogeny. Coalescent Theory. Drift versus selection in population. Kin and group Selection.	
MODULE 2	15Hrs
INHERITANCE OF QUANTITATIVE TRAITS Quantitative versus Qualitative traits. Gene and genotype frequencies, mating patterns, Hardy-Weinberg principle, heterozygotes, extension of H-W principle to multiple alleles, sex-linked alleles. Non-random mating, inbreeding and assortative mating, inbreeding coefficient. Factors that change allelic frequencies	
MODULE 3	15Hrs
GENETIC POLYMORPHISMS AMONG POPULATIONS Genetic polymorphism, transient and stable and factors responsible for stable polymorphism. DNA markers and populations differences. Application of population genetics. Role of population genetics in genetic counselling. Genetic origin and evolution of human races. Genetic Demography, age and gender specific	

death and birth rates, intrinsic rate of natural increase. Index of opportunity for natural selection.	
MODULE 4	15Hrs
Molecular Evolution Dating major evolutionary events. The Cambrian explosion and the K-T radiation. Aligning DNA and protein sequences. Selection at the molecular level: variations in substitution rates and their causes in nuclear, organellar, and viral DNA. Mechanisms of genomic evolution: Endosymbiosis and lateral gene transfer, Transposition and gene duplications, Domain shuffling and concerted evolution. Genetic assimilation and canalization in development.	

TEXT BOOKS/REFERENCES: 1. D.B. Futuyma. Evolutionary Biology, Third Edition. Sinauer, 1997. 2. Hedrick P.W.(2011). Genetics of Populations. Jones and Bartlett Publishers, Massachusetts. 3. Jobling, M., Hollox, E., Hurles, M., Kivisild, T. and Tyler-Smith, C. (2013). Human Evolutionary Genetics. Garland Science. 4. RDM Page and LC Holmes. Molecular Evolution: A Phylogenetic Approach. Blackwell Science, 1998. 5. Relethford, J.H. (2012). Human Population Genetics. John Wiley & Sons. 6. Snusted, D.P., Simmons, M. J. (2010). Principles of Genetics. John Wiley & Sons, New York. 7. Knight, J.C. (2009). Human Genetic Diversity –Functional consequences for Health and Disease. Oxford University Press, USA.

EXPERIMENTS
1. Homology modelling
2. Construction of Phylogenetic trees: roots, nodes, clades etc.
3. Study of Quantitative inheritance in Kernel colour in Wheat/Skin colour in man.
4. Problem solving on: (a) Probability (b) multiple alleles (c) Gene interactions (d) Sex Linkage
5. Linkage mapping
6. Pedigree analysis

TEXT BOOKS/ REFERENCES 1. Brooker, R. J. 1999. Genetics: Analysis and Principles. Benjamin Cummings, Longman, INC. 2. D. Graur and W-H Li. <i>Fundamentals of Molecular Evolution</i> . Sinauer, 1999. 3. RDM Page and LC Holmes. <i>Molecular Evolution: A Phylogenetic Approach</i> . Blackwell Science, 1998. 4. Nielsen, R. and Slatkin, M. (2013). An Introduction to Population Genetics: Theory and Applications. Sinauer Associates, Inc.

SEMESTER	III					
YEAR	II					
COURSE CODE	22BS2304					
TITLE OF THE COURSE	CHEMISTRY II					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
•	To study the basic types of bonding, various theories of chemical bonding and chemical bonds in molecules.
•	To make students understand about the liquid state of matter, different properties of liquids, laws governing liquids and colligative properties and their applications.
•	To impart knowledge to understand basic concepts of organic chemistry starting from nomenclature to types of organic reactions.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will get in basic knowledge about types of chemical bonding and chemical bonding in molecules.	L1
CO2	Enable to understand in depth knowledge about chemical bonding and various theories related to that.	L2
CO3	Students will learn about the basic principles of organic chemistry	L3
CO4	Students will be equipped with fundamental knowledge of liquid state of matter.	L2

COURSE CONTENT:	
MODULE 1	10 Hrs
CHEMICAL BONDS – I Introduction: Need for the atoms to form molecules, and types of chemical bonds with examples IonicBond: Definition and conditions for formation of an ionic bond between atoms, examples of formation of an ionic compound between alkali metal/alkaline earth metals. Lattice energy, its effect on stability and solubility of ionic solids, Born – Haber cycle for NaCl and MgO. Covalent Bond: Definition, octet rule, Lewis dot formulae of a few simple molecules and ions, electron deficient and excess molecules (BeCl ₂ , BF ₃ , PCl ₅ , SF ₆). Geometry of covalent molecules: (VSEPR concept and hybridisation concepts) basic concepts and definitions: Examples simple inorganic molecules and ions such as NH ₃ , H ₂ O, H ₃ O ⁺ , SF ₄ .	
MODULE 2	11 Hrs
CHEMICAL BONDS – II Theories of covalent bonds (VBT and MOT): Valence bond theory (VBT): postulates and its limitations,	

directional characteristics of covalent bonds, Application of VBT to BeCl₂, BF₃, SiCl₄, PCl₅, SF₆ molecules. Molecular orbital theory: postulates, linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals, pictorial representation of formation of s and p MOs from the corresponding atomic orbitals, Molecular orbital energy level diagram and molecular orbital configuration involving s and p orbitals their importance for the following molecules, (H ₂ , N ₂ , O ₂ , HF and CO). Metallic Bond: Definition, properties of metals and band theory. Weak Intermolecular interactions: van der Waals forces, dipole-dipole interactions and their significance. Hydrogen Bond: Definition, types, importance.	
MODULE 3	12 Hrs
GASEOUS STATE Gaseous state - Elementary aspects of kinetic theory of gases, Ideal and real gases – deviation from ideal behavior- Van der Waals equation for real gases, causes of deviation from ideal behavior, Need for Maxwell-Boltzmann distribution law, mathematical expression for both based on this law (no derivation). Mean free path, collision frequency and collision number. Expressions for most probable velocity, rms velocity and average velocity, relationships between them, problems. Critical phenomenon - Andrew's isotherm on carbon dioxide and explanation of the curves (no experimental details). Explanation of velocity distribution curves. Derivation of critical constants T _c , P _c and V _c from van der Waals's equation and their experimental determination by Cagniard de La Tour method for T _c and P _c . Amagat's mean density method for V _c . Problems on the calculation of T _c , P _c and V _c , a and b. Law of corresponding states - statements, reduced equation of state and explanation, Joule-Thomson effect-explanation. Inversion temperature-definition (no derivation). The application of Joule-Thomson effect to the liquefaction of air and hydrogen by Linde's process.	
MODULE 4	12 Hrs
LIQUIDS AND SOLUTIONS Properties of liquids-Viscosity, Surface tension and Parachor-Definition, mathematical expression, numerical problems and factors affecting them. Viscosity- Definition, mathematical expression, Coefficient of viscosity, effect of temperature, size, weight, shape of molecules and intermolecular forces on it. Surface Tension- Definition, mathematical expression, effect of temperature and solute on it Parachor-Definition, Sugden equation, calculation and applications. Numerical problems. Liquid Mixture: Review of Raoult's law, ideal and non-ideal solutions. Completely miscible liquids- Fractional distillation T _c curves for all the three types, azeotropic mixtures - examples. Completely miscible liquids-Critical solution temperature (Three types), examples. Effect of addition of salt on CST of phenol-water system. Immiscible liquids, Steam distillation and its applications. Distribution law-Statement, partition coefficient and condition for validity of distribution law. Application-solvent extraction. Dilute solutions- Review of colligative properties and concentration terms. Determination of molecular mass of a solute by: (i) Berkeley- Hartley method(ii) Beckmann's method (iii) Landsberger's method. Numerical problems.	

TEXT BOOKS/REFERENCES:

1. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford, A.R. Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication.
3. Experimental Organic Chemistry Laboratory Manual, J.I. Garcia, J.A. Dobado, G. Francisco, Elsevier Publication.
4. Chemistry Practical Inorganic Qualitative Analysis For Under Graduate Students, M.J. Mamtara, S.C. Karad, J.S. Makasana, Lap Lambert Academic Publishing.
5. Advanced Practical Chemistry, K. Chelladurai, K. Subbian, Lap Lambert Academic Publishing.

SEMESTER	III					
YEAR	II					
COURSE CODE	22BS2305					
TITLE OF THE COURSE	COMPUTER APPLICATIONS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
• Graduates of the program will possess strong fundamental concepts in mathematics, science, and technology to address technological challenges • Acquire an attitude and aptitude for research, entrepreneurship and higher studies in the field of Computer Science and information technology.

COURSE OUTCOME:		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	To analyze, design and implement multifaceted biological problems of any domain with innovative and efficient approaches	L2
CO2	Attain better communication, presentation, time management and team work skills leading to responsible & competent professionals	L2

COURSE CONTENT:	
MODULE 1	15 Hrs
CATEGORIES OF COMPUTERS AND OPERATING SYSTEMS Evolution, Generations of computers (I, II, III, IV, V) Classification of computers, Input and output devices, Storage devices: Hard disk, Diskette, Magnetic tape, RAID, ZIP, devices, Digital tape, CD-ROM, DVD (capacity and access time), Main Circuit Board of a PC: Chips, Ports, Expansion. The Minicomputer, Mainframe Computers, Parallel processing Computer & the Super Computer, Operating System concepts, Windows 98/XP and later versions, Windows server NT/2000, Unix/Linux & servers. Introduction to networking: various terminologies, Associated hardware devices, gadgets (Router, Switch) tools, services, and resources, Network Topologies and Protocols, LAN, WAN and MAN World Wide Web (WWW) Network security: fire walls.	
MODULE 2	15 Hrs
INTERNET, VIRUSES AND PROGRAMMING CONCEPTS Introduction, Office Automation Software (Open Source Software). What is a virus? Virus symptoms, How do they get transmitted? What are the dangers? General Precautions, Search engines: Google, Yahoo, Concepts in text-based searching, searching Medline, PubMed, bibliographic databases. Algorithms, Flowcharts, Algorithms: Concepts & definitions, converting algorithms to flowchart; Coding: flowcharts to programs, Comparing algorithms, flowcharts & programs.	

TEXT BOOKS/ REFERENCES

1. Computer Fundamentals, 4th edition (2004) P.K. Sinha, BPB publication, India
2. Computer Networks. 4th edition (2008). Tanenbaum. Pearson Education, India
3. Biostatistics: P.N.Arora ,P.K.Malha.
4. Introduction to Database Management Systems, 1st edition, (2004), Atul Kahate, Pearson education, India.

SEMESTER	III					
YEAR	II					
COURSE CODE	22BS2306					
TITLE OF THE COURSE	CONSTITUTION OF INDIA					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	0	0	0	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
• Define a constitution
• Describe the salient features of the Indian Constitution
• Explain different ways of acquiring Indian Citizenship
• List the Fundamental Rights and Fundamental Duties of Indian citizens
• Describe the Directive Principles of State Policy and their significance

COURSE OUTCOMES:		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will appreciate the fundamental law of the land	L1
CO2	Students will be aware of what kind of government the country will have.	L1
CO3	Aid in understanding what lays down the rules to govern the country	L2
CO4	It also tells about the rights and also the duties of its citizens	L1

COURSE CONTENT:	
MODULE 1	6 Hrs
Framing of the Indian Constitution: Role of the Constituent Assembly. Philosophy of the Constitution: Objectives, resolution, preamble, fundamental Rights and Duties. Human rights and Environmental protection.	
MODULE 2	6 Hrs
Special Rights created in the Constitution of Dalits, Backward Classes, Women and Children, and religious and linguistic minorities. Directive Principles of State policy: The need to balance fundamental rights with directive principles.	
MODULE 3	6 Hrs
Union Executive: President, Prime Minister and Council of Ministers; powers and functions, coalition Government, problems in their working. Union Legislature: Lok Sabha and Rajya Sabha, powers and functions. Recent trends in their functioning.	

MODULE 4	6 Hrs
State Government: Governor, Chief Minister and Council of ministers, Legislature. Centre – State relations: Political, financial, administrative: Recent Trends.	
MODULE 5	6 Hrs
Judiciary: Supreme Court, Judicial Review, Writs, Public interest litigations. Enforcing rights through writs. Emergency provisions (Article 356)	

TEXT BOOKS/ REFERENCES

1. Computer Fundamentals, 4th edition (2004) P.K. Sinha, BPB publication, India
2. Computer Networks. 4th edition (2008). Tanenbaum. Pearson Education, India
3. Biostatistics: P.N.Arora ,P.K.Malha.
4. Introduction to Database Management Systems, 1st edition, (2004), Atul Kahate, Pearson education, India.

SEMESTER	IV					
YEAR	II					
COURSE CODE	22BY2401					
TITLE OF THE COURSE	HUMAN ANATOMY AND PATHOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6
Pre-requisite Courses (if any)						
#	Sem/Year	Course Code	Title of the Course			
-	I	22BS1101	Essentials of Biochemistry			

COURSE OBJECTIVES:

- Students will be able to understand different types of cells and tissues of organs in human system
- Comprehensively able to understand the cellular organization, barriers, targets and functions of different cells and tissues and their pathology

COURSE OUTCOME

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to demonstrate the different cellular and tissue organization of different organ system	L1
CO2	Will be able to explain the functions of different cell types their abnormalities in different organ systems	L2
CO3	Students will be able understand and interpret the cellular abnormalities from the diagnostic data	L3

COURSE CONTENT:

MODULE 1:	15Hrs
Scope of anatomy and physiology; levels of structural organization and body systems; Term used in Gross Anatomy; Classification and Types of tissues: Structure, location and functions of epithelial, muscular, nervous and connective tissues; General principles of cell communication ; Integumentary system: Structure and functions of skin; Superficial Fascia: Distribution of fat and functions.	
MODULE 2 :	15Hrs
Bones: Definition, Classification and functions of bone; Parts, types of epiphyses, Ossification, Blood supply of long bone; Cartilage – Definition, types, structure, distribution, nutrition. Joints: Classification, synovial joints, Blood supply & nerve supply. Muscular system: Functional classification, Prime movers, Fixators, Antagonists, Synergists.	
MODULE 3:	15Hrs
Central Vein System: Classification and structure of blood vessels; Lymphatic system: structure and functions of lymph vessels, lymphoid tissue; Nervous system: Classification of nervous system, Cell in the nervous system, Structure of a neuron, Structure of a typical spinal nerve.	

Histology of organs: Tongue, Stomach, Liver and Kidney, and Brain

MODULE 4:

15Hrs

Injury and infection; Apoptosis, autophagy and necrosis; Introduction to systemic diseases- Heart diseases, Hemostasis and Thrombosis, Stroke, Diabetes mellitus, Multiple sclerosis, , Immunohistochemistry of tissues.

TEXTBOOKS/ REFERENCES:

1. BD Chaurasia's Human , 8th Edition, 2019.
2. Anatomy & Physiology For Dummies, Erin Odya, 2002
3. Paramedical Hand Book on Anatomy, Physiology and Biochemistry, P Arun Jyoti, Arya Bhushan, Venugopal, , 2nd Edition, 2016.
4. Human Anatomy and Physiology, Rahul Phate, 2008,
5. Medical Immunology made memorable, 2nd Ed., John H. L. Playfair and P.M. Lydyard, Churchill Livingstone Publications, 2000.
6. Anatomy Histology and Cell Biology by Klein, 4th Edition, 2010.

HUMAN ANATOMY AND PATHOLOGY -PRACTICALS

1. Preparation of the slides for immune-histochemistry.
2. **Histology of Tongue and Liver.**
3. **Histology of Kidney and Stomach.**
4. Staining/Localization of biomarkers or the target molecules in the tissues.

REFERENCES:

1. Textbook Of Practical Physiology (5Th Edn), Balakrishna Shetty, H Sweekritha Poonja, 2018.
2. Practical Manual of Histology, 2nd Edition, by Hina Sharma.

SEMESTER	IV					
YEAR	II					
COURSE CODE	22BY2402					
TITLE OF THE COURSE	METABOLISM- I					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	I	22BS1101	Essentials of Biochemistry

COURSE OBJECTIVES:

- To understand the metabolic pathways of bio-molecules of the system.
- To create an understanding of structural and functional defects associated with metabolic pathways.

COURSE OUTCOMES

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students should identify the various rate determining steps in metabolism.	L1
CO2	Students should be able to interconnect and compare the carbohydrate and lipid metabolic pathway	L2
CO3	Students should be able to understand various diseases associated with metabolic pathways	L3

COURSE CONTENT:

MODULE I: Carbohydrate metabolism	15Hrs
Introduction to metabolism (anabolic, catabolic, amphibolic, and intermediary metabolism). Glycolytic pathway ; energetics and regulation, aerobic and anaerobic fates of pyruvate, Cori cycle, entry of sugars other than glucose into metabolism, Gluconeogenesis, reciprocal regulation, Pyruvate dehydrogenase complex, TCA cycle: amphibolic nature and regulation, anapleurotic reaction, substrate cycle, pentose phosphate pathway, Degradation, synthesis, and regulation of glycogen. Regulation of blood glucose level by organs and hormones, Diabetes mellitus, carbohydrate metabolic disorders (glycogen storage disorders).	
MODULE 2: Bioenergetics	15Hrs
Reduction Potential, Biological redox couplers, Mitochondrial electron transfer system- Sequence and structure of electron carriers . Proton motive force and the Mitchell hypothesis. F0F1-	

ATPase- structure and mechanism, Coupling of electron transfer to ATP synthesis. Mechanism of oxidative phosphorylation. P/O ratios and their use in localization of sites of ATP synthesis along the chain. Uncouplers, inhibitors and ionophores. Microsomal electron transport. Proton motive force in Halobacteria, H⁺ pumping by bacteriorhodopsin.

MODULE 3: Lipid metabolism

15Hrs

Basic scheme of fat absorption, mobility, degradation and synthesis; Degradation of triacylglycerol and phospholipids- lipases and phospholipases. **Fatty acid oxidation**- even, odd and unsaturated fattyacids by β -oxidation, scheme and energetics of β -oxidation, peroxisomal β -oxidation, branched chain fatty acids by α -oxidation, medium chain fatty acids by ω -oxidation. Metabolism of ketone bodies with physiological significance, **Fatty acid biosynthesis** - FAS- multi functional enzyme, chain elongation and desaturation. Biosynthesis of triacylglycerol, phospholipids and sphingolipids, sphingolipid storage disorders.

MODULE 4: Cholesterol and Circulating lipids

15Hrs

Cholesterol structure, brief idea of synthesis from acetyl CoA, regulation through HMG CoA reductase and utilization as hormones and bile salts, normal and abnormal levels in the body; Insoluble lipid mobilization by lipoproteins- chylomicrons, HDL, LDL, and VLDL – composition, markers and metabolic fate; Receptor mediated endocytosis of LDL. **Regulation of cholesterol metabolism** (brief introduction to Non steroidal anti-inflammatory drugs (NSAIDs); Biochemistry of obesity, atherosclerosis and hypercholesterolemia.

TEXTBOOKS/REFERENCES

1. Biochemistry- Voet, Donald; Voet, Judith G. 3rd Edn, John Wiley and Sons; New York, 2004.
2. Lehninger- Principles of Biochemistry; D L Nelson and M M Cox (Eds), 6th Edn, MacmillanPublications, 2012.
3. Biochemistry- Jeremy M. Berg, John L. Tymoczko, Lubert Stryer. 6th edition, W.H. Freeman, NewYork, 2007.
4. Textbook of Biochemistry with Clinical Corelations - Thomas M. Devlin. 7th edition, John Wiley& Sons, 2010.
5. Biochemistry of Foods - N A Michael Eskin, Fereidoon Shahidi. 3rd edition, Elsevier, 2012.
6. Biochemistry and Molecular Biology -D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C.Elliott. 5th edition, Oxford University Press, 2014.
7. Harpers Illustrated Biochemistry - V.W. Rodwell , D. Bender , K.M. Botham , P. J. Kennelly, P. A.Weil. 30th edition, McGraw-Hill Education, New York, 2015.

Metabolism- I PRACTICALS

1. Estimation of reducing sugar by DNS method / Miller's method.

2. Estimation of serum cholesterol by Zak's method.

3. Estimation of DNA by Diphenylamine Method.

4. Estimation of haemoglobin by SAHLI'S/ acid hematin method.

5. Identification of lipids by Thin layer chromatography.

REFERENCES:

- | |
|--|
| <ol style="list-style-type: none">1. Essentials of Practical Biochemistry, Prem Prakash Gupta, Neelu Gupta, 10.5005/jp/books/12972, 2017.2. A textbook of practical Biochemistry, Joshi and Saraswat, Jain Publishers, New Delhi 2002 |
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SEMESTER	IV					
YEAR	II					
COURSE CODE	22BY2403					
TITLE OF THE COURSE	NUTRITION					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	I	22BS1101	Essentials of Biochemistry

COURSE OBJECTIVES:

- To create an understanding about importance and nutrition value of biomolecules.
- To understand the structural and functional defects due to insufficient/excess nutrients.

COURSE OUTCOMES

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students should be able to demonstrate the composition and structure of various biomolecules in the living systems	L1
CO2	Students should be able to understand macronutrients and micronutrients of food	L2
CO3	Students should be able to demonstrate the abnormal conditions associated with little/excess of bio-molecules.	L3

COURSE CONTENT:

MODULE 1:	08 Hrs
Carbohydrates: Occurrence and physiological functions, factors influencing metabolism. Lactose intolerance. Dental caries. Artificial sweeteners. Role of dietary fiber in health and disease. Disorders related to carbohydrate metabolism. Glycemic index of foods and its uses. Lipids: Concepts of visible and invisible fats. EFA, SFA, MUFA, PUFA- sources and physiological functions. Role of lipoproteins and cholesterol, triglycerides in health and disease. Proteins: Concepts of essential and non-essential amino acids- their role in growth and development. Physiological functions of proteins. Requirements, nitrogen balance concept. Protein efficiency ratio. Methods for evaluating protein quality. Protein energy malnutrition -clinical features and biochemical changes.	
MODULE 2:	08 Hrs

Macro-minerals: Calcium, Phosphorus Magnesium, Sodium, Cobalt, Potassium, Chloride. **Micro minerals:** Iron, Zinc, copper, selenium, chromium, iodine, manganese, Molybdenum and fluoride. **Trace minerals:** Arsenic, Boron, Nickel, Silicon, Vanadium & cobalt: Digestion & absorption, Functions, Toxicity, interaction with other nutrients. RDA and food sources.

Vitamins and Energy metabolism: Fat soluble vitamins: RDA. Vitamin- A, vitamin- D, E & K. Water soluble vitamins: Vitamin-C, Thiamine, Riboflavin, Niacin, Pantothenic acid, Biotin, Folic acid, Vitamin-B12, Vitamin-B6 (Digestion, absorption and transport and excretion, functions, interaction with other nutrients (if any), Deficiency and toxicity, major sources, Assessment of nutritive value and analysis in food material.

MODULE 3:

10 Hrs

Energy metabolism: Basal and resting metabolism- influencing factors. Methods to determine energy requirements & expenditure. Thermogenesis, adaptation to altered energy intake, latest concepts in energy requirements and recommendations for different age groups. BMR and methods of BMR determination. Factors affecting BMR. Energy requirements for different physical activities. Specific dynamic action (SDA) of food. Regulation of food intake: role of hunger and satiety centers, effect of nutrients. Basis for computing nutrient requirements: latest concepts in dietary recommendations, RDAICMR and WHO: their uses and limitations.

MODULE 4:

04 Hrs

Nutrition in various age groups: Physiological adjustments, Nutritional requirements, Effect of malnutrition, and special needs and nutritional problems in Pregnancy, Lactation, infancy, preschool, adolescent, young adults and elderly adults.

REFERENCES:

1. Biochemistry - Donald Voet & Judith G. Voet. John Wiley & Sons, Inc, 2010.
2. Lehninger - Principles of Biochemistry - D. L. Nelson and M. M. Cox. 6th Edn, MacMillan Publications, 2012.
3. Nutrition: Science and Applications. Lori A. Smolin, Mary B. Grosvenor, 3rd Edn, Wiley, 2013.
4. Introduction to Human Nutrition- Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy, Hester Vorster, Wiley-Blackwell. 2nd Edn John Wiley & Sons.. 2009.
5. Nutrition: Everyday Choices - Mary B. Grosvenor, Lori A. Smolin. 1st Edition, Wiley, 2006.
6. Bioactive Food as Dietary Interventions for Liver and Gastrointestinal Disease- Watson, Elsevier, 2012.
7. Nutrition and Metabolism- Lanham S, Mac Donald I and Roche H. 2nd Edn, The Nutrition Society, London, UK, 2012.
8. Introduction to Human Nutrition-Gibney M, Lanham S, Cassidy A and Vorster H. 2nd Edn., The Nutrition Society, London, UK, 2012.
9. Public Health Nutrition- Gibney M, Margetts B, Kearney J and Arab L. The Nutrition Society, London, UK, 2012.

SEMESTER	IV					
YEAR	II					
COURSE CODE	22BS2401					
TITLE OF THE COURSE	BIOSAFETY AND GOOD LABORATORY PRACTICE					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To introduce the students to the concepts of biosafety regulatory frameworks concerning genetically modified organisms at national and international levels.
- To impart knowledge of the principles of GLP and their practical applications.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Gain knowledge of the various safety procedures to be followed in laboratory.	L2
CO2	Gain the skills and knowledge necessary to understand and work in GLP compliant environment.	L2
CO3	This course should generate interest for avenues for pursuing higher studies and careers in these areas	L2

MODULE I – BIOSAFETY	18 Hrs
Introduction, Historical Background; risk assessment and lab acquired infections, Introduction to Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms. Recommended Biosafety Levels for Infectious Agents and Infected Animals. Biosafety Guidelines: Biosafety guidelines and regulations (National and International); Definition of GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Recombinant DNA Guidelines (1990); Rules for the manufacture, use/import/export and storage of hazardous microorganisms/ genetically engineered organisms or cells (Ministry of Environment and Forests Notification,1989); Environmental release of GMOs; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.	

MODULE II – GOOD LABORATORY PRACTICE	12 Hrs
Introduction to GLP, WHO guidelines on GLP, History, Scope (Resources Characterization, Rules, Results, Quality assurance); Levels of Laboratories; General Rules/Protocols for Lab Safety measures; Precaution and Safety in handling of chemicals, Laboratory tools, glasswares and instruments; Sample storage and disposal; Log Book maintenance, Basic SOPs for instrument handling and Maintenance. Keeping data records, its analysis by using statistical and mathematical tools. Result analysis and its interpretation. GLP as given by OECD, FDA etc (International perspective); Internal and External Audits.	

TEXTBOOKS/REFERENCES:

1. Handbook Good Laboratory Practices-World health organization(WHO)
2. Life science protocol manual (2018)-DBT star college scheme
3. Guidelines for good laboratory practices-Indian council of medical research, NewDelhi (2008)
4. Handbook: Good Laboratory Practices (GLP): quality practices for regulated non-clinicalresearch and development-2nd ed.

SEMESTER	V					
YEAR	III					
COURSE CODE	22BY3501					
TITLE OF THE COURSE	HUMAN PHYSIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	IV/ II	22BY2401	HUMAN ANATOMY & PATHOLOGY

COURSE OBJECTIVES:

- To demonstrate an understanding of the physiology and basic regulatory concepts related to the functioning of life processes

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Will be able to demonstrate an understanding of the physiology and basic regulatory concepts of the organ systems associated with this course and the mechanisms that allow the body to carry out those functions, and predict how a perturbation (e.g., disease, experimental manipulation) will alter function.	L2
CO2	The student will be able to explain homeostasis and explain how homeostatic mechanisms normally maintain a constant interior milieu inside human body	L3

COURSE CONTENT:

MODULE 1	18Hrs
Hematology: Blood components and their functions, Formation, and function of blood cells- red blood cells, white blood cells, platelets. Hemostasis and blood clotting: factors affecting blood clotting, role of vitamin K in clotting, hemostatic control mechanisms, Disorders of clotting, Blood groups: the ABO system. role of hemoglobin in oxygen transport. Various buffer systems of the blood, acid base balance, factors affecting acid-base balance. Skeletal System: Extracellular matrix and its components, Bone-ultrastructure, composition, cells: osteoblasts, osteocytes, and osteoclasts. Bone growth, remodeling, and regulation by hormones. Muscular System: Overview of muscular tissue; types, functions & properties. Contractile and regulatory proteins of muscle structure of actin and myosin. Mechanism of muscle contraction, Contraction, and relaxation of skeletal muscle fibers- sliding filament model; Neuromuscular junction; Muscle metabolism	
MODULE 2	15 Hrs
Respiratory System: Components of respiratory system and their functions. Pulmonary ventilation, Lung volumes and capacities, Bohr and Haldane effect, chloride shift; effect of 2, 3- BPG on O₂ affinity of Hb; Clinical importance of 2, 3 BPG. Respiratory center. Respiratory Acidosis and Alkalosis. Dyspnoea, Asphyxia, Cyanosis, Decompression sickness, artificial respiratory methods.	

Cardiovascular System: Systemic and pulmonary circulations, coronary circulation, Basic understanding of Cardiac cycle. Cardiac output, ECG - its principle and significance. Structure and function of blood vessels. Blood pressure and its regulation Role of the cardiovascular center. Brief outline of cardiovascular disorder (hypertension, arteriosclerosis, myocardial infarction, and congestive heart failure.

MODULE 3	12 Hrs

Digestive System: GIT and accessory organs, Composition, function, and regulation of saliva, gastric, pancreatic, intestinal and bile secretions, Mechanism of breakdown and absorption of carbohydrates, lipids, and proteins.

Renal Physiology: Structure of nephron, mechanism of urine formation: Glomerular filtration, Tubular re-absorption & Active secretion, Fluid, electrolyte, and Acid-Base homeostasis, Kidney hormones.

MODULE 4	15 Hrs

Endocrine System: Introduction to endocrinology, classification, and mechanism of action of hormones. Glands - Pituitary, Adrenal, Pancreas & Thyroid; hormones - action, regulation, tests, and disorders. Control of calcium metabolism by parathyroid hormone, calcitonin, and vitamin D.

Nervous System: Organization of nervous system - CNS, PNS. ANS, somatic nervous system; autonomic nervous system-sympathetic and parasympathetic system; enteric nervous system, structure and function of neuron and glial cells, Synapse, generation of action potential, function of voltage-dependent and neurotransmitter-gated ion channels; the role of these ion channels in synaptic transmission, synaptic modification, and neuromodulation; neurotransmitters: glutamate, acetylcholine, glycine, dopamine & serotonin.

TEXTBOOKS/REFERENCES:

1. Guyton and Hall Textbook of Medical Physiology - J. E. Hall, 12th Ed. 5aunders Elsevier.2010.
2. Biochemistry - Donald Voet & Judith G. Voet. 4th Ed., John Wiley & Sons, Inc. 2010.
3. Textbook of Biochemistry with Clinical Corelations - Thomas M. Devlin. 7th edition, JohnWiley & Sons, 2010.
4. Lehninger - Principles of Biochemistry - DL Nelson and M Ni Cox. 6th Ed, MacmillanPublications, 2012.
5. Molecular Cell Biology - Harvey Lodish, David Baltimore and Arnold Berk, Scientific American Publication, 2000.
6. Molecular biology of the cell - Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., andWalter, P. 4th ed. Garland Science, New York, 2002.
7. Harper's Review of Biochemistry - Murray, Robert K. Mayes, Peter A. Rodwell, Victor W. Granner, Daryl K. McGraw-Hill Medical, 2006.
8. Cellular Physiology of Nerve and Muscle - Gary G Mathew. 4th Edition. Wiley-Blackwell2002.
9. Ganong's review of medical physiology - Kim E. Barrett, William F. Ganong. 24th ed. McGraw-Hill Medical ; McGraw-Hill [distributor], New York, London, 2012.
10. Human Biochemistry - James M. Orten, Otto Wilhelm Neuhaus. 9th edition, C. V. Mosby, 1995.
11. Principles of Biochemistry: Mammalian Biochemistry - Emil S. Smith, McGraw-Hill; Subsequent edition, 1982.
12. Principles of Human Physiology - Cindy L. 4th Ed. Stanfield Pearson, 2010.

Human Physiology - Practicals
1. Determination of pulse rate and blood pressure under resting condition and the effect of exercise on it.
2. Determination of bleeding time and clotting time.
3. Urine analysis (Qualitative analysis and abnormal constituents).
4. Titratable acidity of urine
5. Estimation of Inorganic phosphate by Fiske Subbarow method.

TEXT BOOKS/ REFERENCES

1. Practical Clinical Biochemistry - Harold Varley. 4th edn., CBS Publishers, 2018.
2. Practical Clinical Biochemistry: Methods and Interpretation - Ranjna Chawla. Jaypee Brothers Medical Publishers, 2016.
3. Practical and Clinical Biochemistry for Medical Students - T.N. Pattabhiraman. Gajanna Publishers, 2014.
4. Hawk's Physiological Chemistry – Oser. 14th Edn, Tata-McGrawHill, 2006.
5. Biochemistry – Plummer., Tata-McGraw Hill, 2017.

SEMESTER	V					
YEAR	III					
COURSE CODE	22BY3502					
TITLE OF THE COURSE	METABOLISM- II					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	I	22BS1101	Essentials of Biochemistry

COURSE OBJECTIVES:

- To understand the importance of amino acid and nucleotide metabolism in the living systems.
- To understand the diseases associated with defects in the metabolic process.

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students should be able to identify the metabolic, enzyme-assisted reactions of nitrogen bases and fat to fuel living systems.	L1
CO2	Students should be able to demonstrate the role of lipids play in energy storage and usage.	L2
CO3	Students should be able to integrate and assess the complete metabolic processes in living systems particularly human beings.	L3

COURSE CONTENT:

MODULE 1: AMINO ACIDS AND PEPTIDES	15hrs
General metabolic reaction of amino acids– transamination, deamination, oxidative and nonoxidative deamination, glucose – alanine cycle. Urea cycle– regulation and metabolic disorders. Biosynthesis of creatine and creatine phosphate, polyamines, glutathione, physiologically active amines (serotonin and α – histamine) and catecholamines (dopamine, epinephrine and norepinephrine). Role of RER and Golgi complex in the synthesis of glycoproteins and GPI anchored proteins. Biogenic amines – polyamines. Bioactive peptides – Bradykinin, angiotensin, oxytocin and vasopressin.	
MODULE 2: METABOLISM OF STANDARD AMINO ACIDS	15Hrs
Regulation of amino acid and purine/pyrimidine levels by Glutamine Synthetase. Biosynthesis and degradation of twenty standard amino acids – A, G, T, S, C, E, N, D, Q, R, H, P, V, I, M, L, K, W, F&Y.	

MODULE 3: NUCLEOTIDE METABOLISM	15 Hrs
Nitrogen Cycle, nitrogen fixation, nif genes. Structure of nucleoside and nucleotide; Synthesis of purine and pyrimidine nucleotides – the de novo and the salvage pathway and their regulation. Degradation of purine and pyrimidines, DNA and RNA degradation. Heme Metabolism: Biosynthesis and degradation of porphyrin and their regulation.	
MODULE 4: NITROGEN METABOLIC DISORDERS	15 Hrs
Disorders associated with amino acid metabolism. Disorders associated with Nucleotide metabolism, degradation: gout, Lesch-Nyhan syndrome, orotic aciduria, and xanthinuria. Disorders related to heme metabolism (porphyrias, jaundice and Hemoglobinopathies).	

REFERENCES

1. Principles of Biochemistry - Lehninger, 6th Edn. W.H. Freeman and Company, New York, 2013
2. Principles of Biochemistry - Zubay, Parson and Vance. 1st Edn., Brown (William C.) Co, U.S., 1995
3. Biochemistry - Voet and Voet. 4th Edn., Wiley & Sons, 2011.
4. Textbook of Biochemistry with clinical correlations - Devlin, John Wiley & Sons, 7th Ed, 2010.

Metabolism_II- PRACTICALS
1. Estimation of serum bilirubin.
2. Determination of ratio of albumin and globulin in serum.
3. Estimation of uric acid/urea in serum.
4. Estimation of SGPT/SGOT by DNPH method.
5. Estimation of creatinine by Jaffe's method.

REFERENCES:

1. Essentials of Practical Biochemistry, Prem Prakash Gupta, Neelu Gupta, 10.5005/jp/books/12972, 2017.
2. A textbook of practical Biochemistry, Joshi and Saraswat, Jain Publishers, New Delhi 2002

SEMESTER	V					
YEAR	III					
COURSE CODE	22BS3501					
TITLE OF THE COURSE	BIOETHICS AND IPR					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
To recognize, compare, and contrast the general "ways of thinking" of science (biology) and of philosophy (ethics).
To recognize, compare, and contrast the general "ways of thinking" of science (biology) and of philosophy (ethics).
To give elementary essential concepts of Bioethics, IPR and patent laws.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student should develop basic understanding of the concepts of Bioethics, IPR and Patent Laws	L2
CO2	This course should generate interest for avenues for pursuing higher studies and careers in these areas	L2
CO3	General knowledge should create awareness necessary for higher studies in biotechnological fields	L2

COURSE CONTENT:	
MODULE 1: BIOETHICS	15 Hrs
Bioethics- The environmental, legal and socioeconomic impacts of biotechnology; Ethical concerns of biotechnology in research and innovation-The GM crop debate – safety, ethics, perception and acceptance of GM crops; Bioethics of Genetically modified organism; Bioethics of CRISPR technique- for editing human embryos; Bioethics of Gene therapy; Bioethics of Stem cell research; Reproductive medicine and ethics; Use of Animals in Research and Testing, and Alternatives for Animals in Research, Animal Cloning, Human Cloning, and their Ethical Aspects; Public education of the process of biotechnology involved in generating new forms of life for informed decision-making.	
MODULE 2: INTELLECTUAL PROPERTY RIGHTS AND REGULATIONS	15 Hrs
Introduction to Intellectual Property and History. Patents, Trademarks, Copyright, Trade secrets, Industrial Design and Rights, Traditional Knowledge, Geographical Indications - importance of IPR – patentable and non-patentable – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO), Pros and Cons of IP protection. Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. Agreements and Treaties: GATT, TRIPS Agreements; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.	

TEXTBOOKS/REFERENCES:

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBHPublishing Co. New Delhi.
2. Ganguli Prabuddha Gearing up for Patents. "The Indian Scenario", Universities Press (1998)
3. Introduction to Plant Biotechnology, H S Chawla
4. M K Sateesh. Bioethics and Biosafety. Kindle Edition
5. Shomini Parashar, Deepa Goel IPR, Biosafety and Bioethics Pearson India, 2013
6. F. H. Erbisch and K. M. Maredia. Intellectual property rights in agricultural Biotechnology, University Press, 2004.

SEMESTER	V					
YEAR	III					
COURSECODE	22BS3502					
TITLEOFTHECOURSE	BIONFORMATICS					
SCHEME OFINSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisiteCourses(if any)			
#	Sem/Year	CourseCode	Titleofthe Course
-	-	-	-

COURSEOBJECTIVES:

To get introduced to the basic concepts of Bioinformatics and its significance in biological data analysis.
To get an overview about biological macromolecular structures and structure prediction methods.

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Will be able to demonstrate mastery of the core concepts of bioinformatics	L1
CO2	The student will be able to apply basic principles of biology, computer science and mathematics to address complex biological problem	L2
CO3	Should be able to plan basic experiments in microbial genetics concerned with clarifying phenotypes and their relationship with thegenotype	L3

COURSECONTENT:

MODULE 1 BIOLOGICAL DATA TYPES AND SOURCE	07Hrs
Introduction to population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb).	
MODULE 2 SIMILARITY SEARCHING	10Hrs
Global and Local sequence alignment, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs	

MODULE 3 INTERPRETTING the SEQUENCE	07Hrs
Reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank libraries, annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files.	
MODULE 4 SCALING THE HUMAN GENOME	06Hrs
UCSC genome browser, RegulomeDB database, ENCODE-ChIA-PET database, transcription factors binding sites. SNP, EST, STS. Regular Expression (REGEX), Hierarchies and Graphical models (including Markov chain and Bayes algorithm). Genetic variability and connections to clinical data.	

TEXTBOOKS/REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R. F. Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W. Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Bioinformatics. Baxavanis, Wiley and Sons, 2020.
7. Biological Data Analysis. A practical Approach, Fry, J. C. IRL Press, Oxford. 1993.
8. The UCSC Genome Browser database: 2015 update. Rosenbloom KR et al, Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81.

SEMESTER	VI					
YEAR	III					
COURSE CODE	22BY3601					
TITLE OF THE COURSE	ENZYMOLGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	22BS1101	Essentials of biochemistry

COURSE OBJECTIVES:

To create an understanding about enzymes, coenzymes and their properties
To gain knowledge of enzyme assays, enzyme kinetics and drawing enzyme assisted reaction plots.
To learn about protein isolation and purification methods

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonom
CO1	Students would understand active site structure and enzyme catalysis	L1
CO2	Students would have a brief idea about regulation of enzyme activity along with enzyme inhibition.	L2
CO3	Students should learn analytical techniques which can be used to isolate and analyze proteins	L3

COURSE CONTENT:

MODULE 1	15 Hrs
Introduction to enzymes: Classification and nomenclature, Specificity, active site groups, theories of enzyme action. Enzyme assay: Principle and types, enzyme units. Monomeric, oligomeric and multifunctional enzymes, multi enzyme complexes. Enzyme localization (chemical and immune-fluorescence method) and purification. Criteria of purity. Enzyme catalysis: Chemical nature of enzyme catalysis - General acid/base catalysis, electrostatic catalysis, covalent catalysis, Intramolecular catalysis.	
MODULE 2	15 Hrs
Enzyme kinetics of single substrate reactions: Michaelis-Menten and Briggs and Haldane theory (rapid equilibrium and steady state theory). Effect of substrate, temperature, pH and modulators on enzyme activity. Kinetic data evaluation: linear transformation of Michaelis-Menten equation. Pre-steady state kinetics. Methods used in the investigation of the kinetics of enzyme-catalyzed reactions, initial velocity studies and rapid reaction techniques. Integrated velocity equation. Haldane equation. King-Altman procedure for deriving the rate equation. Arrhenius plot and determination of activation energy.	

MODULE 3	15 Hrs
Enzyme Inhibition: Types of reversible inhibitors; competitive, non-competitive, uncompetitive, and mixed inhibitors. Partial, substrate, allosteric and Irreversible inhibition. Allosteric enzymes and metabolic regulation. Study of ATCase as typical allosteric enzyme. Other mechanisms of metabolic regulation reversible covalent modifications, proteolytic cleavage (zymogen activation – digestive enzymes, blood clotting cascade). Enzyme inhibitors as drugs.	
MODULE 4	15 Hrs
The investigation of active site structure - The identification of binding sites and catalytic sites – trapping the E-S complex, use of substrate analogs, enzyme modification by treatment with proteolytic enzymes, photo – oxidation and chemical modification of amino acid side chains. Affinity labelling studies, super-reactive amino acid side chains, X-ray crystallographic and NMR studies. Coenzymes (mechanistic role of NADH, FAD and TPP)	

TEXTBOOKS /REFERENCES:

1. Enzymes - Biochemistry, Biotechnology, Clinical Chemistry, Palmer and Bonner, ElsevierPress, 2007.
2. Biochemistry - Voet and Voet, 4th Ed, Wiley, 2010.
3. Fundamentals of Enzymology - Price and Stevens, 3rd Edn., Oxford University Press, 2000.
4. Fundamentals of Enzyme Kinetics - Bowden, 3rd Edn., Portland Press, 2004.
5. Biophysical Chemistry Part II, Charles R. Cantor - Paul R. Schimmel, W.H. Freeman & Companys, 2008.
6. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis - Robert A. Copeland, Wiley-VCH Publishers, 2000.
7. Biochemical Calculations - Irwin H. Segel, 2nd Ed. John Wiley and Sons, 2010.

Enzymology- Practicals
1. Introduction to enzymology Lab and product curve determination.
2. Isolation of enzymes (amylase/ phosphatase) from biological source and activity determination through time curve.
3. Determination of kinetic constants through LB plot.
4. Effect of pH on enzyme activity.
5. Effect of temperature on enzyme activity.
6. Determination of Arrhenius constant.
7. Effect of activators and inhibitors on enzyme activity.

TEXTBOOKS/ REFERENCES:

1. Practical Enzymology - Hans Bisswanger, 3 rd Edn., Wiley-VCH, 2019.
2. Introductory Practical Biochemistry - Sawhney and Singh. 1st Edn., Narosa Publishing house, 2001,
3. Principles and Techniques of Practical Biochemistry - Wilson, Wilson and Walker, CambridgeUniversity Press, 2000.
4. Introduction to practical Biochemistry - Plummer, 2nd Ed, Tata McGraw-Hill Education, 2001.
5. Basics of Enzyme Immobilization - Alka Dwevedi, 1st Edn., Springer International Publishing, 2016.

SEMESTER	VI					
YEAR	III					
COURSE CODE	22BY3602					
TITLE OF THE COURSE	IMMUNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	22BS1101	Essentials of biochemistry

COURSE OBJECTIVES:

- Students will be able to understand the role of different cells and organs of immune system.
- Students will be able to understand the significance of immune system and immunotherapy in treating diseases

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy
CO1	Student would be acquainted with the basic understanding of immune system as a whole and	L2
CO2	Student would gain fundamental knowledge about the consequences of immune system failure	L3
CO3	Student would be able to demonstrate the significance of immunology diagnosis and therapeutics of the diseases and interpret the diagnostic data in correlation with the patho-physiology	L4

COURSE CONTENT:

MODULE 1: Introduction and Basic concepts in immunology	15 Hrs
Introduction: Basic concepts in immunology, role of immune system, principles of innate and adaptive immunity.	
Innate immunity: Different lines and layers of defence, secretions: skin, lysozyme, pH, mucous. Pattern recognition in innate immune system, the complement system: activation through classical, alternate and lectin pathway, Induced innate immune responses to infections. Functions of natural killers, monocytes, macrophages, eosinophils, neutrophils and basophils.	
MODULE 2 : Antigen Antibody interactions	15 Hrs
Antigen recognition by B-cells: Clonal selection, effector and memory cells, Antibody types, structure, functions, isotypes, allotype, idiotype, Interaction between the antibody and specific antigen, epitope, paratope, affinity, avidity, radio-equilibrium dialysis study, Diversity of Immunoglobulins. Antigen recognition by T cells: TH, TC and TReg cells, T-specific markers, TCR, MHC, Types, functions, gene structure, receptor structure, antigen processing and presentation, exogenous and endogenous antigen.	

MODULE 3: Lymphocyte development and inflammation	15 Hrs
Development and survival of lymphocytes: Lymphocytes in bone marrow and thymus, positive and negative selection of lymphocytes, survival and maturation of lymphocytes, self/non self- recognition. Transplantation and Network theory: Transplant rejection, immunosuppressants. Immuno-surveillance, idiotypes and immune network theory.	
MODULE 4: Pathoimmunology&Immunotechniques	15 Hrs
Pathoimmunology: Effector mechanisms in allergic reactions and IgE, hypersensitivity diseases; Autoimmune diseases- Rheumatoid arthritis, multiple sclerosis. Immuno-techniques: Generation of monoclonal antibodies, Immuno-diffusion techniques, RIA, ELISA. Immuno-electrophoresis, immuno-staining techniques, Immuno-florescence and flow cytometry.	

TEXTBOOKS/REFERENCES:

1. Cellular and Molecular Immunology - Abbas and Lichtman. 7th Edn., Saunders Publishers, 2011.
2. Immunology - Golsby, Kindt, Osborne and Kuby. 5th Edn, Freeman Publishers, 2003.
3. Roitt's Essential Immunology, Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, 12th Edn., Wiley-Blackwell, 2011.
4. Medical Immunology made memorable, 2nd Ed., John H. L. Play fair and P.M. Lydyard, Churchill Livingstone Publications, 2000.
5. Textbook of Immunology - Sai Leela K, Mohanty S K, Veerendra Reddy P. Jaypee Publishers, 2007.
6. Cell and Molecular Biology: Concepts and Experiments - Karp. 7th Ed., Wiley & Sons 2013.
8. Molecular Cell Biology - Harvey Lodish, David Baltimore and Arnold Berk, 3rd Ed., Scientific American Publishers, 1995.

IMMUNOLOGY-PRACTICALS
1. Serum Separation from whole blood and isolation of immunoglobulins from serum.
2. Study of different cells in whole blood using Giemsa/Leishman stain.
3. Blood grouping
4. ELISA/Dot ELISA
5. Radial Immunodiffusion/Ouchterlony Double Diffusion
6. Rocket Immuno Electrophoresis
7. WIDAL/RPR Test

TEXTBOOKS/REFERENCES:

1. Essential Immunology - Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt. 12th edition, ELBS, Blackwell Scientific Publishers, London, 2011.
2. Fundamentals in Immunology - William E Paul. 7th edition, Raven Press, 2012.
3. Immunology - Kubly J, Judy Owen, Jenni Punt, Sharon Stranford. 7th Edition. W.H. Freeman and Company, 2013.

SEMESTER	VI					
YEAR	III					
COURSECODE	22BS3601					
TITLEOFTHECOURSE	PRINCIPLES OF ‘MULTI-OMICS’					
SCHEME OFINSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	TotalHours	Credits
	2	-	-	-	30	2

PerquisiteCourses(if any)			
#	Sem/Year	CourseCode	Titleofthe Course
-	-	-	-

COURSEOBJECTIVES:	
To acquaint students with various aspects of biotechnology and bio-engineering using omics technologies	
To provide key insights into omics approaches in personalized and precision medicine	

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will have knowledge in specific methods used in genomics, proteomics and metabolomics used in analytical processes.	L1
CO2	Students will be able to perform statistical analysis crucial for interpretation of experimental results	L2
CO3	Students will be able to apply specialized research methods necessary for the analysis of proteins, genes and metabolites	L3

COURSECONTENT:	
MODULE1: Genome & Genomics	07Hrs
Genome mapping: Physical and Genetic Map, Genome Sequencing, Next generation sequencing methods ,Genome Annotation, Functional Genomics	
MODULE2: Transcriptomics	07Hrs
Search for transcription factor binding sites, RNA-Seq, Microarrays, Regulatory RNAs: small or large, Computational prediction of miRNA target genes, RNA Darkmatter	

MODULE3: Proteomics and Metabolomics	10Hrs
Basic concepts , Tools of proteomics- SDS PAGE, 2D PAGE , Liquid chromatography , Mass Spectrometry (ESI and MALDI) ,Protein identification by peptide mass fingerprinting ,Applications of proteomics. Fundamental concept, Tools of metabolomics- Capillary electrophoresis, Gas chromatography, Electrochemical detectors, Case studies	
MODULE4: ‘OMICS’: applications and future perspectives	06Hrs
Multi-omics in disease prediction and health. Multi-omics technologies for crop improvement and sustainable agriculture. Applications in Biomedical and Environmental sciences	

TEXTBOOKS/REFERANCES:

1. Bioinformatics - Keith, J., Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis - R. F. Doolittle, Academic Press, 1996.
3. Introduction to Proteomics -Tools for the New Biology by Daniel C. Liebler, Humana Press..
4. Bioinformatics and functional genomics - J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics - Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Metabolomics - Methods and Protocols by Wolfram Weckwerth, Humana Press.
7. Biological Data Analysis. A practical Approach - Fry, J.C. Biological Data Analysis. A practical Approach. IRL Press, Oxford, 1993.
8. Transcriptomics: Expression Pattern Analysis, Virendra Gomase, Somnath Tagore; VDM Publishing, 2009 – Science

SEMESTER	VI					
YEAR	III					
COURSE CODE	22BS3602					
TITLE OF THE COURSE	TOXICOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	22BY2401	Human anatomy and pathology

COURSE OBJECTIVES:
- To learn various toxicants present and their exposure level on day-to-day basis. - To study the effects of toxins on the physiologic, metabolic, reproductive, and developmental processes.

COURSE OUTCOMES

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students would learn and understand all substances can be toxic depending on the means and level of exposure	L1
CO2	Students would learn the basic concepts of cellular toxicity and chemical actions on cells and body organs	L2
CO3	Students would learn the importance and diversity of drug interactions with various organs	L3

COURSE CONTENT:
MODULE 1: Introduction of toxicology 10 Hrs Classification of toxic agents, natural toxins, animal toxins, plant toxins, food toxins, genetic poisons and chemical toxins. Factors affecting toxicity – species and strain, age, sex, nutritional status, hormones, environmental factors, circadian rhythms. Toxicant proceeding <i>in vivo</i> : Absorption, Distribution, Excretion and Metabolism of foreign/toxic compounds.
MODULE –II: Environmental toxicology 5 Hrs Environmental pollution- Sources and types of pollution, Important pollution events, Priority pollutants. Air pollution- Classification and properties of air pollutants, Behaviour and fate of air pollutants, Photochemical smog, Acid Rain, health effects of air pollution. Water pollution- origin of

Wastewater, Domestic Water Pollution, Industrial water pollution, Agricultural water pollution, Toxic water pollutants and their health effects, Groundwater pollution, marine pollution	
MODULE III: Industrial toxicology	5 Hrs
Industrial Chemicals: Government Regulation of Chemicals, Ways of exposure, Toxic effects, Long-term consequences and developmental toxicity. Food Additives and Contaminants types of food additives, Preservatives, Saccharin. Toxicity of trace elements- Iodine, iron, zinc, copper, manganese, selenium, molybdenum, and cobalt Cyto-toxicity of heavy metals- Cadmium, mercury, arsenic, chromium and lead. Brief introduction to toxicity of pesticides and insecticides.	
MODULE - IV: Organ Toxicology	10 Hrs
Basics of organ toxicity- Target organs, Organ selectivity and specificity, gender specific diversity of toxins. Hepatotoxicity - Actions of toxins on the liver, Chronic liver injury; Cardiotoxicity - pathology of cardiac toxicity, mechanisms of cardiotoxicity; Respiratory Toxicity - Systematic lung toxins, Lung pathology; Reproductive System – Teratogenicity; Neurotoxicity- Effect of toxic agents on neurons, Ion channel neurotoxins and Nephrotoxicity- susceptibility of kidney to toxic insult, chemically induced renal injury.	

TEXTBOOKS/ REFERENCES:

1. Pharmacology - Whalen, Finkel, and Panavelil. 6th ed., Lippincott Williams & Wilkins, 2015.
2. Lieberman and Peet, Mark's Basic Medical Biochemistry: A Clinical Approach, 5th ed. Wolters Kluwer, 2018.
3. A Textbook of Modern Toxicology - Hodgson. 4th ed., J Wiley & Sons, 2010.
4. Molecular and Biochemical Toxicology, Smart and Hodgson, eds. 4th ed., J Wiley & Sons, 2008.
5. The Dose makes the Poison: A Plain-language Guide to Toxicology - Frank and Ottoboni, 3rd ed. eBook, J Wiley & Sons, 2011.
6. A-Z Guide to Drug-Herb-Vitamin Interactions, Gaby, Batz, Chester and Constantine, 2nd ed., Three Rivers Press, 2006.
7. Gilbert- A Small Dose of Toxicology - The health effects of common chemicals, CRC Press, 2004.
8. Multiple Chemical Sensitivities: A survival guide - Gibson, New Harbinger Publications, 2000.
9. Toxicology and Clinical Pharmacology of Herbal Products - Cupp and Karch, eds., Springer-Verlag, 2000.
10. Staying Well in a Toxic World - Lawson, Lynwood Press, 2000.

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22BY4701					
TITLE OF THE COURSE	GENETIC ENGINEERING					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	II & III	22BS1202 & 22BS2302	Basics Genetics & Molecular Biology

COURSE OBJECTIVES:	
To understand the concepts of genetic engineering including the tools, techniques, protocols and applications.	
To have knowledge on how to design recombinant molecules using different vectors specific for a particular species and understand the concept of protein expression.	
To be able to learn the applications of rDNA technology and apply the knowledge to their future research.	

COURSE OUTCOME		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Student will gain fundamental knowledge about the tools and strategies used in genetic engineering.	L2
CO2	Students will be able to design, screen, isolate, amplify DNA and also learn the concept of protein expression and apply the knowledge in problem solving and in practice	L3
CO3	The students will understand the applications of rDNA technology from academic and industrial perspective.	L4

COURSE CONTENT:	
MODULE 1: Introduction and Basic Concepts	15 Hrs
Introduction: Overview of major steps involved in genetic engineering. Molecular Tools: Restriction endonucleases: Types and characteristic features; Modification of cut ends. DNA ligases, Alkaline phosphatase, Polynucleotide kinase, DNase I, DNA polymerase and Klenow fragment, Terminal nucleotidyl transferase, RNA dependent DNA Polymerase. Basic principles of gene editing – CRISPR/CAS9.	
MODULE 2: Vectors and Gene transfer	15Hrs
Properties of an ideal vector. Cloning vectors: Prokaryotic vectors (pBR322; pUC18; Lambda phage, Cosmids). Eukaryotic vectors: YAC vector, Shuttle vector, Plant Vectors – (Ti Plasmid-Binary and Co integrated vectors); Animal Vectors: SV 40, retroviral vectors. Expression vectors in Prokaryotes and Eukaryotes – Basic features and role of promoters, terminator and RBS. Methods of Gene transfer: Transformation, Transfection, Microinjection, Electroporation, Microprojectile, Liposome Fusion	
MODULE 3: Selection of Recombinants	15Hrs
Isolation of the desired gene: cDNA library, Genomic library. Selection and screening of recombinants: Identification and selection of transformed cells: <u>Direct methods</u> - Insertional inactivation, Visual screening method, Plaque formation, Complementation of mutation/nutrition <u>Indirect methods</u> - Colony hybridization, Immunochemical detection. Use of selectable and scorable genes: Selectable genes: Plants-npt; Animals-TK. Scorable genes: Plants-Gus; Animals- GFP/RFP.	
MODULE 4: rDNA TECHNIQUES and Applications	15Hrs
Techniques: Gel Electrophoresis, Hybridization – Southern, Northern, Western, Sanger's di-deoxy DNA Sequencing, PCR and its types (Real Time PCR and Multiplex PCR), Basics of New Generation Sequencing. Applications: Production of Insulin, Recombinant Vaccines, hGH, Transgenic animals: Mouse (Knock-out; Methodology, applications); A brief account of Transgenic Sheep, Poultry, Fish, Cow, with value added attributes. Transgenic Plants: Resistance to diseases, Pathogens and insects (Bt gene transfer); Nif gene and its role.	

TEXTBOOKS/REFERENCES

1. Principles of Gene Manipulation - S. B. Primrose, R. M. Twyman and R.W.Old. 6th Edition, S.B.University Press, 2001.
2. Molecular Cloning: A Laboratory Manual - J. Sambrook and D.W. Russel, Vols 1-3, CSHL, 2001.
3. Genomes - Brown TA, 3rd ed. Garland Science, 2006
4. Molecular Biotechnology - Glick and Pasternak, 2nd Ed, ASM press, Washington DC, 1998
5. Elements of Biotechnology - Gupta PK, 2nd Ed, Rastogi publication, Merrut, 2003.
6. Principles of Gene Manipulation - Primrose, Twyman and Old, 6th Ed, Blackwell Science Ltd, 2002.
7. Gene Cloning and DNA analysis - Brown TA. 6th edition, Wiley-Blackwell Publication, 2013.
8. Molecular Biology and Genetic Engg - Singh BD, Kalyani Publishers, 2005.
9. Satyanarayana U, Biotechnology, Books and Allied Ltd, 2008
10. Recombinant DNA: Genes and Genomes - Watson, Caudy, Myers Wilkowsky. 3rd Ed, WH Freeman, 2007.

GENETIC ENGINEERING - PRACTICALS

1.	PCR amplification and analysis by agarose gel electrophoresis.
2.	Preparation of plasmid DNA from <i>E. coli</i> .
3.	Restriction digestion and Ligation
4.	Preparation of competent cells and transformation.
5.	Restriction mapping problems.

REFERENCES:

1. Principles of Gene Manipulation - S. B. Primrose, R. M. Twyman and R.W.Old. 6thEdition, S.B.University Press, 2001.
2. Molecular Cloning: A Laboratory Manual - J. Sambrook and D.W. Russel, Vols 1-3,CSHL, 2001.
3. Genomes - Brown TA, 3rd ed. Garland Science, 2006.

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22BY4702					
TITLE OF THE COURSE	SIGNAL TRANSDUCTION					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	V	22BY3501	Human Physiology

COURSE OBJECTIVES:	
•	To understand the concepts of endocrinology, mode of action, function and disorders related to hormones.
•	To acquire knowledge of ligand receptor interaction and molecular mechanisms behind the transduction of outside signal to inside of the cell.
•	To learn about cell cycle and programmed cell death and apply the knowledge to their future research.

COURSE OUTCOME:		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will learn how hormones control the physiology of an organism.	L2
CO2	They will have a greater understanding of signalling mechanisms and associated disorders which can be applied in disease diagnosis and problem solving.	L3

COURSE CONTENT:	
MODULE 1: Receptors and their Ligands	15 h
Introduction –Hormones, autocrine, paracrine and endocrine signalling, receptor specificity and activation, G-protein coupled receptors, (G-protein, effectors- adenylate cyclase and PLC, cAMP - synthesis and degradation, cGMP, inositol triphosphate, DAG and calcium release) Receptor tyrosine kinases (Insulin, MAP kinase and PI3K pathways), phosphatases, Ion channel receptors. Nuclear signalling: Steroid, thyroid, Vitamin-D and retinoic acid receptors (RAR receptors). .	
MODULE 2: Cell Cycle and Apoptosis	15h
Cell cycle: Cyclins and cyclin-dependent kinases, entry of cell from G2 to M – phase, cell cycle arrest at G1, role of Rb proteins in cell cycle, Growth factors, cytokines and cell cycle check points.	

Apoptosis: Caspases, structure, function and activation. Intrinsic and Extrinsic apoptosis pathways. Anti-apoptotic proteins, Tumor suppressors and Inhibition of cancer.

MODULE 3: Plant Signaling

15h

Introduction, Plant hormones and their functions, Auxin signaling, Cytokinin signaling, Ethylene signaling, Gibberellin signaling, Absciscic acid signaling, Light signaling by phytochromes and cryptochromes. Serine/Threonine Kinase receptors in plants. Calcium as secondary messengers, Role of MAP's (mitogen activated proteins, transcription factors and phytohormones in plant immunity. Symbiotic Interactions of plants and bacteria (nitrogen fixation).

MODULE 4: Microbial signaling

15h

Introduction, Types of bacterial signaling (One-component, two-component and alternative sigma factors). One component system signalling- pH sensor CadC, Two component system – Regulation of K⁺ ion concentration. Alternative sigma factors- General features of σ^{70} family and its subfamilies. Extracytoplasmic sigma factors – mode of action and functions. Bacterial chemotaxis by chemoreceptors and phototaxis by photoreceptors. Quorum sensing (Bioluminescence and Biofilm formation).

REFERENCES

1. Biochemistry - Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. 2010.
2. Lehninger- Principles of Biochemistry - D. L. Nelson and M.M. Cox, 6th Edn. Macmillan Publications, 2012.
3. Text Book of Biochemistry with Clinical correlations; Thomas M. Devlin. 6th Edn., Wiley-Liss, 2012.
4. Cell and Molecular Biology Concepts and experiment - Gerald Karp 6th Edn., Wiley publications.
5. The cell - A molecular approach - Geoffrey M Cooper, 8th Edn, 2018.
6. Molecular Biology of the Cell - Alberts B, Johnson A, Lewis J, et al. 4th edition, New York: Garland Science, 2002.
7. Cell signalling - Hancock, John T. Oxford University Press, 2017.
8. Auxin signalling - Kou *et al.*, Appl. Sci. 12(3),1360; 2022
<https://doi.org/10.3390/app12031360>.
9. Microbial signalling and communication - England, R. Vol. 57. Cambridge University Press 1999.
10. Fundamentals of Biochemistry IV - Special topics. Henry Jakubowski and Patricia F LibreTexts, e Open Education Resource (OER) LibreTexts Project (<https://LibreTexts.org>)
11. Winans, Steve C. "Cell-cell signalling in microbial communities: Microbial signalling a communication, edited by R. England et al." Trends in Microbiology 7.12 (1999): 506.
12. Staron, A.; Sofia, H.J.; Dietrich, S.; Ulrich, L.E.; Liesegang, H.; Mascher, T. The third pillar bacterial signal transduction: Classification of the extracytoplasmic function (ECF) sigma factor protein family. *Mol. Microbiol.* 2009, 74, 557-5
<https://doi.org/10.3390/microorganisms11041012>.
13. Biochemistry -David Rawn. Panima Publishers, 1989.
14. Biochemistry - Geoffrey Zubey. WCB Publishers, 1998.
15. Biochemistry- R. Garret, Charles M Grisham, Belmont. 2013

SIGNAL TRANSDUCTION - PRACTICALS

1.	Identification of pathways based on activated proteins.
2.	Permanent slides for demonstration of fluorescent staining of receptors.
3.	Slide preparation of tissues by H&E and DAPI staining.
4.	Study of different stains used in identification of cellular components and receptors.
5.	Videos on pathways/disorders/techniques with reflection notes.

TEXTBOOKS/REFERENCES:

1. Biochemistry - Donald Voet & Judith G. Voet. John Wiley & Sons, Inc, 2010.
2. Lehninger- Principles of Biochemistry - D. L. Nelson and M.M. Cox 6th Edn. Macmillan Publications, 2012.
3. Routine Cytological Staining Technique - Mathilde E. Boon & Johanna S. Drijver. Macmillan Publishers Limited, 1986. DOI: <https://doi.org/10.1007/978-1-349-18250-3>.
4. Manual of Histological Techniques - Santosh Kumar Mondal , 2ndEdn., Jaypee Brothers Medical Publishers (P) Ltd.
5. Fundamental Techniques in Cell Culture Laboratory Handbook. 4thEdn. The European Collection of Authenticated Cell Cultures (ECACC).

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22BY4703					
TITLE OF THE COURSE	PLANT PHYSIOLOGY AND BIOCHEMISTRY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6
Pre-requisite Courses (if any)						
#	Sem/Year	Course Code	Title of the Course			
-	I	22BS1101	Essentials of Biochemistry			

COURSE OBJECTIVES:

To understand various levels of organization in a plant body with an outlook in the relationship between the structure and function
To understand the Phytoconstituents and processes in plants

COURSE OUTCOME:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students should be able to differentiate various tissue systems of the plants	L1
CO2	Should be able to understand and extract various constituents present in the plant body	L2

COURSE CONTENT:

MODULE 1:	15 h
Plant cell structure - nature of plant cell wall. Tissue and tissue systems - meristematic tissue, permanent tissue and secretory cells. Classification of meristem: (apical, intercalary and lateral), primary and secondary meristem.	
Plant and water relation: Colligative properties of water, free energy concept. Water uptake, conduction, transpiration, mechanism and its regulation by environmental variables.	
Mineral nutrition: Macro, and micronutrients, their role, deficiency and toxicity symptoms, mechanism of ion uptake and translocation.	
MODULE 2:	15h
Photosynthesis: Significance, historical aspects, photosynthetic pigments, Concept of two photosystems, Photophosphorylation, Calvin cycle, C4 pathway, CAM plants photorespiration	
MODULE 3:	15h

Respiration: aerobic and anaerobic respiration, respiratory pathways glycolysis, krebs 'cycle, electron transport, oxidative phosphorylation, pentose phosphate pathway, photorespiration, cyanide resistant respiration. Lipid biosynthesis and its oxidation.

MODULE 4:

15h

Atmospheric nitrogen fixation, nitrogen cycle, nitrogen assimilation, Growth: general aspects of phytohormones, inhibitors-auxins. kinetin, gibberellins, and ethylene: action and their application; photoperiodism and vernalization. Germination, growth movements, parthenocarpy, abscission and senescence.

TEXTBOOKS/REFERENCES:

1. Esau's Plant Anatomy: Meristem, Cells, and Tissues of the Plant Body: Their Structure, Function and Development - Evert, R.F. John Wiley and Sons, Inc, 2006.
2. Plant Anatomy - Vashishta . P.C. Pradeep Publications - Jalandhar, 1984.
3. Plant Anatomy - Vashishta, P.C, Pradeep Publications, 1997
4. Plant Physiology - Taiz, L. and Zeiger, E. 5th edition. Sinauer Associates Inc., U.S.A. 2010
5. Introduction to Plant Physiology - Hopkins, W.G. and Huner, N.P. 4th edition. John Wiley & Sons, U.S.A., 2009.
6. Experiments in Plant Physiology - A Laboratory Manual. Bajracharya, D. Narosa Publishing House, New Delhi, 1999.
7. A text book of plant physiology -V. Verma and Verma. S Chand Publishers, 1995.
8. Fundamental of Plant physiology - V. K. Jain. S Chand Publishers, 2017.
9. Plant physiology. Text book of biochemistry - Ross and Salisbury, Thomson Press (India) Ltd.

PLANT PHYSIOLOGY AND BIOCHEMISTRY-PRACTICALS

- Study of meristem and simple tissues (Permanent slides/ Photographs).
- Extraction of phytochemicals using soxhlet extractor using polar and nonpolar solvents.
- Qualitative analysis of phytochemicals- alkaloids, flavonoids, terpenoids.
- Estimation of total flavonoid content.
- Estimation of methionine/tryptophan/lysine from cereal grains.
- Estimation of β - carotene.
- Determination of starch in plant tissues.

REFERENCES:

1. Experiments in Plant Physiology – A Laboratory Manual - Bajracharya, D. . . New Delhi: Narosa Publishing House,1999.
2. Biochemistry and Molecular Biology of Plants - Buchanan, B., Gruissem, W, and Jones, R. 12th ed. John Wiley & Sons. Ltd, 2015

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22BS4701					
TITLE OF THE COURSE	RESEARCH METHODOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
•	To provide an overview of essential research steps to be followed when conducting research / project work.
•	To understand chief ingredients to be incorporated in conduct as well as writing of scientific reports/dissertation/thesis
•	To know the implication professional research ethics and common misconduct details of researcher and research work

COURSE OUTCOME		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Show and explain the concepts of meaning of research, scope of research including different types of research, scientific research process and research methodology steps	L1
CO2	Perform review of literature using electronic media, selecting research problem formulate research problem statement, writing hypothesis, explain criteria of forming objectives, materials and methods, results and discussion	L2
CO3	Identify and explain experimental research designs for both qualitative and quantitative research	L2
CO4	Explain different sampling methods and sampling design, basic statistical methods for treatment of data and observations	L2

CO5	Demonstrate ingredients and components of a research report, dissertation and thesis and explain integral components of research article and research proposal	L2
CO6	Explain professional research ethics and elaborate on misconduct in research	L2

COURSE CONTENT:	
MODULE 1:	12hrs
INTRODUCTION TO RESEARCH: Meaning, Objectives and Characteristics of research – Scientific Method Types of research - Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical - Research process - Criteria of good research PROBLEM STATEMENT: Defining the research problem - Selecting the problem - Necessity of defining the problem - Techniques involved in defining the problem; LITERATURE SURVEY: Importance of literature review in defining a problem - Survey of literature - Primary and secondary sources - web as a source - searching the web - Identifying gap areas from literature review HYPOTHESIS: Definition of hypothesis, Basic concepts , variables-Dependent and independent variables, Development of working hypothesis; Ingredients of Research Objectives, deriving objectives of research	
MODULE 2:	12hrs
Sampling, Material and Methods: Sample- Sampling - Types of sampling; Material - Experiments, Data – Basics of Analysis; Writing materials and method chapter of a research report Results and Discussion: Representation of results; Tables, graphs; Discussion, Purpose and Function of Discussion Research Designs: Research design; Need of research design - Basic Principles; Features of good design – Important concepts relating to research design; Max-min-con principle, Common Research Designs: Cross-sectional, Case-control, Longitudinal and Cohort research designs, advantages and disadvantages of each of research designs Summary and Conclusion: Writing of Summary, conclusions of research findings, Acknowledgement section of a research report and an article.	
MODULE 3:	10Hrs
Research Ethics: Values, Ethics and Morals, Research Professionalism, Tenets of Ethics; Conducting and reporting of science/engineering; Relationship in research groups; Hazards to good scientific practice; Scientific misconduct: Fabrication, Falsification and Plagiarism. Report and Article Writing: Structure and components of scientific reports; Abstract-Key words; Types of reports; Significance of reporting; Different steps in the preparation of reports; Layout, structure and Language of typical reports; References; Citation styles- APA and MLA styles of citation, intext and end text citations	

Oral Presentation: Importance of effective communication.Planning; Preparation; Practice; Making presentation; Use of visual aids.	
MODULE 4:	11Hrs
Scientific Article Writing:Title preparation – Importance of title; need for specific titles; List of authors and addresses – order of names; defining the order with example; types of abstracts; economy of words; How to write introduction- Rules; exceptions; citations and abbreviations Materials and methods: Purpose; materials; methods; tables and figures; form and grammar; Result and Discussion writing: content of results; handling numbers; clarity; avoiding redundancy; Discussion writing: Components of discussion; factual relationships; strengths and limitations; significance of paper; Stating Acknowledgements: Ingredients of the acknowledgements; courtesy; Citation of theReferences: Rules; electronics aid; in-text citation; styles of referencing Research Proposal Fundamentals:What is a grant proposal? Why proposals fail?; Developing and writing of grant proposals; overview of steps to develop grant proposals; Proposal Development Process: Standard Proposal Parts; writing Budget section. Intellectual Property Rights: IPRs- Invention and Creativity- Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs); A brief summary of: Patents, Copyrights, Trademarks	

REFERENCES:

1. Bruce Tuckman, Brian E Harper, Conducting Educational Research, 6th Edition, 2012 by Rowman & Littlefield Publishers, Inc. ISBN 978-1-4422-0965-7 (electronic)
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
4. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
5. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
6. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
7. Day, R.A., 1992. How to Write and Publish a Scientific Paper, Cambridge University Press.
8. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
9. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.

MINOR PAPERS OFFERED

SEMESTER	IV					
YEAR	II					
COURSECODE	22BY2404					
TITLEOFTHECOURSE	ANATOMY AND PHYSIOLOGY					
SCHEME OFINSTRUCTI ON	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	4

Pre-requisiteCourses(if any)			
#	Sem/Year	CourseCode	Titleofthe Course
-	IV/ II	22BY2401	HUMAN ANATOMY & PATHOLOGY

COURSEOBJECTIVES:

Students will be able to understand different types of cells and tissues of organs in human system
To demonstrate an understanding of the physiology and basic regulatory concepts related to the functioning of life processes.

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Will be able to demonstrate an understanding of the physiology and basic regulatory concepts of the organ systems associated with this course and the mechanisms that allow the body to carry out those functions, and predict how a perturbation (e.g., disease, experimental manipulation) will alter function.	L2
CO2	The student will be able to explain homeostasis and explain how homeostatic mechanisms normally maintain a constant interior milieu inside human body	L3
CO3	Students will be able to demonstrate the different cellular and tissue organization of different organ system	L3
CO4	Will be able to explain the functions of different cell types their abnormalities in different organ systems	L3

COURSECONTENT:

MODULE1	12 Hrs
Scope of anatomy and physiology; levels of structural organization and body systems; Classification and Types of tissues: Structure, location and functions of epithelial, muscular, nervous and connective tissues; General principles of cell communication; Integumentary system : Structure and functions of skin. Cartilage – Definition, types, structure, distribution, nutrition.	

MODULE2	Hrs
Bones: Definition, Classification and functions of bone; Parts, types of epiphyses, Ossification, Blood supply of long bone; Joints: Classification, synovial joints, Blood supply & nerve supply. Blood vessels and Lymph nodes: Classification and structure of blood vessels; structure and functions of lymph vessels, lymphoid tissue	
MODULE3	12 Hrs
Hematology: Blood components and their functions, Blood groups: the ABO system. role of hemoglobin in oxygen transport. Various buffer systems of the blood, acid base balance, factors affecting acid-base balance. Blood Disorders Cardiovascular System: Systemic and pulmonary circulations, Basics of Cardiac cycle. ECG - its principle and significance. Blood pressure and its regulation. Brief outline of cardiovascular disorder (hypertension, arteriosclerosis, myocardial infarction, and congestive heart failure.	
MODULE4	12 Hrs
Muscular System: Overview of muscular tissue; types, functions & properties. Structure of actin and myosin. Mechanism of muscle contraction: Contraction, and relaxation of skeletal muscle fibers- sliding filament model; Neuromuscular junction; Digestive System: GIT and accessory organs, Composition, function, of saliva, gastric, pancreatic, intestinal and bile secretions, Mechanism of breakdown and absorption of carbohydrates, lipids, and proteins. Endocrine System: Basic structure and functions of Glands - Pituitary, Adrenal, Pancreas & Thyroid; hormones -	
MODULE5	12 Hrs
Respiratory System: Components of respiratory system and their functions. Pulmonary ventilation, Lung volumes and capacities, Bohr and Haldane effect, chloride shift; effect of 2, 3- BPG on the affinity of Hb; Artificial respiratory methods. Renal Physiology: Structure of nephron, mechanism of urine formation: Glomerular filtration, Tubular re-absorption & Active secretion, Kidney hormones. Nervous System: Basic organization of nervous system - CNS, PNS. ANS, generation of action potential, neurotransmitters.	

TEXTBOOKS/ REFERENCES:

1. Gray's Basic Anatomy, by Richard Drake FAAA (Author), A. Wayne Vogl FAAA (Author),
2. Guyton and Hall Textbook of Medical Physiology; 12th Ed., J.E.Hall , 5aunders Elsevier , 2010.
3. Anatomy & Physiology For Dummies, Erin Ody, 2002.
4. Molecular Cell Biology - Harvey Lodish , David Baltimore and Arnold Berk, Scientific American Publication 1995.
5. Molecular Biology of Cell - Alberts et. al., Garland Science, 2002.
6. Cellular Physiology of Nerve and Muscle - Gary G Mathew. 4th Edition. Wiley-Blackwell 2002. Human Biochemistry - James M. Orten, Otto Wilhelm Neuhaus. 9th edition, C. V. Mosby, 1995.
7. Principles of Biochemistry: Mammalian Biochemistry - Emil S. Smith, McGraw-Hill; Subsequent edition, 1982.
8. Principles of Human Physiology - Cindy L. 4th Ed. Stanfield Pearson, 2010.

ANATOMY and PHYSIOLOGY - PRACTICALS
1. Histology of Tongue and Liver using permanent slides
2. Histology of Kidney and Stomach- using permanent slides
3. Blood film preparation and Leishman's staining and identification of the blood corpuscles.
4. Differential count of W.B.C.
5. Separation of serum and plasma from blood.
6. Qualitative analysis of Urine components.
7. Identification of abnormal constituents of Urine: albumin, ketone, sugar (glucose), bile salt and blood.
8. Titratable acidity of urine

TEXT BOOKS/ REFERENCES:

1. Practical Clinical Biochemistry - Harold Varley, 4th edn. CBS Publishers, 2018.
2. Practical Clinical Biochemistry: Methods and Interpretation - Ranjna Chawla, Jaypee Brothers Medical Publishers, 2006.
3. Practical and Clinical Biochemistry for Medical Students - T.N. Pattabhiraman, Gajanna Publishers, 2004.
4. Hawk's Physiological Chemistry - Oser, 14th Edn., Tata-McGraw Hill, 2016.
5. Biochemistry - Plummer Tata-McGraw Hill, 2007.
6. Textbook Of Practical Physiology - Balakrishna Shetty, H Sweekritha Poonja,(5Th Edn), 2018.

EMESTER	V					
YEAR	III					
COURSE CODE	22BY3503					
TITLE OF THE COURSE	METABOLISM					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	60	6

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	I	22BS1101	Essentials of Biochemistry

COURSE OBJECTIVES:

- To understand the metabolic pathways of bio-molecules within the system
- To create an understanding of structural and functional defects associated with metabolic pathways

COURSE OUTCOMES

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students should identify the various rate determining steps in metabolism.	L1
CO2	Students should be able to interconnect and compare the carbohydrate and lipid metabolic pathway	L2
CO3	Students should be able to understand various diseases associated with metabolic pathways	L3

COURSE CONTENT:

MODULE I: Carbohydrate metabolism	15Hrs
Introduction to metabolism (anabolic, catabolic, amphibolic, and intermediary metabolism). Glycolytic pathway; energetics and regulation, aerobic and anaerobic fates of pyruvate, Pyruvate dehydrogenase complex, TCA cycle. Regulation of blood glucose level by organs and hormones. Diabetes mellitus- classification, biochemical and clinical changes associated with DM. Diagnosis by glycated hemoglobin test (A1-C test).	

MODULE 2: Lipid metabolism	15Hrs
Basic scheme of fat absorption, mobility, degradation and synthesis; Degradation of triacylglycerol and phospholipids- lipases and phospholipases. Fatty acid oxidation- even, odd and unsaturated fatty acids by β -oxidation, scheme and energetics of β -oxidation .Fatty acid biosynthesis - FAS- multi functional enzyme, chain elongation and desaturation. Cholesterol structure, brief idea of synthesis from acetyl CoA, regulation through HMG CoA reductase and utilization as hormones and bile salts, normal and abnormal levels in the body;	
MODULE 3: Amino acid metabolism	15Hrs
General metabolic reaction of amino acids– transamination, deamination, oxidative and nonoxidative deamination, glucose – alanine cycle. Urea cycle– regulation and metabolic disorders. Biosynthesis and degradation of amino acids.	
MODULE 4: Nucleotide Metabolism	15Hrs
Structure of nucleoside and nucleotide; Synthesis of purine and pyrimidine nucleotides – the de novo and the salvage pathway and their regulation. Degradation of purine and pyrimidines, DNA and RNA degradation. Heme metabolism.	

TEXTBOOK/REFERENCES

1. Biochemistry- Voet, Donald, Voet, Judith G. 3rd Edn, John Wiley and Sons; New York, 2004.
2. Lehninger- Principles of Biochemistry; D L Nelson and M M Cox (Eds), 6th Edn, Macmillan Publications, 2012.
3. Biochemistry- Jeremy M. Berg, John L. Tymoczko, Lubert Stryer. 6th edition, W.H. Freeman, New York, 2007.
4. Textbook of Biochemistry with Clinical Correlations - Thomas M. Devlin. 7th edition, John Wiley & Sons, 2010.
5. Biochemistry of Foods - N A Michael Eskin, Fereidoon Shahidi. 3rd edition, Elsevier, 2012.
6. Biochemistry and Molecular Biology -D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott. 5th edition, Oxford University Press, 2014.
7. Harpers Illustrated Biochemistry - V.W. Rodwell , D. Bender , K.M. Botham , P. J. Kennelly, P. A. Weil. 30th edition, McGraw-Hill Education, New York, 2015.

METABOLISM - PRACTICALS
1.Estimation of reducing sugar by DNS method / Miller's method.
2.Estimation of serum cholesterol by Zak's method.
3.Determination of ratio of albumin and globulin in serum.
4.Estimation of uric acid/urea in serum.
5. Identification of lipids by Thin layer chromatography

REFERENCES:

1. Essentials of Practical Biochemistry, Prem Prakash Gupta, Neelu Gupta, 10.5005/jp/books/12972, 2017.
2. A textbook of practical Biochemistry, Joshi and Saraswat, Jain Publishers, New Delhi 2002

SEMESTER	VI					
YEAR	III					
COURSE CODE	22BY3603					
TITLE OF THE COURSE	ENZYME AND PROTEIN CHEMISTRY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	22BS1101	Essentials of biochemistry

COURSE OBJECTIVES:

- To learn about enzyme properties along with enzyme and inhibition kinetics.
- To understand the protein structure along with analytical techniques to characterize them.

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students would describe the classification and function of various Proteins along with their structural hierarchy.	L1and L2
CO2	Students would understand about regulation of enzyme activity along with enzyme inhibition.	L3
CO3	Students should analyze results obtained after protein characterization	L4

COURSE CONTENT:	
MODULE 1:	15 Hrs
Classification & nomenclature of enzymes, Active site: definition and theories including Lock & key, induced fit model and strain theory- with lysozyme as example; Enzyme specificity: bond, group, absolute and stereo-chemical specificity. Enzyme catalysis: Proximity & Orientation effect, Enzyme activity regulation through allosteric and covalent modification; Units - Katal& IU; Effect of pH, temperature, substrate concentration, enzyme dilution, activators and inhibitors on enzyme activity; Isoenzymes – definition and significance with LDH as example; Clinical and Biotechnological applications of enzyme.	
MODULE 2:	15 Hrs
Derivation of Michaelis-Menten equation with Briggs Haldane modification, Catalytic constants – Km, Vmax, turnover number and catalytic efficiency; Single & double reciprocal plots, Reversible and Irreversible inhibitors, Inhibition kinetics of Competitive, Noncompetitive& Uncompetitive inhibitors with examples; Feedback inhibition with examples; Enzyme assay – continuous/	

discontinuous methods, coupled enzyme assays; Specific activity, enzyme purification – cytosolic, extracellular and membrane bound, criteria for enzyme purity. Coenzyme, cosubstrate and prosthetic groups; Structure and biological significance of selective Coenzymes: Nicotinamide derivatives (NADH, NADPH), riboflavin derivatives (FADH ₂ , FMNH ₂), folic acid and ascorbic acid.	
MODULE 3:	15 Hrs
Classification based on composition, shape and function, Peptide bond - properties, Structural organization of proteins: primary structure – N and C-terminals, secondary structures -alpha, pi and polyproline helices, β sheet, turns and bends with forces stabilizing secondary structures; Ramachandran plot and determination of secondary structures; Tertiary and quaternary structures explained with respect to Hemoglobin, Collagen and Keratin; Forces stabilizing Tertiary and quaternary structures, Denaturation of proteins – salting out; Hofmeister series.	
MODULE 4:	15 Hrs
Protein assay – UV absorbance by peptide bond and aromatic residues, FolinCiocalteu, Biuret and Bradford method; Isolation and purification of proteins (non enzymatic) through gel permeation, ion exchange and affinity chromatography; Sequence determination by Sanger and Edman methods; Hydropathy plot to determine transmembrane regions, Mass spectroscopy of proteins: introduction to MALDI-TOF, ESI-MS and MS/MS techniques.	

TEXTBOOKS/ REFERENCES:

1. Enzymes - Biochemistry, Biotechnology, Clinical Chemistry, Palmer and Bonner, Elsevier Press, 2007.
2. Biochemistry - Voet and Voet, 4th Ed, Wiley, 2010.
3. Fundamentals of Enzymology - Price and Stevens, 3rd Edn., Oxford University Press, 2000.
4. Fundamentals of Enzyme Kinetics - Bowden, 3rd Edn., Portland Press, 2004.
5. Biophysical Chemistry Part II, Charles R. Cantor - Paul R. Schimmel, W.H. Freeman & Company, 2008.
6. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis - Robert A. Copeland, Wiley-VCH Publishers, 2000.
7. Biochemical Calculations - Irwin H. Segel, 2nd Ed. John Wiley and Sons, 2010.

Enzymology- Practicals
1. Introduction to enzymology Lab and product curve determination.
2. Isolation of enzymes (amylase/ phosphatase) from biological source and activity determination through time curve.
3. Determination of kinetic constants through LB plot.
4. Effect of pH on enzyme activity.
5. Effect of temperature on enzyme activity.
6. Determination of Arrhenius constant.
7. Effect of activators and inhibitors on enzyme activity.

TEXTBOOKS/ REFERENCES:

1. Practical Enzymology - Hans Bisswanger, 3 rd Edn., Wiley-VCH, 2019.
2. Introductory Practical Biochemistry - Sawhney and Singh. 1st Edn., Narosa Publishing house,2001.
3. Principles and Techniques of Practical Biochemistry - Wilson, Wilson and Walker,Cambridge University Press, 2000.
4. Introduction to practical Biochemistry - Plummer, 2nd Ed, Tata McGraw-Hill Education,2001.
5. Basics of Enzyme Immobilization - Alka Dwevedi, 1st Edn., Springer InternationalPublishing, 2016.

SEMESTER	IV					
YEAR	II					
COURSE CODE	22BT2401					
TITLE OF THE COURSE	PLANT BIOTECHNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To equip the students with fundamentals of culturing plant cells/tissues, culture environment, cell proliferation, differentiation and media formulation. - To familiarize the student with various important applications of plant tissue culture. - To equip the students with knowledge on various recombinant DNA techniques and genetically modified organisms with the novel traits.	

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will be able to explain the basic requirements of plant tissue culture.	L1
CO2	Students will be able to describe the various applications of plant biotechnology for crop improvement.	L2
CO3	Students will be able to describe various tissue culture methods and their applications.	L2
CO4	Students will be able to apply the technical skills – media preparation, sterilization and inoculation of plant material for callus induction to establish nurseries for horticultural and agricultural crops	L3

COURSE CONTENT:	
MODULE 1	15Hrs
INTRODUCTION: Importance, history and developments of plant tissue culture. Concept of cellular totipotency. <i>In-vitro</i> methods in plant tissue culture, design of plant tissue culture Lab. Aseptic Techniques, Nutrient media: General composition and types of media (MS, Gamborg & Nitsch). Sterilization and pre-treatment to explants, use of growth regulators (auxins, cytokines and gibberellins). Adjuvants in plant culture media.	
MODULE 2	15Hrs
PRINCIPLES OF TISSUE CULTURE: Callus Culture-Definition of callus, types of callus. Initiation, maintenance sub culture and organogenesis. Micropropagation in plants: Advantages, methods, stages of micropropagation, applications. Soma clonal variation for disease resistance and desired agronomic traits.	

Somatic embryogenesis: Embryoid and embryogenesis. Protocol and importance of somatic embryogenesis. Synthetic Seeds and its applications.

MODULE 3

15Hrs

ORGAN CULTURE AND SOMATIC HYBRIDIZATION: Culture protocols and importance of root, meristem, ovary and ovule culture. Factors affecting organogenesis, **Cytodifferentiation, dedifferentiation** differentiation and factors affecting differentiation. Anther culture for double haploids: Applications in crop improvement.

Protoplast culture and fusion: Definition of protoplast, isolation principle, culture protocol, action of enzymes, regeneration of plants, protoplast fusion, somatic cell hybridization and its application. Cybrids and its applications.

Suspension culture: Batch and continuous cell suspension culture. Importance of suspension culture in production of secondary metabolites.

MODULE 4

15Hrs

PLANT TRANSGENICS: **Technique of transformation**-Agrobacterium mediated and physical methods (Micro projectile and electroporation). Plant viral vectors. **Gene edition techniques** - CRISPR and TALEN. Application of transgenic plants. Transgenic Plants: Resistance to diseases (Pathogen resistant-viral, fungal and bacterial); insects (Bt gene transfer); Fertilizer management- Nif gene transfer. Edible vaccines from Plants – Banana, Watermelon. Plant antibodies.

TEXT BOOKS/ REFERENCES:

1. Chawla HS. 2020. Introduction to Plant Biotechnology 3rd Edi. OXFORD & IBH PUBLISHING.
2. Purohit SD. 2012. Introduction to Plant Cell, Tissue and Organ Culture. Prentice Hall India Learning Pvt Ltd.
3. Satyanarayana U. 2020. Biotechnology, Books and Allied Ltd.
4. Slater A, Scott NW and Fowler MR. 2008. Plant Biotechnology – genetic manipulation of plants 2nd Ed. Oxford Publishing.
5. Singh BD. 2014. Biotechnology: Expanding horizons. Kalyani Publishers.
6. Halford NG. 2006. Plant biotechnology: current and future applications of genetically modified crops. John Wiley Publishers.

EXPERIMENTS

1. Preparation of plant culture media
2. Sterilization and inoculation of plant material for callus induction
3. **Plant protoplast isolation**
4. **Preparation of synthetic seeds**
5. **Isolation of DNA from plant source by CTAB method**
6. Anther and embryo culture
7. Demonstration of cell suspension culture.

REFERENCES:

1. Lindsey K. 2007. Plant Tissue Culture Manual. Springer.
2. Nagar S and Aadhi M. 2010. Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications.

SEMESTER	IV					
YEAR	II					
COURSE CODE	22BT2402					
TITLE OF THE COURSE	GENETIC ENGINEERING					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To provide basic understanding and knowledge on the various tools and techniques used for recombinant DNA technology.
- To equip the students with knowledge on enzymes, vectors used in different steps of gene cloning besides detection and characterization methods.
- To familiarize students with various applications of recombinant DNA technology in research and development.

COURSE OUTCOMES:

CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will display clear understanding on the use of different enzymes and vector for genetic manipulation.	L1
CO2	Students will be able to explain the steps involved in cloning.	L2
CO3	Students will be able to explain various techniques used in recombinant DNA technology.	L3
CO4	Students will display comprehensive knowledge on various application and evolving scope of this technology.	L2

COURSE CONTENT:

MODULE 1	15Hrs

INTRODUCTION TO GENETIC ENGINEERING

History and fundamentals of r-DNA technology. Molecular tools for gene cloning: Nucleases -Endo and Exonucleases – Nomenclature, Types and characteristic features. Modification of cut ends. DNA ligases and DNA Recombinases. DNA Modifying Enzymes - Alkaline phosphatase, Polynucleotide kinase, DNase, RNase, DNA polymerase and Klenow fragment, terminal nucleotidyl transferase, RNA dependent DNA Polymerase.

MODULE 2	15Hrs

VEHICLES FOR CLONING

Properties of an ideal vector. Types: Cloning and expression vectors. Cloning vectors: Prokaryotic vectors: Plasmids- pBR 322; pUC 18; Bacteriophages - Lambda phage, Cosmids. Eukaryotic vectors: YAC vectors; Shuttle vectors- Yeast and *E. coli*. For higher plants: Integrative DNA transfer-

Agrobacterium vectors-Ti Plasmid-Binary and Co-integrated vectors; Non integrative DNA transfer-Plant viral vectors (CaMV). For animals: Animal viral vectors- SV 40 (3 types); Expression vectors in Prokaryotes and Eukaryotes.

MODULE 3

15Hrs

GENE ISOLATION AND TRANSFER

Isolation of passenger DNA. Cutting of DNA molecules - Physical methods, chemical and enzymatic methods. Joining of DNA molecules-Homopolymer tails, Linkers, Adapters. Transformation. Indirect methods - Colony hybridization,

Immunochemical detection. Use of selectable and scorable genes: Selectable genes: Plants-npt; Animals-TK. Scorable genes: Plants-Gus; Animals-lux.

MODULE 4

15Hrs

CHARACTERIZATION OF CLONED DNA

Electrophoresis: Gel electrophoresis, Hybridization: Southern; Northern; Western; Dot blots, Autoradiography, **DNA sequencing: Sanger's Dideoxy method, Molecular probes.**

Applications of rDNA technology: Transgenic animals: Mouse (Knock-out; Methodology, applications); A brief account of Transgenic Sheep, Poultry, Fish, Cow, with value added attributes. Transgenic Plants: Resistance to diseases (Pathogen resistant-viral, fungal and bacterial); insects (Bt gene transfer); Fertilizer management- Nif gene transfer.

TEXT BOOKS/REFERANCES:

1. Gupta PK. 2003. Elements of Biotechnology, 2nd Ed. Rastogi publication, Merrut,
2. Singh BD. 2005. Molecular Biology and Genetic Engineering. Kalyani Publishers
3. Glick BR, Pasternak JJ and Patten CL. 2010. Molecular Biotechnology, 4th Ed. Wiley, Washington DC.
4. Howe C. 2007. Gene Cloning and Manipulation. Cambridge University Press.
5. Brown TA. 2013. Gene Cloning and DNA analysis, 6th Edi. Wiley-Blackwell Publications.
6. Primrose SB and Twyman RM. 2002. Principles of Gene Manipulation, 6th Ed. Blackwell Science Ltd.
7. Watson JD, Caudy AA, Myers RM and Wilkowsky JA. 2007. Recombinant DNA: Genes and Genomes, 3rd Ed. WH Free.

EXPERIMENTS

1. Extraction of DNA from plant/bacteria and animal sources
2. Quantification of DNA by spectrophotometry
3. Preparation of competent cells using CaCl_2
4. Bacterial transformation by chemical method
5. Isolation of plasmid from transformed bacterial cells
6. Linearization of plasmid DNA and its visualization by agarose gel electrophoresis
7. Demonstration of physical methods of transformation using virtual videos

TEXT BOOKS/ REFERENCES

1. Ayyagari NA. 2007. Lab Manual in Biochemistry Immunology and Biotechnology. New Delhi: Tata McGraw-Hill Pub.
2. Kumar A. 2011. Molecular Biology and Recombinant DNA Technology: A Practical Book. Narendra Publishing House.

SEMESTER	IV					
YEAR	II					
COURSE CODE	22BT2403					
TITLE OF THE COURSE	FUNDAMENTALS OF PLANT PHYSIOLOGY AND PATHOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To familiarize student about the mechanism and physiology life processes in plants.
- To study the economic and pathological importance of microorganisms

COURSE OUTCOMES:

CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will acquire knowledge on proper functioning of plant.	L1
CO2	Students can describe various topics of plant physiology like: plant-water relation, mineral nutrients essential for plant and their translocation etc.	L2
CO3	Students will be able to explain various plant pathogens and role of toxin and enzyme in plant disease	L2
CO4	Student will be able to describe some important plant disease, its etiology and control	L3

COURSE CONTENT:

MODULE 1	8 Hrs
Photosynthesis Light harvesting complexes, Mechanisms of electron transport, Photoprotective mechanisms, CO ₂ fixation, C ₃ pathway, C ₄ pathway, CAM pathway. Respiration and photorespiration: Citric acid cycle, Plant mitochondrial electron transport, ATP synthesis, Alternate oxidase, Photorespiratory pathway. Sensory photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes, phototropins. stomatal movement, photoperiodism, biological clocks.	
MODULE 2	8 Hrs
Solute transport and photoassimilate translocation Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem, Transpiration, Mechanisms of loading and unloading of photoassimilates.	

Stress physiology

Responses of plants to Biotic (pathogen and insects) stress, Abiotic (water, temperature and salt) stress, mechanisms of resistance to biotic stress and tolerance to abiotic stress. Nitrogen assimilation: Biological nitrogen fixation.

MODULE 3**8 Hrs****Introduction to plant pathology**

Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases. Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development.

Host parasite interaction, recognition concept and infection, symptomatology, disease development - role of enzymes, toxins, growth regulators; defence strategies- oxidative burst; phenolics, phytoalexins, PR proteins, elicitors.

MODULE 4**6 Hrs**

Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; Disease management strategies.

Study of diseases of crop plants

Potato Spindle Tuber Disease, Tobacco Mosaic Disease, Bacterial blight of Paddy, Citrus canker, Rust of coffee, Powdery mildew of cucurbits, Wilt of Tomato, Phloem Necrosis of Coffee.

TEXT BOOKS/REFERANCES:

1. Hopkins WG & Huner NPA. 2004. Introduction to plant physiology. John Wiley & Sons.
2. Mukherji S & Ghosh A K. 2005. Plant Physiology. New Central Book Agency, Kolkata.
3. Pathak VN. 1972. Essentials of Plant Pathology. Prakash Pub., Jaipur
4. Agrios GN. 2010. Plant Pathology. Acad. Press.
5. Singh RS. 2008. Plant Diseases, 8th Ed. Oxford & IBH. Pub. Co.
6. Mehrotra RS & Aggarwal A. 2007. Plant Pathology, 7th Ed. Tata McGraw Hill Publ. Co. Ltd.
7. Nene YL & Thapliyal PN. 1993. Fungicides in Plant Disease Control, 3rd Ed. Oxford & IBH, New Delhi.

SEMESTER	IV					
YEAR	II					
COURSE CODE	22BS2401					
TITLE OF THE COURSE	BIOSAFETY AND GOOD LABORATORY PRACTICE					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To introduce the students to the concepts of biosafety regulatory frameworks concerning genetically modified organisms at national and international levels.
- To impart knowledge of the principles of GLP and their practical applications.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Gain knowledge of the various safety procedures to be followed in laboratory.	L2
CO2	Gain the skills and knowledge necessary to understand and work in GLP compliant environment.	L2
CO3	This course should generate interest for avenues for pursuing higher studies and careers in these areas	L2

COURSE CONTENT:	
MODULE I – BIOSAFETY	18 Hrs
Introduction, Historical Background; risk assessment and lab acquired infections, Introduction to Biological Safety Cabinets& their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms. Recommended Biosafety Levels for Infectious Agents and Infected Animals. Biosafety Guidelines: Biosafety guidelines and regulations (National and International); Definition of GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Recombinant DNA Guidelines (1990); Rules for the manufacture, use/import/export and storage of hazardous microorganisms/ genetically engineered organisms or cells (Ministry of Environment and Forests Notification, 1989); Environmental release of GMOs; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.	

MODULE II – GOOD LABORATORY PRACTICE	12 Hrs
Introduction to GLP, WHO guidelines on GLP, History, Scope (Resources Characterization, Rules, Results, Quality assurance); Levels of Laboratories; General Rules/Protocols for Lab Safety measures; Precaution and Safety in handling of chemicals, Laboratory tools, glassware and instruments; Sample storage and disposal; Log Book maintenance, Basic SOPs for instrument handling and Maintenance. Keeping data records, its analysis by using statistical and mathematical tools. Result analysis and its interpretation. GLP as given by OECD, FDA etc (International perspective); Internal and External Audits.	

REFERENCES:

- Handbook: Good Laboratory Practices. 2001. World health organization (WHO).
- Life science protocol manual. 2018. DBT star college scheme.
- Guidelines for good laboratory practices. 2008. Indian council of medical research, New Delhi.
- Handbook: Good Laboratory Practices (GLP): quality practices for regulated non-clinical research and development, 2nd ed. 2008. World health organization (WHO).

SEMESTER	V					
YEAR	III					
COURSE CODE	22BT3501					
TITLE OF THE COURSE	IMMUNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To provide basic understanding on Immune system: Cells and organs of the immune system - To give basic framework and knowledge on structure and functions of antibodies, antigens and antigen specificity of antibodies. antigen -antibody interactions, generation of immune response - To equip the students with knowledge on immunological techniques and vaccines

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will be able to identify different immune cells, lymphoid organs and explain their functions	L1
CO2	Students will be able to demonstrate/identify the working of innate vs adaptive immune system	L2
CO3	Students will be able to depict the basic structures of antibodies and the nature of their interaction with antigens. Should display basic functions of antibodies via their effector mechanisms, isotypes of antibodies.	L3
CO4	Students will be able to explain immunotechniques and vaccines	L2

COURSE CONTENT:	
MODULE 1	15Hrs
COMPONENTS, CELLS AND TISSUES OF THE IMMUNE SYSTEM	
Elements of Immune System: History and scope of Immunology, Innate, and Acquired immunity, Humoral and Cell mediated Immunity. Cells and organs of immune system and their functions – Primary and secondary lymphoid organs, T cells, B Cells, macrophage, NK cells Basic outline or scheme of clonal selection in the humoral (B cell) and cellular (T cell) branches of immunity. Immunological memory.	
MODULE 2	15Hrs
ANTIGENS AND ANTIBODIES	
Antigens and Antibodies: Antigens – types, epitopes, haptens, factors affecting immunogenicity, adjuvant concept; Antibodies – structure, isotypes, and functions of Immunoglobulins. Antibody production: Polyclonal and monoclonal. Complement system – components, functions, activation pathways (classical,	

alternative, lectin mediated).

MODULE 3

15Hrs

IMMUNE RESPONSES

Antigen presenting cells (APCs), target cell concept; Major Histocompatibility Complex (MHC) – MHC I and II. Antigen processing and presentation- endogenous and exogenous antigen processing. Interleukins and Interferons – brief introduction and their important functions. Products and factors produced by T-cell activation; dendritic cells; cytokines (interleukins and interferons) Primary and secondary Immune response.

MODULE 4

15Hrs

MODULE IV: IMMUNOLOGICAL TECHNIQUES AND VACCINES 12Hrs

Principles in brief of Antigen-Antibody reactions – Precipitation, Hemagglutination – Blood grouping, ELISA, Immunofluorescence.

Vaccines and Immunization: Passive and Active immunization, immunization schedules. Types of Vaccines – Inactivated, Attenuated, and Recombinant vaccines.

TEXT BOOKS/REFERANCES:

1. Kindt TJ, Osborne BA, Goldsby RA. 2006. Kuby Immunology, 6th Ed. New York: W. H. Freeman & Company.
2. Vaman Rao C. 2007. Immunology, 2nd Ed. Narosa Publishing.
3. Roitt IM. 2001. Essentials of Immunology, Blackwell Scientific Publishers, London.
4. Murphy K and Weaver C. 2016. Janeway's Immunobiology, 9th Ed. W.W. Norton & Company. <https://doi.org/10.1201/9781315533247>
5. Abbas AK, Lichtman AH, Pillai S. 2011. Cellular and Molecular Immunology. 7th Ed, Elsevier Health.

EXPERIMENTS

1. Agglutination Reactions: Blood group identification and Rh Typing
2. Precipitation Reactions Demonstration:
 - I. Radial Immuno Diffusion
 - II. Ouchterlony double diffusion
 - III. Rocket Immuno Electrophoresis
3. Serum separation and quantification of serum proteins
4. Enzyme linked Immunoassay: Qualitative Vs Quantitative
 - a. Concepts of specificity of antibodies with the enzyme-based calorimetry
 - b. Different types of ELISA: Direct (sandwich type) scheme; Indirect Antibody ELISA;
 - c. Demonstration of qualitative Dot ELISA
5. Determination of the concentration of viable cells in a suspension by Haemocytometer counting and determination of parentage viability (trypan blue).
6. Study of different cells in whole blood using Giemsa/Leishman stain.

TEXT BOOKS/ REFERENCES

1. Balakrishnan S, Karthik K, Duraisamy S. 2015. Practical Immunology- A Laboratory Manual. DOI:10.13140/RG.2.1.4075.4728.
2. Hay FC, Westwood OMR. 2002. Practical Immunology, 4th Ed. Wiley-Blackwell, Malden, MA.
3. Nigam A. 2008. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw-Hill Pub., (India).

SEMESTER	V					
YEAR	III					
COURSE CODE	22BT3502					
TITLE OF THE COURSE	ANIMAL BIOTECHNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	4	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To provide basic understanding on the set up/conditions and techniques necessary for animal cell culture. - To give knowledge on the basic components of tissue engineering and different methods to produce transgenic animals. - To aware the student with various important applications of animal biotechnology.	

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will be able to determine the basic requirements of animal cell culture.	L1
CO2	Students will be able to explain the pre requisites of tissue engineering and determine the ways to produce transgenic animals with modified genetic traits.	L2
CO3	Will be able to illustrate the various applications of animal biotechnology in various fields to improve the welfare of society.	L2
CO4	Students will be able to apply the technical skills – media preparation, primary culture of animal cells from tissue, and subculturing.	L3

COURSE CONTENT:	
MODULE 1	15Hrs
BASICS OF ANIMAL TISSUE CULTURE	
Introduction, cell culture laboratory-design and layout. Equipment and Instrumentation. Types of culture media (natural and chemically defined). Importance of serum in the media. Methods of sterilization, Detection of Mycoplasma contaminants. Primary Cell Culture: Isolation techniques (explant method, mechanical, enzymatic). Secondary Cell Culture: Transformed and continuous cell lines (Hela).	

MODULE 2	15Hrs
STEM CELLS AND TISSUE ENGINEERING Stem cells – Adult, Embryonic, Induced pluripotent stem cells. Isolation and characterization of adult stem cells. Three-dimensional tissue culture and Tissue engineering, Scaffolds requirement and Biomaterials (Natural and Synthetic) for tissue engineering, transplantation of engineered cells.	
MODULE 3	15Hrs
TRANSGENIC ANIMALS Principal methods for production of transgenic animals (DNA microinjection, embryonic stem cell-mediated gene transfer and retrovirus-mediated gene transfer), importance and applications of transgenic animals. Gene knock out and mice models for tackling human diseases. IVF technology.	
MODULE 4	15Hrs
APPLICATIONS OF ANIMAL BIOTECHNOLOGY Pharmaceutical products produced by mammalian cells (plasminogen activator, erythropoietin, interleukins, interferons), Livestock pharming products. Cell culture-based vaccines.	

TEXT BOOKS/REFERENCES:

1. Freshney R Ian. 2010. Culture of Animal Cells, 6th Ed, Wiley-Blackwell.
2. John Davis. 2011. Animal Cell Culture Essential Methods, Wiley & Sons.
3. Satyanarayana U. 2008. Biotechnology, Books and Allied Ltd.
4. Glick BR, Pasternak JJ, Patten CL. 2010. Molecular Biotechnology, 4th Ed. American Society for Microbiology.

EXPERIMENTS

1. Laboratory requirements and safety measures for animal cell culture.
 2. Preparation of balanced salt solution
 3. Preparation of cell culture media (serum/non-serum supplemented/DMEM).
 4. Primary cell culture from fibroblast cells/liver cells/chick embryo
 5. Subculture by trypsinization
 6. Assessment of viability and counting using trypan blue exclusion method
- #Virtual videos of the experiments should supplement wet lab experiments.

TEXT BOOKS/ REFERENCES

- Freshney R Ian. 2010. Culture of Animal Cells, 6th Ed), Wiley-Blackwell.
- Davis JM. 2011. Animal Cell Culture: Essential Methods, Wiley.

SEMESTER	V					
YEAR	III					
COURSE CODE	22BS3501					
TITLE OF THE COURSE	BIOETHICS AND IPR					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

To recognize, compare, and contrast the general "ways of thinking" of science (biology) and of philosophy (ethics).
To recognize, compare, and contrast the general "ways of thinking" of science (biology) and of philosophy (ethics).
To give elementary essential concepts of Bioethics, IPR and patent laws.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student should develop basic understanding of the concepts of Bioethics, IPR and Patent Laws	L2
CO2	This course should generate interest for avenues for pursuing higher studies and careers in these areas	L2
CO3	General knowledge should create awareness necessary for higher studies in biotechnological fields	L2

COURSE CONTENTS	
MODULE I – BIOETHICS	15 Hrs
Bioethics- The environmental, legal and socioeconomic impacts of biotechnology; Ethical concerns of biotechnology in research and innovation-The GM crop debate – safety, ethics, perception and acceptance of GM crops; Bioethics of Genetically modified organism; Bioethics of CRISPR technique- for editing human embryos; Bioethics of Gene therapy; Bioethics of Stem cell research; Reproductive medicine and ethics; Use of Animals in Research and Testing, and Alternatives for Animals in Research, Animal Cloning, Human Cloning, and their Ethical Aspects; Public education of the process of biotechnology involved in generating new forms of life for informed decision-making.	

MODULE II – INTELLECTUAL PROPERTY RIGHTS AND REGULATIONS	15 Hrs
Introduction to Intellectual Property and History. Patents, Trademarks, Copyright, Trade secrets, Industrial Design and Rights, Traditional Knowledge, Geographical Indications - importance of IPR – patentable and non-patentable – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO), Pros and Cons of IP protection. Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. Agreements and Treaties: GATT, TRIPS Agreements; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.	

REFERENCES:

1. Beier FK. Crespi RS and Straus T. 1985. Biotechnology and Patent protection. Oxford and IBHPublishing Co. New Delhi.
2. Ganguli P. 1998. Gearing up for Patents....The Indian Scenario. Universities Press.
3. HS Chawla. 2020. Introduction to Plant Biotechnology, 3rd Ed. OXFORD & IBH PUBLISHING.
4. Sateesh M K. 2010. Bioethics and Biosafety. Arihant publications.
5. Parashar S, Goel D. 2013. IPR, Biosafety and Bioethics. Pearson India.
6. Erbisch FH and Maredia KM. 2004. Intellectual property rights in agricultural Biotechnology, University Press.

SEMESTER	V					
YEAR	III					
COURSE CODE	22BS3502					
TITLE OF THE COURSE	BIONFORMATICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To get introduced to the basic concepts of Bioinformatics and its significance in biological data analysis.
- To get an overview about biological macromolecular structures and structure prediction methods.

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Will be able to demonstrate mastery of the core concepts of bioinformatics	L1
CO2	The student will be able to apply basic principles of biology, computer science and mathematics to address complex biological problem	L2
CO3	Should be able to plan basic experiments in microbial genetics concerned with clarifying phenotypes and their relationship with the genotype	L3

COURSE CONTENT:

MODULE 1	07Hrs
BIOLOGICAL DATA TYPES AND SOURCE: Introduction to population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Virus data bank (UICTVdb)	
MODULE 2	10Hrs
SIMILARITY SEARCHING: Global and Local sequence alignment, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs	

MODULE 3	07Hrs
INTERPRETTING THE SEQUENCE: Reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank libraries, annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files.	
MODULE 4	06Hrs
SCALING THE HUMAN GENOME: UCSC genome browser, RegulomeDB database, ENCODE-ChIA-PET database, transcription factors binding sites. SNP, EST, STS. Regular Expression (REGEX), Hierarchies and Graphical models (including Markov chain and Bayes algorithm). Genetic variability and connections to clinical data.	

TEXT BOOKS/REFERANCES:

1. Keith J. 2008. Bioinformatics. Humana Press.
2. Doolittle RF. 1996. Computer methods for macromolecular sequence analysis. Academic Press.
3. Mount DW. 2004. Bioinformatics. Sequence and genome analysis. Cold Spring Harbor Lab. press.
4. Pevsner J. 2003. Bioinformatics and functional genomics. John Wiley & Sons Inc.
5. Dunn MJ, Jorde LB, Little PFR, Subramaniam S. 2005. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics. John Wiley and Sons.
6. Baxavanis A and Ouellette F. 1998. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. John Wiley & Sons, New York.
7. Fry JC. 1993. Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Rosenbloom KR *et al.* 2015. The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43 (Database issue): 670-81.

SEMESTER	VI					
YEAR	III					
COURSE CODE	22BT3601					
TITLE OF THE COURSE	BIOPROCESS TECHNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To impart basic understanding of principles and key concepts relevant to industrial biotechnology - To describe the design aspects of bioreactor including the upstream and downstream processing - To apply the biotechnological concept in the production of biologicals

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Student will be able to describe the isolation and screening of industrially important strains.	L1
CO2	Students can determine fermentation process and different types of fermentation media.	L2
CO3	Students will be able to analyse different bioreactor systems and their components	L3
CO4	Student will be to apply the principles of different upstream and downstream processes involved in bioprocesses	L3
CO5	Apply the concept of microbial technologies in food processing and biorefineries as well as production of biologicals	L3
CO6	The course will enable the student to apply the knowledge in various aspects of fermentation or industrial biotechnology processes.	L4

COURSE CONTENT:	
MODULE 1	15 Hrs
INTRODUCTION: History, Scope and Development of Fermentation technology; Isolation and screening of industrially important microorganisms – primary and secondary screening; Strain improvement: Mutant selection and Recombinant DNA technology. Preservation of industrially important microbes. Culture collection centers.	

MODULE 2	15 Hrs
FERMENTATION PROCESS AND FERMENTER: Types of fermentation - Microbial growth in batch, fed-batch and continuous fermentation. Other types like surface, submerged and solid state fermentation. Different parameters affecting fermentation - pH, temperature, dissolved oxygen, foaming and aeration. Basic components, design of fermenters. Types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.	
MODULE 3	15 Hrs
UPSTREAM AND DOWNSTREAM PROCESSING: Upstream processing: Formulation of fermentation media, Nutrients: growth factors, carbon, nitrogen, energy and mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization, inoculum preparation. Downstream processing: Steps in recovery and purification of fermented products, Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid Liquid extraction, Solvent recovery, Supercritical fluid extraction, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing, Effluent treatment.	
MODULE 4	15 Hrs
INDUSTRIAL BIOPROCESSING: Production of alcohol beverages (wine, beer), organic acid (citric acid), antibiotics (penicillin), amino acid (glutamic acid), vitamins (Vitamin B12), enzyme (amylase), hormone (insulin), fermented dairy products (Yoghurt, cheese), Single Cell Protein (SCP).	

TEXT BOOKS/REFERANCES:

1. Stanbury PF, Whitaker A, Hall SJ. 2016. Principles of Fermentation Technology. Butterworth-Heinemann Press. UK.
2. Peppler HJ, Perlman D. 2014. Microbial Technology: Fermentation Technology. Academic Press.
3. Smith JE. 2009. Biotechnology. Cambridge University Press.UK.
4. Todaro CM, Vogel HC. 2014. Fermentation and Biochemical Engineering Handbook. William Andrew Press. Norwich, NY.
5. Lancini G, Lorenzetti R. 2014. Biotechnology of Antibiotics and other Bioactive Microbial Metabolites. Springer publications, Germany.
6. Satyanarayana U. 2008. Biotechnology. Books and Allied Ltd.

EXPERIMENTS

1. Study of fermenter (Demonstration using video or model or Industrial visit)
2. Isolation of Amylase producing microorganisms and production of Amylase using solid state/submerged fermentation and estimation of Amylase activity
3. Production of ethanol /alcohol using Grapes/ Ginger/ Pomegranate/molasses and estimation of alcohol by specific gravity method
4. Immobilization of yeast by calcium alginate gel entrapment and assay for enzyme-Invertase and Catalase
5. Microbial production of antibiotics
6. Algal culture– Spirulina
7. Production and Estimation of citric acid from *Aspergillus niger*.
8. Preservation Techniques.

TEXT BOOKS/ REFERENCES:

1. Aneja KR. 2014. Laboratory Manual of Microbiology and Biotechnology. Scientific international.
2. Atlas RM. 1984. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
3. Brock TD and Madigan MT. 1996. Biology of Microorganisms. Prentice Hall of India Private Limited.
4. Cappuccino JG and Sherman N. 1999. Microbiology - A Laboratory Manual, 4th Ed. The Addison Wesley Longman, Inc England.

SEMESTER	VI					
YEAR	III					
COURSE CODE	22BT3602					
TITLE OF THE COURSE	ENVIRONMENTAL BIOTECHNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To familiarize the student with biotechnological methods in detection of environmental pollution.
- To impart the knowledge on use of microorganisms in waste treatment.
- To equip the students with knowledge on biotechnology tools and its environmental applications.

COURSE OUTCOMES:

CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will learn about environmental quality evaluation, monitoring, and remediation of contaminated environments.	L1
CO2	Students will be able to describe the waste management and xenobiotic degradation methods.	L2
CO3	Students will be able to perform the experiments to assess the quality of the water, to isolate the xenobiotic degrading bacteria.	L3
CO4	Students will be able to critically analyze the environmental issues and apply the biotechnology knowledge in resolving the problems.	L4

COURSE CONTENT:	
MODULE 1	15Hrs
INTRODUCTION: Conventional fuels and their environmental impact – Firewood, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol. Biotechnological methods of pollution detection- General bioassay, cell biological methods, immunoassays, DNA-based methods, use of biosensors.	
MODULE 2	15Hrs
BIOREMEDIATION: Concepts and principles, bioremediation using microbes, <i>in-situ</i> and <i>ex-situ</i> bioremediation, biosorption and bioaccumulation of heavy metals. Phyto-remediation. Xenobiotics: Degradation by microorganisms with reference to pesticides, herbicides, polyaromatic hydrocarbons.	
MODULE 3	15Hrs
WASTE TREATMENT: Waste water treatment- conventional wastewater treatment, use of algae, Bioreactors for waste-water treatment, eutrophication, use of cell immobilization. Solid waste management- Waste as a source of energy, biotechnology in paper and pulp industry, production of oil and fuels from wood waste, anaerobic and aerobic composting, vermiculture, biofuels.	
MODULE 4	15Hrs
BIOHYDROMETALLURGY AND BIOMINING: Bioleaching, biosorption, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.	

TEXT BOOKS/ REFERENCES:

1. Jördening HJ and Winter J. 2004. Environmental Biotechnology: Concepts and Applications, 1st Ed. Wiley-Blackwell publications.
2. Evams G M. 2003. Environmental Biotechnology-Theory and applications. John Wiley and sons Ltd.
3. Mohapatra PK. 2013. Textbook of Environmental Biotechnology. I.K. International Publishing House Pvt. Limited.
4. Thakur IS. 2006. Environmental Biotechnology: Basic concepts and Applications. I K Internationals Publishing House Pvt. Ltd.
5. Satyanarayana U. 2020. Biotechnology. Books and Allied Ltd.

EXPERIMENTS
1. Detection of coliforms for determination of the purity of potable water by MPN Method. 2. Isolation of xenobiotic degrading bacteria by selective enrichment techniques. 3. Calculation of Total Dissolved Solids (TDS) of water sample. 4. Determination of sulphates in the water by turbidometric method. 5. Calculation of BOD and COD of sewage water sample. 6. Effect of heavy metals (Cd /Cr/Zn/Cu) on seed germination and plant growth.
REFERENCES: 1. Pillai S. 2009. A Comprehensive Laboratory Manual for Environmental Science and Technology. New Age International (P) Limited, Publishers. 2. Thakur I S. 2006. Environmental Biotechnology: Basic concepts and Applications. I K International Publishing House Pvt. Ltd.

SEMESTER	VI					
YEAR	III					
COURSE CODE	22BS3601					
TITLE OF THE COURSE	PRINCIPLES OF ‘MULTI-OMICS’					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To acquaint students with various aspects of biotechnology and bio-engineering using omics technologies - To provide key insights into omics approaches in personalized and precision medicine

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will have knowledge in specific methods used in genomics, proteomics and metabolomics used in analytical processes.	L1
CO2	Students will be able to perform statistical analysis crucial for interpretation of experimental results	L2
CO3	Students will be able to apply specialized research methods necessary for the analysis of proteins, genes and metabolites	L3

COURSE CONTENT:	
MODULE 1	07Hrs
GENOME & GENOMICS: Genome mapping: Physical and Genetic Map, Genome Sequencing, Next generation sequencing methods ,Genome Annotation, Functional Genomics	
MODULE 2	07Hrs
TRANSCRIPTOMICS: Search for transcription factor binding sites, RNA-Seq, Microarrays, Regulatory RNAs: small or large, Computational prediction of miRNA target genes, RNA Darkmatter	

MODULE 3	10Hrs
PROTEOMICS AND METABOLOMICS: Basic concepts , Tools of proteomics- SDS PAGE, 2D PAGE , Liquid chromatography , Mass Spectrometry (ESI and MALDI) ,Protein identification by peptide mass fingerprinting ,Applications of proteomics. Fundamental concept, Tools of metabolomics- Capillary electrophoresis, Gas chromatography, Electrochemical detectors, Case studies	
MODULE 4	06Hrs
‘OMICS’: APPLICATIONS AND FUTURE PERSPECTIVES: Multi-omics in disease prediction and health. Multi-omics technologies for crop improvement and sustainable agriculture. Applications in Biomedical and Environmental sciences	

TEXT BOOKS/REFERANCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Introduction to Proteomics -Tools for the New Biology by Daniel C. Liebler, Humana Press.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Metabolomics- Methods and Protocols by Wolfram Weckwerth, Humana Press.
7. Fry, J.C. (2093). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Transcriptomics: Expression Pattern Analysis, Virendra Gomase, Somnath Tagore; VDM Publishing, 2009 – Science

SEMESTER	VI					
YEAR	III					
COURSE CODE	22BS3602					
TITLE OF THE COURSE	TOXICOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
1. To learn various toxicants present and their exposure level on day-to-day basis.
2. To study the effects of toxins on the physiologic, metabolic, reproductive, and developmental processes.

COURSE OUTCOMES

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will learn and understand all substances can be toxic depending on the means and level of exposure	L1
CO2	Students will learn the basic concepts of cellular toxicity and chemical actions on cells and body organs	L2
CO3	Students will learn the importance and diversity of drug interactions with various organs	L3

COURSE CONTENT:	
MODULE 1	10 Hrs
INTRODUCTION OF TOXICOLOGY: Classification of toxic agents, natural toxins, animal toxins, plant toxins, food toxins, genetic poisons and chemical toxins. Factors affecting toxicity – species and strain, age, sex, nutritional status, hormones, environmental factors, circadian rhythms. Toxicant proceeding <i>in vivo</i> : Absorption, Distribution, Excretion an Metabolism of foreign/toxic compounds.	

MODULE II	5 Hrs
ENVIRONMENTAL TOXICOLOGY: Environmental pollution- Sources and types of pollution, Important pollution events, Priority pollutants. Air pollution- Classification and properties of air pollutants, Behaviour and fate of air pollutants, Photochemical smog, Acid Rain, health effects of air pollution. Water pollution- origin of Wastewater, Domestic Water Pollution, Industrial water pollution, Agricultural water pollution, Toxic water pollutants and their health effects, Groundwater pollution, marine pollution	
MODULE III	5 Hrs
INDUSTRIAL TOXICOLOGY: Industrial Chemicals: Government Regulation of Chemicals, Ways of exposure, Toxic effects, Long-term consequences and developmental toxicity. Food Additives and Contaminants types of food additives, Preservatives, Saccharin. Toxicity of trace elements- Iodine, iron, zinc, copper, manganese, selenium, molybdenum, and cobalt Cyto-toxicity of heavy metals- Cadmium, mercury, arsenic, chromium and lead. Brief introduction to toxicity of pesticides and insecticides.	
MODULE IV	10 Hrs
ORGAN TOXICOLOGY: Basics of organ toxicity- Target organs, Organ selectivity and specificity, gender specific diversity of toxins. Hepatotoxicity - Actions of toxins on the liver, Chronic liver injury; Cardiotoxicity - pathology of cardiac toxicity, mechanisms of cardiotoxicity; Respiratory Toxicity - Systemic lung toxins, Lung pathology; Reproductive System – Teratogenicity; Neurotoxicity- Effect of toxic agents on neurons, Ion channel neurotoxins and Nephrotoxicity- susceptibility of kidney to toxic insult, chemically induced renal injury.	

Reference books:

1. Whalen, Finkel, and Panavelil, Pharmacology, 6th ed. (Lippincott Williams & Wilkins: 2015).
2. Lieberman and Peet, Mark's Basic Medical Biochemistry: A Clinical Approach, 5th ed. (Wolters Kluwer: 2018).
3. Hodgson, A Textbook of Modern Toxicology, 4th ed. (J Wiley & Sons: 2010).
4. Molecular and Biochemical Toxicology, 4th ed., Smart and Hodgson, eds. (J Wiley & Sons: 2008).
5. Frank and Ottoboni, The Dose makes the Poison: A Plain-language Guide to Toxicology, 3rd ed. eBook, (J Wiley & Sons: 2011).
6. Ottoboni, The Dose makes the Poison: A Plain-language Guide to Toxicology, 2nd ed., (J Wiley & Sons: 1997).
7. A-Z Guide to Drug-Herb-Vitamin Interactions, 2nd ed., Gaby, Batz, Chester and Constantine, eds. (Three Rivers Press: 2006).
8. Gilbert, A Small Dose of Toxicology: The health effects of common chemicals, (CRC Press: 2004).
9. Gibson, Multiple Chemical Sensitivities: A survival guide, (New Harbinger Publications: 2000).
10. Toxicology and Clinical Pharmacology of Herbal Products, Cupp and Karch, eds. (Springer-Verlag: 2000).
11. Lawson, Staying Well in a Toxic World, (Lynwood Press: 2000).

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22BT4701					
TITLE OF THE COURSE	FOOD TECHNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
• To comprehend basic concepts of food sciences and properties of foods, and the factors (chemical and enzymatic) affecting these properties. • To equip the students with fundamentals of food processing and preservation. • To provide understanding on emerging concepts in food technology

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Student will be able to explain the basic concepts of food sciences and properties of foods, and the chemical and enzymatic factors affecting these properties.	L1
CO2	Students will be able to comprehend different food standards for various categories of foods.	L2
CO3	Students will be able to understand different analytical techniques employed across various categories of foods	L3
CO4	Students will be able to describe the effect of food constituents on food quality	L2
CO5	Students will be able to determine the fundamentals of food processing and preservation	L2
CO6	Students will be able to understand some emerging concepts in food technology	L3

COURSE CONTENT:	
MODULE 1	15 Hrs
INTRODUCTION TO FOOD SCIENCE AND TECHNOLOGY Basics of chemistry of food constituents- carbohydrates, proteins, lipids, vitamins, minerals, water (different forms of water present in foods and their effect on quality and preservation of foods), minor constituents affecting texture, colour, taste, odour; Food microbiology, Food biochemistry, Food additives, General food composition and effect of food constituents on food quality.	
MODULE 2	15 Hrs
FOOD ANALYSIS Food adulterations, standards of identity, purity and methodology for analysis of a) Cereals, legumes, oil seeds and their products; b) Fruits, vegetables, tubers, and their products; c) Tea, coffee, cocoa, chocolate, spices, sugar, condiments; d) Milk and milk products; e) Meat, fish and poultry products; f) Miscellaneous foods e.g., fermented products.	
MODULE 3	15 Hrs
FOOD PROCESSING AND PRESERVATION Food processing: Introduction to food processing of various foods including dairy, bakery, brewing, fruit and vegetable products, plantation products, oilseeds, meat, fish, poultry; pro and prebiotics and nutraceuticals. Food preservation: Principles of food preservation by dehydration, thermal treatments like pasteurization, sterilization, canning, retorting etc., low temperature i.e., chilling and freezing, chemical preservation/ bio-preservation, traditional methods like salting/ syruping, pickling, fermentation etc., non- thermal processes like MAP, irradiation, high pressure processing etc., and hurdle technology.	
MODULE 4	15 Hrs
ENZYMES AND GENETICALLY MODIFIED FOODS Enzymes: Enzymes used in food industry, recovery of enzymes from natural sources, cheese making and whey processing, enzymatic processing of fruit juices. Role of enzymes in baking, meat and meat processing; comparative methods of toxicity test in (novel) foods; biosensors; enzymatic approach to tailor made fats; catabolic processes and oxygen-dependent reactions in food; use of lipases and reactions in organic solvents and two phases. Genetically modified foods: Need for GM foods, Potential benefits in agriculture, Crop engineered for input and output traits, nutritional improvement, animal foods, issues of concern, tests for detecting GM foods, safety of GM foods.	

TEXT BOOKS/REFERENCES:

1. Lee BH. 2014. Fundamentals of Food Biotechnology. John Wiley and sons
2. Lloyd RA, Pentzer WT. 2017. Handling transportation and storage of fruits and vegetables, Medtech scientific international PVT LTD (Vol 1 & 2).
3. Potter NN, Hotchkiss JH. 1995. Food Science, 5th Ed. Springer US
4. Manay NS, Shadaksharaswami M. 2004. Foods: Facts and Principles, 4th Ed. New Age Publishers.
5. Srilakshmi B. 2002. Food Science. New Age Publishers.
6. Meyer LM. 2004. Food Chemistry. New Age Publishers.
7. Deman JM. 1990. Principles of Food Chemistry, 2nd Ed. Van Nostrand Reinhold, NewYork.
8. Ramaswamy H and Marcott M. 2005. Food Processing Principles and Applications. CRC Press.

EXPERIMENTS

1. Food analysis methods
 - a) Moisture determination
 - b) Ash determination
 - c) Crude protein determination
 - d) Crude fat determination
2. Fermented Foods
 - a) Production of vegetable pickles
 - b) Production of yogurt
3. Estimation of food bioactive (phenolics, pigments etc)
4. Fruit and vegetable processing
5. Milk processing (Video/ Industry Visit)
6. Microbial production of enzyme and its application in food industry (Amylase/Pectinase/ Lipase etc)

TEXT BOOKS/ REFERENCES

1. AOAC International. 2003. Official methods of analysis of AOAC International. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities
2. Kirk RS and Sawyer R. 1991. Pearson's Chemical Analysis of Foods. 9th Ed. Harlow, UK, Longman Scientific and Technical.
3. Leo ML. 2004. Handbook of Food Analysis. 2nd Edition. Vol 1,2 and 3, Marcel Dekker.
4. Linden G. 1996. Analytical Techniques for Foods and Agricultural Products. VCH.

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22BT4702					
TITLE OF THE COURSE	MEDICAL BIOTECHNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To provide knowledge on the cause and molecular mechanism of human diseases. - To equip students with technologies/techniques that targets/uses biomolecules (nucleic acids and proteins) for a specific disease diagnosis and treatment. - To familiarize students with features of nanomaterials and its various applications in medical field (diagnosis and treatment).	

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will be able to illustrate the cause and molecular basis of different diseases.	L1
CO2	Students will be able to explain different techniques that use biomolecules (DNA, RNA, protein) for disease diagnosis.	L2
CO3	Students will be able to describe wide range of therapeutic strategies using biomolecules/genetic material.	L2
CO4	Students will be able to demonstrate skills to diagnose diseases by molecular methods.	L3
CO5	Students will be able to explain and demonstrate the applications of nanomaterials in disease diagnoses and treatment.	L2

COURSE CONTENT:	
MODULE 1	
15Hrs	
DISEASES- MOLECULAR MECHANISM Infectious disease (Bacterial Infection- Tuberculosis, Salmonellosis, Viral infection – Corona, Dengue, Parasitic disease- Amoebiasis and Malaria); Genetic characteristics of causative agent, pathogenesis, symptoms. Metabolic disease (Example: Diabetes), Genetic disorders (Example: Sickle Cell anemia); Cancer (Example: Breast cancer). Antimicrobial Resistance (AMR).	

MODULE 2	15Hrs
MOLECULAR DIAGNOSTICS Immunological approaches (ELISA to detect HIV, Dengue), DNA based approaches (PCR/Real Time PCR/Next generation sequencing to detect HIV, <i>Salmonella typhimurium</i>), RNA signatures of diseases (changes in gene expression using transcriptome analyses- TB, Cancer).	
MODULE 3	15Hrs
MOLECULAR THERAPEUTICS Protein therapeutics: Pharmaceutical (Insulin), Recombinant Antibodies (Monoclonal antibodies), Enzymes [Glucocerebrosidase (GCase) for Gaucher disease]. Nucleic acid therapeutics: Targeting specific mRNA and DNA (Antisense RNA, Aptamers), Gene Therapy: Gene delivery systems as viral [adenoviral, herpes simplex virus], nonviral delivery systems (physical: DNA bombardment, electroporation) and (chemical: Cationic lipids, cationic polymers). In vivo and Ex-vivo delivery (Cytokine IL-12 in cancer). Genome Editing: (CRISPR Cas9 system for genetic disorder). Advanced Immunotherapy: Chimeric Antigen receptor (CAR-T) cell therapy.	
MODULE 4	15Hrs
NANOBIOTECHNOLOGY Introduction to Nanomaterials, Biological synthesis of Nanomaterials: Synthesis using microorganisms, synthesis using plant extracts (silver nano particles), Nanoformulations. Characterization Methods: Microscopy (Scanning Electron Microscopy – Transmission Electron Microscopy), Spectral analyses (FTIR, UV-visible) Applications: Nanomaterials in diagnosis and treatment. Biosensors and Biochips.	

TEXT BOOKS/REFERENCES:

1. Glick GR, Delovitch TL, Pattern CL. 2014. Medical Biotechnology, 1st Edi. ASM Press.
2. Pongracz J and Keen M. 2008. Medical Biotechnology, 1st Edi. Elsevier publications.
3. Prajapat R, Kasturi M, Manivannan B, Mishra A. 2021. Fundamentals of Medical Biotechnology. Nova Science Publishers, Inc.

EXPERIMENTS

1. Detection of bacteria (*E. coli/S. aureus*) by Polymerase Chain Reaction (PCR).
2. ELISA/WIDAL test for antigen/antibody detection (Demo)
3. Synthesis of silver nano particle from aloe vera extract
4. Evaluation of antimicrobial activity of silver nanomaterial
5. Bioinformatics Tools for gene editing using CRISPR-Cas9 system
6. Sickling test to identify sickle shaped RBCs

7. Determine susceptibility of bacteria to beta-lactam antibiotics by Kirby Bauer disc diffusion method.

a. #Virtual videos of the experiments should supplement wet lab experiments.

TEXT BOOKS/ REFERENCES

- Susweta *et al.*, 2015. Duplex PCR for specific detection of *Escherichia coli* and its differentiation from other Enterobacteriaceae. The Indian Journal of Animal Sciences, 85(8). <https://epubs.icar.org.in/index.php/IJAnS>
- ELISA detection kit – Hand Book. Himeda.
- Kuntauruk *et al.*, 2010. Sandwich ELISA for hemoglobin A2 quantification and identification of beta-thalassemia carriers. *Int J Hematol*, 91(2):219-28. doi: 10.1007/s12185-009-0490-3.
- Anju *et al.*, 2021. Green synthesis of silver nanoparticles from *Aloe vera* leaf extract and its antimicrobial activity <https://doi.org/10.1016/j.matpr.2021.02.665>
- CHOP-CHOP web tool for selecting target site for CRISPR Cas9 - <https://chopchop.cbu.uib.no>

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22BT4703					
TITLE OF THE COURSE	AGRICULTURAL BIOTECHNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To equip the students with knowledge on biocontrol agents and bio-fertilizers, and its formulation.
- To familiarize the student with hybrid seed production technology.
- To equip the students with knowledge on various recombinant DNA techniques and genetically modified organisms with the novel traits.

COURSE OUTCOMES:

CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will be able to demonstrate the biocontrol agents and bio-fertilizers formulation.	L3
CO2	Students will be able to explain the hybrid seed production technology.	L2
CO3	Students will be able to describe the gene transformation techniques in plants.	L2
CO4	Students will be able to describe the various applications of transgenics and molecular farming.	L2

COURSE CONTENT:

MODULE 1	15Hrs
INTRODUCTION: Conventional crop improvement techniques and their limitations, biotechnology for crop improvement, future prospects of biotechnology for agriculture. Biopesticides: Baculovirus, <i>Bacillus thuringensis</i> and mycopesticides (Trichoderma). Isolation, Identification, Mode of action, Characterization, Mass production Technology, formulations, and methods of applications. Integrated pest management -Insect pheromones. Biofertilizers: Importance of biofertilizers, types of biofertilizers, microorganisms used as biofertilizers (special emphasis to <i>Rhizobium</i>, VAMs), mode of action, methods of Application, mass	

production and commercial importance.	
MODULE 2	15Hrs
<u>Seed BIOTECHNOLOGY:</u> Seed development and structure: Development of the male and female gametophytes, pollination, fertilization, and formation of the zygote; molecular basis of embryogenesis. Seed structure and composition, determinants of seed structure. Hybrid seed production technology: Variability and its conservation in crop plants, mode of reproduction in relation to plant breeding, breeding systems, controlling pollination, genetic principles, qualitative and quantitative traits, different methods of breeding for self and cross pollinated crops, plant introduction and acclimatization, wide crosses, male sterility, apomixes, polyploidy. Terminator gene technology. High technology green house; Climate management.	
MODULE 3	15Hrs
GENETIC ENGINEERING OF CROP PLANTS: Gene transfer techniques for desirable traits in crop plants. Selectable markers, reporter gene and promoters used in plant transformation vectors. Biotic stress tolerance; insect, pest and pathogen resistance. Abiotic stress tolerance; salt, water and drought tolerance. Herbicide tolerance. Post-harvest Protection: Antisense RNA technology for extending shelf life of fruits and shelf life of flowers. Artificial Intelligence in smart farming.	
MODULE 4	15Hrs
MOLECULAR FARMING: Transgenic plants as production systems-production of alkaloids, steroids, colouring agents, flavoring agents, biodegradable plastics, industrial enzymes, therapeutic proteins, biopharmaceuticals. Beta carotene production in rice (Golden rice) and potato. Intellectual Property Rights (IPR): IPRs and agricultural technology implications for India, Plant Breeder's Rights, legal implications, commercial exploitation of traditional knowledge and protection. Ethical issues associated with consumption of GM food, labelling of GM crops and foods.	

TEXT BOOKS/ REFERENCES:

1. Purohit SS. 2018. Agricultural Biotechnology, 3rd Edi. Agrobios (India) publishers.
2. Chawl HS. 2020. Introduction to Plant Biotechnology, 3rd Ed. OXFORD & IBH PUBLISHING.
3. Allard RW. 1999. Principles of plant breeding, 2nd edition. Wiley publisher.
4. Buchanan BB, Jones RL and Gruissem W. 2015. Biochemistry and Molecular Biology of Plants. Wiley.
5. Lyrett G W and Grierson D. 1990. Genetic Engineering of Crop Plants. Butterworths publishers.

EXPERIMENTS

1. Seed viability testing
2. Testing the biochemical composition of a seed – total carbohydrate, total protein and total nitrogen.
3. Seed inoculation with *Rhizobium* culture and observation for root nodulation
4. Preparation and formulation of bio-control agent
5. Preparation and formulation biofertilizer
6. Demonstration of hybridization techniques (Emasculation and Pollination)
7. Preparation of vermi-compost using agricultural waste/ Production of edible mushroom.

REFERENCES:

1. Purohit SS. 2018. Agricultural Biotechnology, 3rd Edi. Agrobios (India) publishers.
2. Nagar S and Aadhi M. 2010. Practical Book of Biotechnology and Plant Tissue Culture. S Chand Publications.
3. Singh B, LaL GM. 2022. Practical Manual of Genetics & Plant Breeding. Sathish serial publishing house.

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22BS4701					
TITLE OF THE COURSE	RESEARCH METHODOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	45	3
Perquisite Courses (if any)						
#	Sem/Year	Course Code	Title of the Course			
-	-	-	-			

COURSE OBJECTIVES:
To provide an overview of essential research steps to be followed when conducting research / project work.
To understand chief ingredients to be incorporated in conduct as well as writing of scientific reports/dissertation/thesis
To know the implication professional research ethics and common misconduct details of researcher and research work

COURSE OUTCOME		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Show and explain the concepts of meaning of research, scope of research including different types of research, scientific research process and research methodology steps	L1
CO2	Perform review of literature using electronic media, selecting research problem formulate research problem statement, writing hypothesis, explain criteria of forming objectives, materials and methods, results and discussion	L2
CO3	Identify and explain experimental research designs for both qualitative and quantitative research	L2
CO4	Explain different sampling methods and sampling design, basic statistical methods for treatment of data and observations	L2
CO5	Demonstrate ingredients and components of a research report, dissertation and thesis and explain integral components of research article and research proposal	L2
CO6	Explain professional research ethics and elaborate on misconduct in research	L2

COURSE CONTENT:	
MODULE 1:	12 hrs
INTRODUCTION TO RESEARCH: Meaning, Objectives and Characteristics of research – Scientific Method Types of research - Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical - Research process - Criteria of good research PROBLEM STATEMENT: Defining the research problem - Selecting the problem - Necessity of defining the problem - Techniques involved in defining the problem; LITERATURE SURVEY: Importance of literature review in defining a problem - Survey of literature - Primary and secondary sources - web as a source - searching the web - Identifying gap areas from literature review. HYPOTHESIS: Definition of hypothesis, Basic concepts, variables-Dependent and independent variables, Development of working hypothesis; Ingredients of Research Objectives, deriving objectives of research.	
MODULE 2:	12 hrs
Sampling, Material and Methods: Sample- Sampling - Types of sampling; Material - Experiments, Data – Basics of Analysis; Writing materials and method chapter of a research report Results and Discussion: Representation of results; Tables, graphs; Discussion, Purpose and Function of Discussion Research Designs: Research design; Need of research design - Basic Principles; Features of good design – Important concepts relating to research design; Max-min-con principle, Common Research Designs: Cross-sectional, Case-control, Longitudinal and Cohort research designs, advantages and disadvantages of each of research designs Summary and Conclusion: Writing of Summary, conclusions of research findings, Acknowledgement section of a research report and an article.	
MODULE 3:	10Hrs
Research Ethics: Values, Ethics and Morals, Research Professionalism, Tenets of Ethics; Conducting and reporting of science/engineering; Relationship in research groups; Hazards to good scientific practice; Scientific misconduct: Fabrication, Falsification and Plagiarism. Report and Article Writing: Structure and components of scientific reports; Abstract-Key words; Types of reports; Significance of reporting; Different steps in the preparation of reports; Layout, structure and Language of typical reports; References; Citation styles- APA and MLA styles of citation, intext and end text citations. Oral Presentation: Importance of effective communication. Planning; Preparation; Practice; Making presentation; Use of visual aids.	
MODULE 4:	11Hrs
Scientific Article Writing: Title preparation – Importance of title; need for specific titles; List of authors and addresses – order of names; defining the order with example; types of abstracts; economy of words; How to write introduction- Rules; exceptions; citations and abbreviations Materials and methods: Purpose; materials; methods; tables and figures; form and grammar; Result and Discussion writing: content of results; handling numbers; clarity; avoiding redundancy; Discussion writing: Components of discussion; factual relationships; strengths and limitations; significance of paper;	

Stating Acknowledgements: Ingredients of the acknowledgements; courtesy; Citation of the References: Rules; electronics aid; in-text citation; styles of referencing

Research Proposal Fundamentals: What is a grant proposal? Why proposals fail?; Developing and writing of grant proposals; overview of steps to develop grant proposals; Proposal Development Process: Standard Proposal Parts; writing Budget section.

Intellectual Property Rights: IPRs- Invention and Creativity- Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs); A brief summary of: Patents, Copyrights, Trademarks

REFERENCES:

1. Tuckman B, Harper BE. 2012. Conducting Educational Research, 6th Edition. Rowman& Littlefield Publishers, Inc. ISBN 978-1-4422-0965-7 (electronic).
2. Kothari CR. 1990. Research Methodology: Methods and Techniques. New Age International.
3. Garg BL, Karadia R, Agarwal F and Agarwal UK. 2002. An introduction to Research Methodology. RBSA Publishers.
4. Anderson TW. 1974. An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
5. Sinha SC and Dhiman AK. 2002. Research Methodology, Ess Publications. 2 volumes.
6. Trochim WMK. 2005. Research Methods: the concise knowledge base. Atomic Dog Publishing. 270p.
7. Day RA. 1992. How to Write and Publish a Scientific Paper. Cambridge University Press.
8. Fink A. 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications.
9. Coley SM and Scheinberg CA. 1990. Proposal Writing. Sage Publications.

MINOR COURSES OFFERED

SEMESTER	IV					
YEAR	II					
COURSE CODE	22BT2404					
TITLE OF THE COURSE	PLANT BIOTECHNOLOGY (MINOR)					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To equip the students with fundamentals of culturing plant cells and tissues, culture environment, cell proliferation, differentiation and media formulation.
- To familiarize the student with various important applications of plant tissue culture
- To equip the students with knowledge on various recombinant DNA techniques and genetically modified organisms with the novel traits.

COURSE OUTCOMES:

CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will be able to explain the basic requirements of plant tissue culture.	L1
CO2	Students will be able to describe the various applications of plant biotechnology for crop improvement.	L2
CO3	Students will be able to describe various tissue culture methods and their applications.	L2
CO4	Students will be able to apply the technical skills – media preparation, sterilization and inoculation of plant material for callus induction to establish nurseries for horticultural and agricultural crops	L3

COURSE CONTENT:

MODULE 1

15Hrs

INTRODUCTION: Importance, history and developments of plant tissue culture. Concept of cellular totipotency. *In-vitro* methods in plant tissue culture, design of plant tissue culture Lab. Aseptic Techniques, Nutrient media: General composition and types of media (MS, Gamborg & Nitsch). Sterilization and pre-treatment to explants, use of growth regulators (auxins, cytokines and

gibberellins). Adjuvents in plant culture media.

MODULE 2

15Hrs

PRINCIPLES OF TISSUE CULTURE: Callus culture-Definition of callus, types of callus. initiation, maintenance sub culture and organogenesis.
Micropropagation in plants: Advantages, methods, stages of micropropagation, applications. Somaclonal variation for disease resistance and desired agronomic traits.
Somatic embryogenesis: Embryoid and embryogenesis. Protocol and importance of somatic embryogenesis. Synthetic Seeds and its applications.

MODULE 3

15Hrs

ORGAN CULTURE AND SOMATIC HYBRIDIZATION: Culture protocols and importance of root, meristem, ovary and ovule culture. Factors affecting organogenesis, Cytodifferentiation, dedifferentiation differentiation and factors affecting defferentiation. Anther culture for double haploids: Applications in crop improvement.
Protoplast culture and fusion: Definition of protoplast, isolation principle, culture protocol, action of enzymes, regeneration of plants, protoplast fusion, somatic cell hybridization and its application. Cybrids and its applications
Suspension culture: Batch and continuous cell suspension culture. Importance of suspension culture in production of secondary metabolites.

MODULE 4

15Hrs

PLANT TRANSGENICS: Technique of transformation-Agrobacterium mediated and physical methods (Micro projectile and electroporation). Plant viral vectors. Gene edition techniques - CRISPR and TALEN. Application of transgenic plants. Transgenic Plants: Resistance to diseases (Pathogen resistant-viral, fungal and bacterial); insects (Bt gene transfer); Fertilizer management- Nif gene transfer. Edible vaccines from Plants – Banana, Watermelon. Plant antibodies.

TEXT BOOKS/ REFERENCES:

1. Chawla HS. 2020. Introduction to Plant Biotechnology 3rd Edi. OXFORD & IBH PUBLISHING.
2. Purohit SD. 2012. Introduction to Plant Cell, Tissue and Organ Culture. Prentice Hall India Learning Pvt Ltd.
3. Satyanarayana U. 2020. Biotechnology, Books and Allied Ltd.
4. Slater A, Scott NW and Fowler MR. 2008. Plant Biotechnology – genetic manipulation of plants 2nd Ed. Oxford Publishing.
5. Singh BD. 2014. Biotechnology: Expanding horizons. Kalyani Publishers.
6. Halford NG. 2006. Plant biotechnology: current and future applications of genetically modified crops. John Wiley Publishers.

EXPERIMENTS

1. Preparation of plant culture media
2. Sterilization and inoculation of plant material for callus induction
3. Plant protoplast isolation
4. Preparation of synthetic seeds
5. Isolation of DNA from plant source by CTAB method
6. Anther and embryo culture
7. Demonstration of cell suspension culture

REFERENCES:

1. Lindsey K. 2007. Plant Tissue Culture Manual. Springer.
2. Nagar S and Aadhi M. 2010. Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications.

SEMESTER	V					
YEAR	III					
COURSE CODE	22BT3503					
TITLE OF THE COURSE	ANIMAL BIOTECHNOLOGY (MINOR)					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	4	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To provide basic understanding on the set up/conditions and techniques necessary for animal cell culture.
- To give knowledge on the basic components of tissue engineering and different methods to produce transgenic animals.
- To aware the student with various important applications of animal biotechnology.

COURSE OUTCOMES:

CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will be able to determine the basic requirements of animal cell culture.	L1
CO2	Students will be able to explain the pre requisites of tissue engineering and determine the ways to produce transgenic animals with modified genetic traits.	L2
CO3	Will be able to illustrate the various applications of animal biotechnology in various fields to improve the welfare of society.	L2
CO4	Students will be able to apply the technical skills – media preparation, primary culture of animal cells from tissue, and subculturing.	L3

COURSE CONTENT:

MODULE 1

15Hrs

BASICS OF ANIMAL TISSUE CULTURE

Introduction, cell culture laboratory-design and layout. Equipment and Instrumentation. Types of culture media (natural and chemically defined). Importance of serum in the media. Methods of sterilization, Detection of Mycoplasma contaminants.

Primary Cell Culture: Isolation techniques (explant method, mechanical, enzymatic). Secondary Cell

Culture: Transformed and continuous cell lines (Hela).	
MODULE 2	15Hrs
STEM CELLS AND TISSUE ENGINEERING Stem cells – Adult, Embryonic, Induced pluripotent stem cells. Isolation and characterization of adult stem cells. Three-dimensional tissue culture and Tissue engineering, Scaffolds requirement and Biomaterials (Natural and Synthetic) for tissue engineering, transplantation of engineered cells.	
MODULE 3	15Hrs
TRANSGENIC ANIMALS Principal methods for production of transgenic animals (DNA microinjection, embryonic stem cell-mediated gene transfer and retrovirus-mediated gene transfer), importance and applications of transgenic animals. Gene knock out and mice models for tackling human diseases. IVF technology.	
MODULE 4	15Hrs
APPLICATIONS OF ANIMAL BIOTECHNOLOGY Pharmaceutical products produced by mammalian cells (plasminogen activator, erythropoietin, interleukins, interferons), Livestock pharming products. Cell culture-based vaccines.	

TEXT BOOKS/REFERENCES: 1. Freshney R Ian. 2010. Culture of Animal Cells, 6th Ed, Wiley-Blackwell. 2. John Davis. 2011. Animal Cell Culture Essential Methods, Wiley & Sons. 3. Satyanarayana U. 2008. Biotechnology, Books and Allied Ltd. 4. Glick BR, Pasternak JJ, Patten CL. 2010. Molecular Biotechnology, 4th Ed. American Society for Microbiology.

EXPERIMENTS
1. Laboratory requirements and safety measures for animal cell culture. 2. Preparation of balanced salt solution 3. Preparation of cell culture media (serum/non-serum supplemented/DMEM). 4. Preparation of hepatocytes 5. Primary cell culture by explant method 6. Sub culturing by trypsinization 7. Assessment of viability and counting using trypan blue exclusion method #Virtual videos of the experiments should supplement wet lab experiments.
TEXT BOOKS/ REFERENCES • Freshney R Ian. 2010. Culture of Animal Cells, 6th Ed), Wiley-Blackwell. • Davis JM. 2011. Animal Cell Culture: Essential Methods, Wiley.

SEMESTER	VI					
YEAR	III					
COURSE CODE	22BT3603					
TITLE OF THE COURSE	INDUSTRIAL BIOTECHNOLOGY (MINOR)					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
•	To impart basic understanding of principles and key concepts relevant to industrial biotechnology
•	To describe the design aspects of bioreactor including the upstream and downstream processing
•	To apply the biotechnological concept in the production of biologicals

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Student will be able to describe of isolation and screening of industrially important strains	L1
CO2	Students can determine fermentation process and different types of fermentation media	L2
CO3	Students will be able analyse different bioreactor systems and their components	L3
CO4	Student will be apply the principles of different upstream and downstream processes involved in bioprocesses	L3
CO5	Apply the concept of microbial technologies in food processing and biorefineries as well as production of biologicals	L3
CO6	The course will enable the student to apply the knowledge in various aspects of fermentation or industrial biotechnology processes.	L4

COURSE CONTENT:	
MODULE 1	15 Hrs
History, Scope and Development of Fermentation technology; Isolation and screening of industrially important microorganisms – primary and secondary screening; Strain improvement: Mutant selection and Recombinant DNA technology. Preservation of industrially important microbes. Culture collection	

centers.	
MODULE 2	15 Hrs
Fermentation Process and Fermenter: Types of fermentation - Microbial growth in batch, fed-batch and continuous fermentation. Other types like surface, submerged and solid state fermentation. Different parameters affecting fermentation - pH, temperature, dissolved oxygen, foaming and aeration. Basic components, design of fermenters. Types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.	
MODULE 3	15 Hrs
Upstream and Downstream Processing Upstream processing: Formulation of fermentation media, Nutrients: growth factors, carbon, nitrogen, energy and mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization, inoculum preparation. Downstream processing: Steps in recovery and purification of fermented products, Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid Liquid extraction, Solvent recovery, Supercritical fluid extraction, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing, Effluent treatment.	
MODULE 4	15 Hrs
Industrial Bioprocessing : Production of alcohol beverages (wine, beer), organic acid (citric acid), antibiotics (penicillin), amino acid (glutamic acid), vitamins (Vitamin B12), enzyme (amylase), hormone (insulin), fermented dairy products (Yoghurt, cheese), Single Cell Protein (SCP).	

TEXT BOOKS/REFERANCES:

1. Stanbury PF, Whitaker A, Hall SJ. 2016. Principles of Fermentation Technology. Butterworth-Heinemann Press. UK.
2. Peppler HJ, Perlman D. 2014. Microbial Technology: Fermentation Technology. Academic Press.
3. Smith JE. 2009. Biotechnology. Cambridge University Press.UK.
4. Todaro CM, Vogel HC. 2014. Fermentation and Biochemical Engineering Handbook. William Andrew Press. Norwich, NY.
5. Lancini G, Lorenzetti R. 2014. Biotechnology of Antibiotics and other Bioactive Microbial Metabolites. Springer publications, Germany.
6. Satyanarayana U. 2008. Biotechnology. Books and Allied Ltd.

EXPERIMENTS

1. Study of fermenter (Demonstration using video or model or Industrial visit)
2. Isolation of Amylase producing microorganisms and production of Amylase using solid state/submerged fermentation and estimation of Amylase activity
3. Production of ethanol /alcohol using Grapes/ Ginger/ Pomegranate/molasses and estimation of alcohol by specific gravity method
4. Immobilization of yeast by calcium alginate gel entrapment and assay for enzyme-Invertase and Catalase
5. Microbial production of antibiotics
6. Algal culture– Spirulina
7. Production and Estimation of citric acid from *Aspergillus niger*.
8. Preservation Techniques.

TEXT BOOKS/ REFERENCES

1. Aneja KR. 2014. Laboratory Manual of Microbiology and Biotechnology. Scientific international.
2. Atlas RM. 1984. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
3. Brock TD and Madigan MT. 1996. Biology of Microorganisms. Prentice Hall of India Private Limited.
4. Cappuccino JG and Sherman N. 1999. Microbiology - A Laboratory Manual, 4th Ed. The Addison Wesley Longman, Inc England.

SEMESTER	IV					
YEAR	II					
COURSE CODE	22GS2401					
TITLE OF THE COURSE	CYTOGENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- Understand chromatin structure, higher-order organization, cell cycle checkpoints, and regulatory proteins. - Differentiate meiosis and mitosis, explain genetic controls, and analyze mitotic machinery. - Study epigenetic modifications, environmental impact on transcription, RNAi mechanisms, and their roles.

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to describe chromatin organization and distinguish mitosis and meiosis.	L1
CO2	Students will be able to assess chromosomal domains' effects and analyze cell cycle regulation.	L2
CO3	Should be able to evaluate environmental transcription impact and RNAi mechanisms.	L3
CO4	Should be able to assess epigenetic study methods and evaluate RNAi's genetic analysis utility.	L4

COURSE CONTENT:	
MODULE 1	15Hrs
CHROMATIN STRUCTURE AND ORGANIZATION Histones, DNA, Nucleosome, and higher-level organization. Chromosome organization: Metaphase chromosome: centromere and kinetochore, telomere and its maintenance; Holocentric chromosomes and supernumerary chromosomes Chromosomal domains (matrix, loop domains) and their functional significance Chromatin remodelling and epigenetics, Heterochromatin and euchromatin, position effect variegation, boundary elements, Functional states of chromatin and alterations in chromatin organization. Structural and functional organization of interphase nucleus, Giant chromosomes, Polytene chromosomes, Lampbrush chromosomes.	
MODULE 2	15Hrs
CHROMOSOMAL ANOMALIES: STRUCTURAL AND NUMERICAL VARIATION Structural and numerical variations of chromosomes and their implications; euploidy, haploids, diploids and polyploids; Utilization of aneuploids in gene location; Variation in chromosome behaviour, somatic segregation and chimeras, endomitosis and somatic reduction; Evolutionary significance of chromosomal aberrations, balanced lethal and chromosome complexes; Chromosome Breakage: Types of chromosome breaks: Single-strand breaks, double-strand breaks, and	

chromosomal rearrangements, Molecular and cellular consequences of unrepaired breaks, DNA damage sources: Ionizing radiation, chemicals, and replication stress, techniques for studying chromosome breaks: Comet assay, **DNA repair assays**.

MODULE 3

15Hrs

TECHNIQUES FOR STUDYING CHROMOSOMES

Classical Chromosome Staining Techniques: Giemsa Staining: **Principles and applications in karyotyping**, Aceto-orcein and Feulgen Staining: Detection of DNA and chromosomal structure C-banding and G-banding: Differential staining of constitutive heterochromatin and chromosome banding patterns, AgNOR Staining: Visualization of nucleolar organizer regions, Fluorescence In Situ Hybridization (FISH): Principles of FISH: Probe design and target specificity, Types of FISH: DNA FISH, RNA FISH, and Comparative Genomic Hybridization (CGH), FISH applications: Chromosome mapping, gene localization, and chromosomal abnormalities detection, Multicolor FISH (mFISH) and Spectral Karyotyping (SKY) for complex chromosomal analysis, Chromosome Painting and Genomic Probing: Chromosome painting techniques: Whole chromosome and chromosome arm painting, Genomic probes and microarrays: Array Comparative Genomic Hybridization (aCGH) and high-resolution mapping.

MODULE 4

15Hrs

APPLICATIONS OF CYTOGENETICS

Molecular cytogenetics: Applications in cancer research, prenatal diagnosis, and genetic mapping, cancer cytogenetics, Advances in genomic probing: Next-generation sequencing and its impact on chromosome studies. Chromosome manipulations in Plants: in-vitro techniques to overcome the fertilization barriers in crops; Polyploidy. Genetic consequences of polyploidization and role of polyploids in crop breeding. Reversion of autopolyploid to diploids; Genome mapping in polyploids; Interspecific hybridization and allopolyploids.

TEXT BOOKS/REFERANCES:

1. "Genes IX" by Benjamin Lewin
2. "Cytogenetics" by Rebeca S. Hunt and Mariano Rocchi
3. "Principles of Genetics" by D. Peter Snustad and Michael J. Simmons
4. "Genetic Analysis: An Integrated Approach" by Mark F. Sanders and John L. Bowman
5. "Human Molecular Genetics" by Tom Strachan and Andrew P. Read
6. Modern Genetic Analysis, Griffiths AJF et al., - Freeman

EXPERIMENTS

1. Sample collection and harvesting of cells for chromosome analysis.
2. Chromosome preparation and staining: using various techniques such as Giemsa, Wright, or G-banding.
3. Study of polytene chromosomes of *Drosophila melanogaster*.
4. Study of metaphase chromosomes of *Drosophila melanogaster*.
5. Study of inversion and other chromosomal aberrations.
6. Genetic crosses and analysis of P1, P2, F1, F2 & test cross progeny in *Drosophila* - Sex linked inheritance and Interaction of genes
7. Chromosome breakage analysis

TEXT BOOKS/ REFERENCES

1. "Cytogenetic Laboratory Management: Chromosomal, FISH and Microarray-Based Best Practices and Procedures" by Marilyn S. Arsham (Wiley-Blackwell)
2. This book provides comprehensive guidance on managing a cytogenetic laboratory and covers various techniques including FISH and microarray analysis.
3. "Cytogenetics: Basic and Applied Aspects" by Uma Rao (CRC Press)
4. This book covers both the basic principles of cytogenetics and its practical applications, making it useful for those looking for laboratory techniques.
5. "Human Cytogenetics: A Practical Approach" by Rooney, D. E., & Czepulkowski, B. H. (Oxford University Press)
6. This practical guide focuses on human cytogenetics and provides protocols and techniques for various cytogenetic analyses.
7. "Atlas of Human Cytogenetics" by L. D. Müller-Höcker and C. E. Alman (Springer)
8. While more visual in nature, this atlas provides images of various chromosomal abnormalities and cytogenetic techniques.

SEMESTER	IV					
YEAR	II					
COURSE CODE	22GS2402					
TITLE OF THE COURSE	DEVELOPMENTAL BIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To introduce students to the fundamental principles of developmental biology, including the mechanisms of cell differentiation, morphogenesis, and tissue patterning. - To provide students with a detailed understanding of the molecular and genetic basis of embryonic development, including the role of signaling pathways and gene regulation.

COURSE OUTCOMES:		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to explain the major stages of embryonic development, including the formation of the germ layers, organogenesis, and morphogenesis.	L1
CO2	Students will be able to describe the molecular and genetic mechanisms underlying key developmental processes, such as cell fate determination, differentiation, and patterning.	L2
CO3	Students will be able to design and carry out experiments to investigate specific questions related to developmental biology.	L3

COURSE CONTENT:	
MODULE 1	15Hrs
INTRODUCTION TO DEVELOPMENTAL BIOLOGY: Definition and scope of developmental biology, Historical perspectives and major contributors: Hans Spermann, Scott Gilbert, Ernset McCulloch etc., Importance of developmental biology to medicine and biotechnology. Origin of life: a) Haldane's Experiment, origin of biomolecules, primitive life forms b) RNA world, concept of ribozyme and evolution of enzymes c) Endosymbiotic origin of mitochondria and chloroplast d) Law of thermodynamics and sustenance of life.	
MODULE 2	15Hrs
EARLY EMBRYONIC DEVELOPMENT: Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic	

equivalence and the cytoplasmic determinants; imprinting.

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

MODULE 3

15Hrs

POST EMBRYONIC DEVELOPMENT :

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum.

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila.

Neurulation and organogenesis: Development of brain, eye, heart in frog; Extra-embryonic membranes. Placentation in mammals.

Programmed morphogenetic histogenetic cell death (apoptosis); Erythropoiesis, myelopoiesis; Ageing.

MODULE 4

15Hrs

GENETIC CONTROL OF DEVELOPMENT AND AND REGENERATIVE MEDICINE :

Genetic control of development: Organizer concept and embryonic induction. Concept of neoteny and paedogenesis-Regeneration in Planarians and Amphibians. **Metamorphosis in Amphibians.**

Regenerative Medicine: Regenerative Medicine: Introduction to stem cell and regenerative medicine. Embryonic stem cells (ESC), Human ESCs in regenerative medicine, Stem cell bioengineering, Extracellular microenvironments (ECM), Engineering cancer microenvironments

TEXT BOOK/ REFERENCES:

1. "Developmental Biology" by Scott F. Gilbert and Michael J. F. Barresi (Sinauer Associates, Inc., 2016).
2. "Principles of Development" by Lewis Wolpert, Cheryll Tickle, and Alfonso Martinez Arias (Oxford University Press, 2015).
3. "Essential Developmental Biology" by Jonathan M. W. Slack (Wiley-Blackwell, 2012).
4. "From Egg to Embryo: Regional Specification in Early Development" by Rosa Beddington (Cambridge University Press, 1996).
5. "The Embryo: Normal and Abnormal Development and Growth" by Ronan O' Rahilly and Fabiola Muller (Wiley-Liss, 2001).
6. "Developmental Biology" by Carlos A. F. De Souza and Anna Lucia M. M. Junqueira (Springer, 2015).
7. "Developmental Biology: A Very Short Introduction" by Lewis Wolpert (Oxford University Press, 2011).
8. "Developmental Biology Protocols" edited by Rocky S. Tuan and Cecilia W. Lo (Humana Press, 2000).
9. Cell biology, Genetics, Molecular biology, evolution and ecology, Minkoff, E. C. (2083). Evolutionary biology. Reading, MA: Addison- Wesley Publishing Company.
10. Sober, E. (2004). Conceptual issues in evolutionary biology. Cambridge, MA:MIT Press.

11. Fundamentals of ecology by Eugene Odum, Cengage; 5 edition (2005).
12. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
13. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013).

EXPERIMENTS

1. Blastoderm mounting in chick embryo.
2. Slides of different stages of chick embryo-18 hours [primitive streak stage], 24 hours, 48 hours 72 hours and 96 hours.
3. Study of the developmental stages and life cycle of *Drosophila* from stock culture.
4. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages).
5. Examination of gametes from frog/rat sperm and ova through permanent slides or photomicrographs.
6. Immunohistochemical staining to study the expression pattern of gap and pair rule gene proteins.
7. Study of different types of placenta.

REFERENCES

1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press.
3. Carlson, R. F. Patten's Foundations of Embryology.
4. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers.
5. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press.

SEMESTER	IV					
YEAR	II					
COURSE CODE	22GS2403					
TITLE OF THE COURSE	QUANTITATIVE GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To help students understand the forces that have an impact on levels of genetic variations in natural and/or experimental populations for both qualitative and quantitative traits. - To familiarize students with the principles and applications of different statistical methods used in biological research. - To impart knowledge about detecting variations at the genetic level.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will get in basic knowledge about population genetics and association mapping.	L1
CO2	Enable to obtain in depth knowledge about the principles and applications of various statistical tools used in research.	L2
CO3	Students will learn about the basic principles involved in variations at a genetic level.	L3
CO4	Students will be equipped with functional knowledge about identification of diseased gene/locus for various diseases.	L2

COURSE CONTENT:	
MODULE 1	7 Hrs
INTRODUCTION AND HISTORICAL BACKGROUND Multiple factor hypothesis, Qualitative and quantitative characters; Analysis of continuous variation mean, range, SD, CV; Components of variation- Phenotypic, Genotypic; Nature of gene action- additive, dominance and epistatic, linkage effect; Principles of analysis of variance and linear model, Expected variance components, Random and fixed effect model, Comparison of means and variances for significance.	
MODULE 2	8 Hrs
DESIGNS FOR PLANT BREEDING EXPERIMENTS: Designs for plant breeding experiments- principles and applications; Variability parameters, the concept of selection; simultaneous selection modes and selection of parents, MANOVA; Association analysis- Genotypic and phenotypic correlation; Path analysis; Discriminate function and principal component analysis, Genetic divergence analysis- Metroglyph and D2; Generation mean analysis; Parent progeny regression analysis; Mating designs- classification, Diallel, partial diallel; L × T; NCDs;	

and TTC; Concept of combining ability and gene action; $G \times E$ interaction-Adaptability and stability.	
MODULE 3	7 Hrs
METHODS AND MODELS FOR STABILITY ANALYSIS: Basic models- principles and interpretation, Bi-plot analysis; QTL mapping, Strategies for QTL mapping- Desired population and statistical methods, QTL mapping in genetic analysis; Markers, Marker-assisted selection and factors influencing the MAS; Simultaneous selection based on marker and phenotype.	
MODULE 4	8 Hrs
VARIABILITY PARAMETERS: Analysis and interpretation of Index score and Metroglyph; Clustering and interpretation of D2 analysis; Genotypic and phenotypic correlation analysis and interpretation; Path coefficient analysis and interpretation; Estimation of different types of heterosis, inbreeding depression and interpretation; A, B, and C Scaling test; $L \times T$ analysis and interpretation; QTL analysis; Use of computer packages; Diallel analysis; $G \times E$ interaction and stability analysis.	

TEXT BOOKS/REFERANCES:

1. "Introduction to Quantitative Genetics" by D. S. Falconer and T. F. C. Mackay
2. "Statistical Genetics of Quantitative Traits: Linkage, Maps and QTL" by Rongling Wu and George Casella
3. "Quantitative Genetics in the Wild" by Anne Charmantier and Dany Garant

SEMESTER	IV					
YEAR	II					
COURSE CODE	22BS2401					
TITLE OF THE COURSE	BIOSAFETY AND GOOD LABORATORY PRACTICE					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To introduce the students to the concepts of biosafety regulatory frameworks concerning genetically modified organisms at national and international levels.
- To impart knowledge of the principles of GLP and their practical applications.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Gain knowledge of the various safety procedures to be followed in laboratory.	L2
CO2	Gain the skills and knowledge necessary to understand and work in GLP compliant environment.	L2
CO3	This course should generate interest for avenues for pursuing higher studies and careers in these areas	L2

MODULE I	18 Hrs
BIOSAFETY: Introduction, Historical Background; risk assessment and lab acquired infections, Introduction to Biological Safety Cabinets& their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms. Recommended Biosafety Levels for Infectious Agents and Infected Animals. Biosafety Guidelines: Biosafety guidelines and regulations (National and International); Definition of GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Recombinant DNA Guidelines (1990); Rules for the manufacture, use/import/export and storage of hazardous microorganisms/ genetically engineered organisms or cells (Ministry of Environment and Forests Notification, 1989); Environmental release of GMOs; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.	

MODULE II	12 Hrs
GOOD LABORATORY PRACTICE: Introduction to GLP, WHO guidelines on GLP, History, Scope (Resources Characterization, Rules, Results, Quality assurance); Levels of Laboratories; General Rules/Protocols for Lab Safety measures; Precaution and Safety in handling of chemicals,	

Laboratory tools, glasswares and instruments; Sample storage and disposal; Log Book maintenance, Basic SOPs for instrument handling and Maintenance. Keeping data records, its analysis by using statistical and mathematical tools. Result analysis and its interpretation. GLP as given by OECD, FDA etc (International perspective); Internal and External Audits.

REFERENCES:

- Handbook Good Laboratory Practices-World health organization(WHO)
- Life science protocol manual (2018)-DBT star college scheme
- Guidelines for good laboratory practices-Indian council of medical research, New Delhi (2008).
- Handbook: Good Laboratory Practices (GLP): quality practices for regulated non-clinical research and development-2nd ed.

SEMESTER	V					
YEAR	III					
COURSE CODE	22GS3501					
TITLE OF THE COURSE	MICROBIAL GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To provide students with a solid foundation in microbial genetics, covering DNA structure, replication, transcription, translation, and gene regulation. - To introduce students to the concepts of mutation, mutagenesis, horizontal gene transfer, and microbial evolution. - To equip students with practical skills in recombination, genetic engineering techniques, and genomic analysis.	

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will be able to explain the molecular basis of genetic information storage, processing, and regulation in microbial organisms.	L1
CO2	Students will grasp the mechanisms underlying genetic variation, mutation repair, and the role of horizontal gene transfer in shaping microbial diversity.	L2
CO3	Students will be able to perform experiments related to cloning, gene expression analysis, and genomic comparisons, fostering an understanding of applications in biotechnology and research.	L3

COURSE CONTENT:	
MODULE 1	15Hrs
FUNDAMENTALS OF MICROBIAL GENETICS Introduction to Microbial Genetics: Definition, scope, and significance of microbial genetics. Historical overview and key discoveries. DNA Structure and Replication Molecular structure of DNA: DNA replication: enzymes, mechanisms, and fidelity. RNA Transcription and Gene Expression: Transcription initiation, elongation, and termination. Genetic code and translation process. Regulation of Gene Expression: Operons and regulatory elements in prokaryotes. Eukaryotic gene regulation: transcription factors, enhancers, and silencers.	

MODULE 2	15Hrs
GENETIC VARIATION AND MUTATION Mutagenesis and DNA Repair: Types of mutations: point mutations, insertions, deletions. Mutagenic agents and their mechanisms of action. DNA repair pathways: mismatch repair, base excision repair. Horizontal Gene Transfer: Transformation, transduction, conjugation. Mobile genetic elements: plasmids, transposons. Microbial Evolution and Adaptation: Mechanisms of microbial evolution. Adaptive radiation, speciation, and niche specialization.	
MODULE 3	15Hrs
MICROBIAL GENOMICS Genomic Analysis Techniques: Whole-genome sequencing methods and technologies. Comparative genomics and functional annotation . Bioinformatics Tools in Microbial Genetics: Sequence alignment algorithms and databases. Phylogenetics and evolutionary analysis. Applications of Microbial Genomics: Pathogenomics: understanding virulence and drug resistance. Metagenomics and ecological insights.	
MODULE 4	15Hrs
MICROBIOME Introduction to Microbiomes: Definition and significance of microbiomes, Gut Microbiome: Composition and function of the gut microbiome Skin and Oral Microbiomes: Skin microbiome: diversity and role in health, Oral microbiome and its connection to oral health. Therapeutic Applications and Future Directions: Fecal microbiota transplantation (FMT) and its use in medicine, Probiotics, prebiotics, and postbiotics.	

TEXT BOOKS/REFERENCES: 1. "Microbial Genetics" by Stanley Maloy, John Cronan, and David Freifelder. 2. "Genetics: A Conceptual Approach" by Benjamin A. Pierce. 3. "Principles of Genetics" by Snustad and Simmons. 4. "Recombinant DNA: Genes and Genomes - A Short Course" by James D. Watson. 5. "Microbial Genomics" by David W. Ussery. 6. "Introduction to Genetic Analysis" by Anthony J. F. Griffiths. 7. "Bioinformatics Algorithms: An Active Learning Approach" by Phillip Compeau and Pavel Pevzner. 8. "Microbial Evolution and Coevolution" by Joshua S. Weitz and Richard E. Lenski. 9. "Molecular Evolution: A Phylogenetic Approach" by Roderick D.M. Page and Edward C. Holmes. 10. "The Human Microbiome Handbook" by Kelly S. Bender and Jack A. Gilbert.

EXPERIMENTS

1) DNA Extraction and Gel Electrophoresis

Isolate DNA from bacterial cells and visualize its size using gel electrophoresis.

2) Polymerase Chain Reaction (PCR) and DNA Amplification

Perform PCR to amplify a specific DNA fragment using primers and a DNA polymerase.

3) Plasmid Transformation in Bacteria

Introduce a recombinant plasmid into bacterial cells and select for transformed cells.

4) Mutagenesis and Mutation Detection

Induce mutations in bacterial cultures using mutagenic agents and screen for mutant phenotypes.

6) Construction of Recombinant Plasmids

Clone a specific DNA fragment into a plasmid vector for expression or analysis.

7) Gene Expression Analysis using Reporter Assays

Measure gene expression by fusing a reporter gene (e.g., GFP) to a regulatory sequence and quantifying reporter activity.

8) Comparative Genomics and Phylogenetic Analysis

Analyze DNA sequences from different microbial species to construct phylogenetic trees and infer evolutionary relationships.

REFERENCES

1. Mullis, K. B., & Faloona, F. A. (1987). Specific synthesis of DNA in vitro via a polymerase-catalyzed chain reaction. *Methods in Enzymology*, 155, 335-350.
2. Cohen, S. N., Chang, A. C., & Hsu, L. (1972). Nonchromosomal antibiotic resistance in bacteria: Genetic transformation of *Escherichia coli* by R-factor DNA. *Proceedings of the National Academy of Sciences of the United States of America*, 69(8), 2110-2114.
3. Ames, B. N., McCann, J., & Yamasaki, E. (1975). Methods for detecting carcinogens and mutagens with the *Salmonella*/mammalian-microsome mutagenicity test. *Mutation Research/Fundamental and Molecular Mechanisms of Mutagenesis*, 31(6), 347-364.
4. Cohen, S. N., Chang, A. C., Boyer, H. W., & Helling, R. B. (1973). Construction of biologically functional bacterial plasmids in vitro. *Proceedings of the National Academy of Sciences of the United States of America*, 70(11), 3240-3244.
5. Chalfie, M., Tu, Y., Euskirchen, G., Ward, W. W., & Prasher, D. C. (1994). Green fluorescent protein as a marker for gene expression. *Science*, 263(5148), 802-805.

SEMESTER	V					
YEAR	III					
COURSE CODE	22GS3502					
TITLE OF THE COURSE	MOLECULAR GENETICS & GENOMICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	4	0	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To provide students with a comprehensive understanding of the structures and components of genes, genomes, chromosomes, and chromatin - To enable students with a Understand modern technologies used for analyzing structure and function of genes - To familiarize students with the genetic basis of human diseases and the application of molecular genetics and genomics in clinical practice.

COURSE OUTCOMES:		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to explain the basic principles and concepts of molecular genetics and genomics.	L1
CO2	Students will be able to describe the molecular mechanisms of gene expression, regulation, and transmission.	L2
CO3	Students will be able to evaluate the genetic basis of human diseases and apply molecular genetics and genomics knowledge to clinical practice.	L3

COURSE CONTENT:	
MODULE 1	15Hrs
MOLECULAR BASIS of HEREDITY: DNA as genetic material, Experiments of Griffith; Avery, Mc Cleod; Mc Carthy and Harshey Chase. RNA as genetic material- Experiment of Fraenkel and Singer. Nucleic acids: DNA structure and types, RNA types and structure, Ribozymes, DNA Replication and repair: DNA Replication in prokaryotes and eukaryotes. Mutations	
MODULE 2	15Hrs
GENOME ORGANIZATION: Prokaryotic genome:- Chromosomal and plasmid, Eukaryotic genome:- Eukaryotic nuclear genomes: Arabidopsis, rice, yeast, Drosophila, C. elegans and mouse genome. Eukaryotic organelle genomes - Chloroplast and Mitochondria. Fine structure of the Gene: Cistron, muton and recon. Gene Expression and its control: Genetic code, RNA processing, translation in prokaryotes and eukaryotes. Comparative genomics: Whole genome	

analysis, Genome sequence, molecular phylogeny, Base Composition, C-value, CpG islands, Junk DNA. Comparative genomics as an aid to gene mapping and study of human disease genes.

MODULE 3

15Hrs

ACCESSING THE GENOME:

Genomic Physical mapping: Genetic Linkage, Recombination, Map unit, Genetic marker: DNA markers RFLPs, SSLPs, SNPs., Restriction mapping. Strategies for Sequencing Genomes: Genomic Libraries, From shot gun sequencing to NGS. Interpreting a genome sequence. Human Genome Project: History, organization and goals of human genome project. Organization of human genome. RNAi-Discovery of RNA interference (RNAi): PTGS, RNAi and related phenomena. Categories of small non-coding RNAs: dsRNAs, siRNAs, shRNAs, piRNAs and miRNAs, Detection of small RNAs. Molecular basis of RNAi /siRNA /miRNA mediated gene silencing. RNAi in defense and the regulation of chromatin structure and gene expression; RNAi suppressors. Large-scale genetic analysis using RNAi.

MODULE 4

15Hrs

MOLECULAR GENETICS OF DISEASE MANIFESTATION:

Genetic and Epigenetic changes to genome. Single factorial disorders (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzheimer's Disease), Teratogens' and Congenital Malformations (Developmental Diseases), Genetic Disease Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer).

TEXT BOOK/ REFERENCES:

1. Molecular Biology of the Cell, 6th Edition by Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter (2015).
2. Principles of Genetics, 6th Edition by Robert H. Tamarin (2015).
3. An Introduction to Genetic Analysis, 11th Edition by Anthony J.F. Griffiths, Susan R. Wessler, Sean B. Carroll, and John Doebley (2015).
4. Genomes 4 by T.A. Brown (2013).
5. Genes VIII by Benjamin Lewin (2013).
6. Molecular Genetics of Bacteria, 4th Edition by Larry Snyder and Wendy Champness (2013).
7. Human Molecular Genetics, 4th Edition by Tom Strachan and Andrew P. Read (2010).
8. Plant Molecular Biology, 2nd Edition by Chris Bowler and Paul Chory (2010).
9. Epigenetics: How Environment Shapes Our Genes by Richard C. Francis (2012).
10. The Epigenetics Revolution: How Modern Biology is Rewriting Our Understanding of Genetics, Disease, and Inheritance by Nessa Carey (2013).
11. Genetics and Analysis of Quantitative Traits by Michael Lynch and Bruce Walsh (1998).
12. The Selfish Gene: 30th Anniversary Edition by Richard Dawkins (2006).

EXPERIMENTS

1. Isolation of genomic DNA from bacteria, plant and whole blood samples.
2. Electrophoresis: Agarose gel electrophoresis for genomic and PCR DNA.
3. Polymerase chain reaction (PCR): Amplification of specific DNA sequences using PCR.
4. Restriction fragment length polymorphism (RFLP): Digestion of DNA with restriction enzymes followed by gel electrophoresis to detect polymorphisms.
5. Cloning: Insertion of a DNA fragment into a vector for replication and expression in a host organism.
6. Bioinformatics analysis: Using various software tools to analyze DNA sequences, identify mutations, and predict the effects of genetic variants.
7. Comparative genomics: Comparing the genomes of different organisms to identify evolutionary relationships and functional differences (Phylogenetic tree construction).

REFERENCES

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular Biology of the Cell (6th ed.). Garland Science.
2. Griffiths, A. J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C., & Gelbart, W. M. (2000). An Introduction to Genetic Analysis (7th ed.). W. H. Freeman.
3. Hartl, D. L., & Jones, E. W. (2017). Genetics: Analysis of Genes and Genomes (9th ed.). Jones and Bartlett Publishers.
4. Weaver, R. F. (2011). Molecular Biology (5th ed.). McGraw-Hill.
5. Felsenfeld, G., & Davies, D. R. (2012). Genes, Chromosomes, and Disease: From Simple Traits to Complex Traits to Personalized Medicine (2nd ed.). Cold Spring Harbor Laboratory Press.

SEMESTER	V					
YEAR	III					
COURSE CODE	22BS3501					
TITLE OF THE COURSE	BIOETHICS AND IPR					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

To recognize, compare, and contrast the general "ways of thinking" of science (biology) and of philosophy (ethics).
To recognize, compare, and contrast the general "ways of thinking" of science (biology) and of philosophy (ethics).
To give elementary essential concepts of Bioethics, IPR and patent laws.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student should develop basic understanding of the concepts of Bioethics, IPR and Patent Laws	L2
CO2	This course should generate interest for avenues for pursuing higher studies and careers in these areas	L2
CO3	General knowledge should create awareness necessary for higher studies in biotechnological fields	L2

COURSE CONTENTS	
MODULE I	15 Hrs
BIOETHICS Bioethics- The environmental, legal and socioeconomic impacts of biotechnology; Ethical concerns of biotechnology in research and innovation-The GM crop debate – safety, ethics, perception and acceptance of GM crops; Bioethics of Genetically modified organism;Bioethics of CRISPR technique- for editing human embryos; Bioethics of Gene therapy; Bioethics of Stem cell research;Reproductive medicine and ethics;Use of Animals in Research and Testing, and Alternatives for Animals in Research,Animal Cloning, Human Cloning, and their Ethical Aspects; Public education of theprocess of biotechnology involved in generating new forms of life for informed decision-making.	

MODULE II	15 Hrs
INTELLECTUAL PROPERTY RIGHTS AND REGULATIONS	
Introduction to Intellectual Property and History. Patents, Trademarks, Copyright, Trade secrets, Industrial Design and Rights, Traditional Knowledge, Geographical Indications - importance of IPR – patentable and non-patentable – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO), Pros and Cons of IP protection. Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. Agreements and Treaties: GATT, TRIPS Agreements; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.	

REFERENCES:

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBHPublishingCo. New Delhi.
2. Ganguli Prabuddha Gearing up for Patents. The Indian Scenario” , Universities Press (1998)
3. Introduction to Plant Biotechnology, H S Chawla
4. M K Sateesh. Bioethics and Biosafety. Kindle Edition
5. Shomini Parashar, Deepa Goel IPR, Biosafety and Bioethics Pearson India 2013
6. F. H. Erbisch and K. M. Maredia. Intellectual property rights in agricultural Biotechnology, UniversityPress.
7. SivamiahShantharam, Jane F. Montgomery. Biotechnology, Biosafety and Biodiversity. Oxford & IBHPubl. New Delhi.
8. Jecker Nany S, Jones & Barlet Bioethics: An Introduction to the History Methods and Practice, NewDelhi.
9. Private Power, Public Law: The Globalization of Intellectual Property Rights By Susan
10. K. Sell Cambridge University Press, 2000.
11. Essentials of Intellectual Property: Law, Economics, and Strategy By Alexander I.
12. Poltorak; Paul J. Lerner Wiley, 2011 (2nd edition).
13. Diane O. Fleming, Debra L. Hunt Biological Safety: Principles and Practices, 4th Edition. ASM 2006.

SEMESTER	V					
YEAR	III					
COURSE CODE	22BS3502					
TITLE OF THE COURSE	BIONFORMATICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To get introduced to the basic concepts of Bioinformatics and its significance in biological data analysis. - To get an overview about biological macromolecular structures and structure prediction methods.

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Will be able to demonstrate mastery of the core concepts of bioinformatics	L1
CO2	The student will be able to apply basic principles of biology, computer science and mathematics to address complex biological problem	L2
CO3	Should be able to plan basic experiments in microbial genetics concerned with clarifying phenotypes and their relationship with the genotype	L3

COURSE CONTENT:	
MODULE 1	07Hrs
BIOLOGICAL DATA TYPES AND SOURCE: Introduction to population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Virus data bank (UICTVdb).	
MODULE 2	10Hrs
SIMILARITY SEARCHING: Global and Local sequence alignment, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs	

MODULE 3	07Hrs
INTERPRETTING the SEQUENCE: Reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank libraries, annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files.	
MODULE 4	06Hrs
SCALING THE HUMAN GENOME: UCSC genome browser, RegulomeDB database, ENCODE-ChIA-PET database, transcription factors binding sites. SNP, EST, STS. Regular Expression (REGEX), Hierarchies and Graphical models (including Markov chain and Bayes algorithm). Genetic variability and connections to clinical data.	

TEXT BOOKS/REFERENCES: 1. Bioinformatics. Keith, J. Humana Press, 2008. 2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996. 3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004. 4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003. 5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005. 6. Baxavanis (1998). Bioinformatics. 7. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford. 8. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81

SEMESTER	VI					
YEAR	III					
COURSE CODE	22GS3601					
TITLE OF THE COURSE	HUMAN GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
• To Understand the Fundamental Concepts of Human Genetics. • To Explore Molecular Genetics and Genetic Disorders • To Analyze Complex Traits, Genetic Basis of Common Diseases, and Ethical Considerations

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will be able to define and explain the scope and significance of human genetics, as well as identify key historical developments in the field.	L1
CO2	Students will be able to discuss the significance of the Human Genome Project and understand the impact of functional genomics on gene expression profiling using microarrays.	L2
CO3	Students will be able to explain gene-environment interactions and understand the mechanisms of epigenetic modifications, including DNA methylation and histone modification.	L3

COURSE CONTENT:	
MODULE 1	15Hrs
INTRODUCTION TO HUMAN GENETICS	
Overview of Human Genetics: Definition, scope, and importance of human genetics. Historical developments and key milestones. Genetic mapping of human chromosomes, mapping of genetic disease to chromosome location, multi-locus mapping of human chromosomes, physical mapping of human genome. gene structure predictions, gene ontology consortium recommendations.	
Human Genome Project and Functional Genomics: Human Genome Project overview and impact. Functional genomics: gene expression profiling and microarrays.	

MODULE 2	15Hrs
GENETIC DISORDERS Overview of genetic disorders: types and classifications: Single Gene Disorders, multifactorial disorders Polygenic Inheritance and Quantitative Traits: Polygenic traits, continuous variation, and heritability. Threshold model and multifactorial traits. Genetic Disorders Affecting Blood: Hemoglobinopathies: sickle cell disease and thalassemias. Neurogenetic Disorders: Neurological genetic disorders: Huntington's disease, amyotrophic lateral sclerosis (ALS), etc. Genetic Basis of Common Diseases: Complex diseases: diabetes, cardiovascular diseases, and cancer. GWAS and identification of susceptibility genes.	
MODULE 3	15Hrs
GENETIC COUNSELING AND PEDIGREE ANALYSIS Introduction to Genetic Counseling: Definition and importance of genetic counseling, Types of genetic counseling. Basics of Pedigree Analysis: Introduction to pedigrees as a visual tool for genetic inheritance, Standard symbols and conventions used in pedigree charts. Advanced Pedigree Analysis and Genetic Counseling: Consanguinity and its implications in pedigrees	
MODULE 4	15Hrs
REPRODUCTIVE GENETICS AND GENETIC ENGINEERING Reproductive Technologies and Prenatal Diagnosis: In vitro fertilization, preimplantation genetic diagnosis, and genetic screening. Prenatal testing methods: amniocentesis, chorionic villus sampling. Gene Therapy and CRISPR-Cas9: Principles of gene therapy and its applications. CRISPR-Cas9 technology for genome editing and potential implications. Ethical, Legal, and Social Issues in Human Genetics: Ethical dilemmas in genetic testing, privacy, and consent. Legal frameworks and societal considerations.	

TEXT BOOKS/REFERANCES: 1. "Human Genetics: Concepts and Applications" by Ricki Lewis. 2. "Principles of Human Genetics" by D. Peter Snustad and Michael J. Simmons. 3. "Introduction to Genetic Analysis" by Anthony J.F. Griffiths, Susan R. Wessler, et al. 4. "Human Molecular Genetics" by Tom Strachan and Andrew P. Read. 5. "Medical Genetics" by Lynn B. Jorde, John C. Carey, Michael J. Bamshad. 6. "Genetics: Analysis and Principles" by Robert J. Brooker. 7. "Genes VIII" by Benjamin Lewin. 8. "Genetics in Medicine" by Thompson & Thompson. 9. "Genetic Disorders and the Fetus: Diagnosis, Prevention, and Treatment" by Aubrey Milunsky and Jeff M. Milunsky. 10. "Essentials of Medical Genetics for Health Professionals" by Laura M. Gunder McClary.

List of Laboratory/Practical Experiments	
1) Karyotyping and Chromosomal Aberrations	Prepare karyotypes from human cell samples and identify chromosomal abnormalities.
2) Pedigree Analysis and Genetic Counseling	Analyze pedigrees to trace inheritance patterns and assess the risk of genetic diseases.
3) Mendelian Genetics Simulation	Use simulation software to explore Mendelian inheritance patterns and generate offspring based on genetic traits.
4) Calculating Hardy-Weinberg Equilibrium	Use allele frequencies to calculate expected genotype frequencies and test for Hardy-Weinberg equilibrium.
5) Genetic Diversity Analysis using DNA Sequences	Analyze DNA sequences from different individuals to calculate genetic diversity indices and construct phylogenetic trees.
6) Quantitative Trait Analysis using Statistical Tools	Analyze quantitative traits in a population using statistical tools to estimate heritability and assess the contribution of genetics.
7) Prenatal Diagnosis Techniques	Explore non-invasive prenatal testing methods such as amniocentesis and chorionic villus sampling to detect chromosomal abnormalities.

REFERENCES

1. Rooney, D. E., & Czepulkowski, B. H. (Eds.). (2001). "Human Cytogenetics: Constitutional Analysis." Oxford University Press.
2. Nathaniel, T. I., & Lewis, C. (2013). "Genetic Counseling Practice: Advanced Concepts and Skills." Wiley-Blackwell.
3. Virtual Genetics Education Centre (VGEC). (www.virtualgenetics.org)
4. Hartl, D. L., & Clark, A. G. (2006). "Principles of Population Genetics." Sinauer Associates.
5. Nei, M., & Kumar, S. (2000). "Molecular Evolution and Phylogenetics." Oxford University Press.
6. Lynch, M., & Walsh, B. (1998). "Genetics and Analysis of Quantitative Traits." Sinauer Associates.
7. DeCherney, A. H., Nathan, L., Laufer, N., Roman, A. S. (Eds.). (2019). "Current Diagnosis & Treatment: Obstetrics & Gynecology." McGraw-Hill Education.

SEMESTER	VI					
YEAR	III					
COURSE CODE	22GS3602					
TITLE OF THE COURSE	POPULATION GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	4	0	60	6

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To explain the core concepts of population genetics, including allele and genotype frequencies, the Hardy-Weinberg equilibrium, and the impact of microevolutionary forces on genetic variation within populations.
- To provide students with a detailed understanding for applying molecular markers and statistical techniques to assess genetic diversity, determine genetic differentiation among populations, and interpret population structure using real-world data.

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to define key terms in population genetics, such as gene pool, allele frequency, and genetic drift. Explain the fundamental principles of the Hardy-Weinberg equilibrium and its assumptions	L2
CO2	Students will be able to analyze genetic diversity within populations by interpreting molecular marker data. Apply statistical methods to assess genetic differentiation and infer population structure based on empirical datasets.	L3
CO3	Students will be able to evaluate the impact of evolutionary forces like selection and genetic drift on population dynamics. Synthesize molecular evolution concepts to interpret evolutionary relationships, divergence times, and molecular adaptations.	L4
CO4	Students will be able to design and present a research project that applies population genetics principles to address a real-world question or issue. Reflect on the ethical considerations and practical implications of using population genetics in diverse contexts such as medicine, conservation, and forensics.	L5

COURSE CONTENT:	
MODULE 1	15Hrs
INTRODUCTION TO POPULATION GENETICS: Definition and scope of population genetics, Key concepts: gene pool, allele frequency, genotype frequency, Historical development and significance. Genetic drift: definition, types, and effects, Gene flow: impact on genetic diversity. Mutation: role in generating genetic variation. Natural selection: mechanisms and outcomes. Polygenic traits vs. Mendelian traits. Heritability and its estimation. Phenotypic variation: genetic vs. environmental components. Response to selection and selective breeding. Linkage and Linkage Disequilibrium; Haplotype frequency estimation with unphased genotypes; genetic association and multiple testing corrections.	
MODULE 2	15Hrs
GENETIC VARIATION AND EVOLUTION: DNA sequence variation: SNPs, indels, and CNVs, Molecular markers in population genetics (microsatellites, SNPs). Applications of molecular markers in studying genetic diversity. Population subdivision and its causes. FST and related indices for measuring genetic differentiation. Genetic structure analysis: clustering methods, Principal Component Analysis (PCA). Molecular clocks and their applications. Molecular phylogenetics and constructing phylogenetic trees. Examples of rapid evolution in response to environmental changes. Evolutionary arms race and coevolution. Human evolution: insights from population genetics.	
MODULE 3	15Hrs
APPLIED POPULATION GENETICS: Genetic diversity and conservation of endangered species. Minimum Viable Population (MVP) and effective population size (N_e). Inbreeding depression and its management. Studying ecological interactions using genetic data. Landscape genetics and gene flow patterns. Identifying source populations and migration routes. Genetic basis of diseases and their prevalence in populations. Genome-wide association studies (GWAS) and identifying disease-associated variants. Personalized medicine and its ethical considerations. Human genetic diversity and migration patterns. Genetic admixture and its implications. Population genetics and forensic applications.	
MODULE 4	15Hrs
ADVANCED TOPICS IN POPULATION GENETICS: Coalescent theory: concepts and applications. Coalescent simulations and their significance. Molecular clock and coalescent-based dating methods. Positive selection and detecting adaptive evolution. Molecular basis of adaptation in specific organisms. Evolution of gene families and functional divergence. Comparative genomics and studying genome evolution. Horizontal gene transfer and its impact on genomes. Evolution of non-coding DNA and regulatory elements. Emerging techniques in population genetics: Next-generation sequencing and its applications in population genetics. Single-cell genomics and its potential insights.	

TEXT BOOK/ REFERENCES:

1. "Principles of Population Genetics" by Daniel L. Hartl and Andrew G. Clark.
2. "Population Genetics: A Concise Guide" by John H. GillespieCarlson, R. F. Patten's Foundations of Embryology.
3. "Population Genetics and Microevolutionary Theory" by Alan R. Templeton.
4. "An Introduction to Population Genetics Theory" by James F. Crow and Motoo Kimura

EXPERIMENTS

1. Hardy-Weinberg equilibrium simulation.
2. Microsatellite analysis for genetic diversity.
3. Genetic drift simulation with populations of different sizes.
4. SNP genotyping and population structure analysis.
5. Molecular clock estimation.
6. GWAS analysis using computational tools.

REFERENCES:

1. "Population Genetics: A Laboratory Guide" by David L. Duffy (Wiley)
2. "Population Genetics: A Concise Guide" by John H. Gillespie (Johns Hopkins University Press)
3. "Principles of Population Genetics" by Daniel L. Hartl and Andrew G. Clark (Sinauer Associates)
4. "Molecular Population Genetics" by Matthew W. Hahn (Sinauer Associates)

SEMESTER	VI					
YEAR	III					
COURSE CODE	22BS3601					
TITLE OF THE COURSE	PRINCIPLES OF ‘MULTI-OMICS’					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To acquaint students with various aspects of biotechnology and bio-engineering using omics technologies - To provide key insights into omics approaches in personalized and precision medicine

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will have knowledge in specific methods used in genomics, proteomics and metabolomics used in analytical processes.	L1
CO2	Students will be able to perform statistical analysis crucial for interpretation of experimental results	L2
CO3	Students will be able to apply specialized research methods necessary for the analysis of proteins, genes and metabolites	L3

COURSE CONTENT:	
MODULE 1	07 Hrs
GENOME & GENOMICS: Genome mapping: Physical and Genetic Map, Genome Sequencing, Next generation sequencing methods ,Genome Annotation, Functional Genomics	
MODULE 2	07 Hrs
TRANSCRIPTOMICS: Search for transcription factor binding sites,RNA-Seq, Microarrays, Regulatory RNAs: small or large, Computational prediction of miRNA target genes, RNA Darkmatter	

MODULE 3 PROTEOMICS AND METABOLOMICS	07Hrs
Basic concepts , Tools of proteomics- SDS PAGE, 2D PAGE , Liquid chromatography , Mass Spectrometry (ESI and MALDI) ,Protein identification by peptide mass fingerprinting ,Applications of proteomics. Fundamental concept, Tools of metabolomics- Capillary electrophoresis, Gas chromatography, Electrochemical detectors, Case studies.	
MODULE 4 ‘OMICS’: APPLICATIONS AND FUTURE PERSPECTIVES	06Hrs
Multi-omics in disease prediction and health. Multi-omics technologies for crop improvement and sustainable agriculture. Applications in Biomedical and Environmental sciences	

TEXT BOOKS/REFERANCES:
1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Introduction to Proteomics -Tools for the New Biology by Daniel C. Liebler, Humana Press..
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Metabolomics- Methods and Protocols by Wolfram Weckwerth, Humana Press.
7. Fry, J.C. (2093). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Transcriptomics: Expression Pattern Analysis, Virendra Gomase, Somnath Tagore; VDM Publishing, 2009 – Science

SEMESTER	VI					
YEAR	III					
COURSE CODE	22BS3602					
TITLE OF THE COURSE	TOXICOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

1. To learn various toxicants present and their exposure level on day-to-day basis.
2. To study the effects of toxins on the physiologic, metabolic, reproductive, and developmental processes.

COURSE OUTCOMES

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will learn and understand all substances can be toxic depending on the means and level of exposure	L1
CO2	Students will learn the basic concepts of cellular toxicity and chemical actions on cells and body organs	L2
CO3	Students will learn the importance and diversity of drug interactions with various organs	L3

COURSE CONTENT:

MODULE 1	10 Hrs
INTRODUCTION OF TOXICOLOGY: Classification of toxic agents, natural toxins, animal toxins, plant toxins, food toxins, genetic poisons and chemical toxins. Factors affecting toxicity – species and strain, age, sex, nutritional status, hormones, environmental factors, circadian rhythms. Toxicant proceeding <i>in vivo</i> : Absorption, Distribution, Excretion and Metabolism of foreign/toxic compounds.	
MODULE II	5 Hrs
ENVIRONMENTAL TOXICOLOGY: Environmental pollution- Sources and types of pollution, Important pollution events, Priority pollutants. Air pollution- Classification and properties of air pollutants, Behaviour and fate of air pollutants, Photochemical smog, Acid Rain, health effects of air pollution. Water pollution- origin of Wastewater, Domestic Water Pollution, Industrial water pollution, Agricultural water pollution, Toxic water pollutants and their health effects, Groundwater pollution, marine pollution	

MODULE III	5 Hrs
INDUSTRIAL TOXICOLOGY:	
Industrial Chemicals: Government Regulation of Chemicals , Ways of exposure, Toxic effects, Long-term consequences and developmental toxicity. Food Additives and Contaminants types of food additives, Preservatives, Saccharin. Toxicity of trace elements- Iodine, iron, zinc, copper, manganese, selenium, molybdenum, and cobalt Cyto-toxicity of heavy metals- Cadmium, mercury, arsenic, chromium and lead. Brief introduction to toxicity of pesticides and insecticides.	
MODULE - IV –	10 Hrs
ORGAN TOXICOLOGY:	
Basics of organ toxicity- Target organs, Organ selectivity and specificity, gender specific diversity of toxins. Hepatotoxicity - Actions of toxins on the liver, Chronic liver injury; Cardiotoxicity - pathology of cardiac toxicity, mechanisms of cardiotoxicity; Respiratory Toxicity - Systemic lung toxins, Lung pathology; Reproductive System – Teratogenicity; Neurotoxicity- Effect of toxic agents on neurons, Ion channel neurotoxins and Nephrotoxicity- susceptibility of kidney to toxic insult, chemically induced renal injury.	

Reference books:

1. Whalen, Finkel, and Panavelil, Pharmacology, 6th ed. (Lippincott Williams & Wilkins: 2015).
2. Lieberman and Peet, Mark's Basic Medical Biochemistry: A Clinical Approach, 5th ed. (Wolters Kluwer: 2018).
3. Hodgson, A Textbook of Modern Toxicology, 4th ed. (J Wiley & Sons: 2010).
4. Molecular and Biochemical Toxicology, 4th ed., Smart and Hodgson, eds. (J Wiley & Sons: 2008).
5. Frank and Ottoboni, The Dose makes the Poison: A Plain-language Guide to Toxicology, 3rd ed. eBook, (J Wiley & Sons: 2011).
6. Ottoboni, The Dose makes the Poison: A Plain-language Guide to Toxicology, 2nd ed., (J Wiley & Sons: 1997).
7. A-Z Guide to Drug-Herb-Vitamin Interactions, 2nd ed., Gaby, Batz, Chester and Constantine, eds. (Three Rivers Press: 2006).
8. Gilbert, A Small Dose of Toxicology: The health effects of common chemicals, (CRC Press: 2004).
9. Gibson, Multiple Chemical Sensitivities: A survival guide, (New Harbinger Publications: 2000).
10. Toxicology and Clinical Pharmacology of Herbal Products, Cupp and Karch, eds. (Springer-Verlag: 2000).
11. Lawson, Staying Well in a Toxic World, (Lynwood Press: 2000).

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22GS4701					
TITLE OF THE COURSE	ANIMAL GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
• To Develop a Comprehensive Understanding of Animal Genetics Fundamentals • To Explore Molecular Genetics and Genetic Improvement Strategies • To Explore Reproductive Genetics, Biotechnology, and Ethical Considerations

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will be able to apply the principles of Mendelian inheritance to animals, including the understanding of dominance, segregation, and independent assortment.	L1
CO2	Students will be able to explain the use of molecular markers for trait mapping and selection in animal breeding.	L2
CO3	Students will be introduced to the concept of transgenic animals and gene editing technologies, particularly CRISPR-Cas9, in animal genetics. They will also understand the ethical and regulatory aspects surrounding gene editing.	L3

COURSE CONTENT:	
MODULE 1	15Hrs
FUNDAMENTALS OF ANIMAL GENETICS Introduction to Animal Genetics: Definition, scope, and importance of animal genetics. Historical developments and key contributors. Basic genetic concepts relevant to animal breeding. Mendelian Inheritance in Animals: Mendel's laws of inheritance and their application in animals. Patterns of inheritance: dominance, segregation, and independent assortment. Pedigree analysis and its significance in animal breeding. Genetic Variation and Population Genetics: Sources of genetic variation in animal populations. Hardy-Weinberg equilibrium and its application to animal populations. Factors influencing genetic diversity and allele frequencies. Quantitative Genetics and Selection: Introduction to quantitative traits and heritability. Principles of selection: genetic gain, response to selection, and selection methods. Breeding value estimation and selection indexes.	

MODULE 2	15Hrs
MOLECULAR GENETICS AND GENETIC IMPROVEMENT Genome Structure and Function: Chromosomal structure and organization in animals. DNA replication, transcription, and translation. Genetic code and gene expression regulation. Marker-Assisted Selection and Genomic Selection: Use of molecular markers for trait mapping and selection. Introduction to genomic selection and its advantages. Case studies of successful genomic selection programs in animal breeding. Genetic Disorders and Genetic Improvement: Identification and management of genetic disorders in animal populations. Strategies for reducing the incidence of genetic disorders through breeding. Genetic improvement programs for disease resistance and production traits.	
MODULE 3	15Hrs
REPRODUCTIVE GENETICS AND BIOTECHNOLOGY Reproductive Technologies in Animal Breeding: Artificial insemination, embryo transfer, and in vitro fertilization. Cloning, its applications, and ethical considerations. Challenges and opportunities in using reproductive technologies. Transgenic Animals and Gene Editing: Introduction to transgenic animals and their applications. Overview of gene editing technologies (CRISPR-Cas9) in animals. Ethical and regulatory aspects of gene editing. Genetic Diversity Conservation: Importance of conserving genetic diversity in livestock and endangered species. Role of cryopreservation, gene banks, and assisted reproductive technologies. Case studies of successful genetic diversity conservation efforts.	
MODULE 4	15Hrs
APPLIED ANIMAL BREEDING AND ETHICAL CONSIDERATIONS Breeding Objectives and Strategies: Defining breeding objectives for different animal production systems. Strategies for balanced selection of multiple traits. Considerations for optimizing breeding goals. Breeding Programs and Genetic Evaluation: Design and implementation of breeding programs. Genetic evaluation methods: BLUP, GEBVs, and genetic trends. Challenges in incorporating molecular and genomic information. Ethical and Societal Aspects of Animal Genetics: Ethical considerations in animal breeding and biotechnology. Public perception, animal welfare, and environmental concerns. Regulatory frameworks and responsible use of genetic technologies.	

TEXT BOOKS/REFERANCES:

1. B. D. Singh. (2006). "Introduction to Animal Genetics and Breeding."
2. F. Nicholas. (2001). "Introduction to Veterinary Genetics."
3. T. A. Brown. (2017). "Gene Cloning and DNA Analysis: An Introduction."
4. J. F. Medrano, H. T. Reinschmidt, and J. E. Womack. (2019). "Genetics for Animal Scientists."
5. R. Fries and A. Ruvinsky. (2011). "The Genetics of Cattle."
6. D. P. Sponenberg and A. C. Kennedy. (2013). "Sheep and Goat Medicine."
7. W. G. Hill. (2010). "Understanding Animal Breeding."
8. D. R. Notter. (2017). "The Genetics of Sheep."
9. M. F. Rothschild and A. Ruvinsky. (2010). "The Genetics of Pigs."
10. H. M. S. Gregory. (2019). "Genetics: The Continuity of Life."

EXPERIMENTS	
1) Phenotype Observation and Mendelian Traits	Observe phenotypic traits in a population of animals and determine if they follow Mendelian inheritance patterns.
2) Allele Frequencies and Hardy-Weinberg Equilibrium	Collect data on specific phenotypic traits, calculate allele frequencies, and determine if the population is in Hardy-Weinberg equilibrium.
3) Heritability Estimation Using Parent-Offspring Data	Collect data on a quantitative trait from parents and their offspring, and estimate heritability using the parent-offspring regression.
4) Punnett Square and Monohybrid Cross	Perform a monohybrid cross between two animals with known genotypes and predict the phenotypic ratio using Punnett squares.
5) Gel Electrophoresis for Molecular Markers	Use gel electrophoresis to visualize PCR-amplified DNA fragments and identify genetic variations.
6) Observation of Drosophila Eye Color Mutations	Observe different eye color mutations in Drosophila melanogaster and understand the genetic basis of the variations.
7) Simulation of Genetic Drift Using Beanbags	Simulate genetic drift in a small population using beanbags as "alleles" and observe how allele frequencies change over generations.

REFERENCES 1. Hartl, D. L., & Jones, E. W. (2005). "Genetics: Analysis of Genes and Genomes." 2. Freeman, S., & Herron, J. C. (2007). "Evolutionary Analysis." 3. Falconer, D. S., & Mackay, T. F. (1996). "Introduction to Quantitative Genetics." 4. Snustad, D. P., & Simmons, M. J. (2015). "Principles of Genetics." 5. Brown, T. A. (2017). "Gene Cloning and DNA Analysis: An Introduction." 6. Miko, I. (2008). "Mendel and the Laws of Genetics." 7. Smith, J. M. (1989). "Evolutionary Genetics."

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22GS4702					
TITLE OF THE COURSE	PLANT GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	4	0	60	6

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To comprehend fundamental genetic concepts in plants, including Mendelian inheritance, chromosome structure, and gene expression.
- To evaluate various plant breeding and biotechnology approaches to enhance plant traits and productivity.

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to apply molecular techniques learned in the course, such as DNA extraction, PCR, and gel electrophoresis, to analyze plant genetic material and trait inheritance patterns.	L3
CO2	Students will be able to evaluate the benefits and limitations of different plant breeding strategies, including classical breeding and biotechnology approaches. Synthesize information to propose innovative genetic improvement strategies for specific plant traits.	L4
CO3	Students will be able to design and present a hypothetical plant breeding project that addresses a real-world agricultural challenge, incorporating genetic principles and biotechnological methods. Reflect on the ethical considerations and societal implications of using genetic modification in plant agriculture.	L5

COURSE CONTENT:

MODULE 1	15Hrs
INTRODUCTION TO PLANT SYSTEMS: Plant Systems: Biochemical and molecular basis of Growth and differentiation: Concept of growth and differentiation vs. morphogenesis; Site and cell types involved in growth and differentiation. Kinematics of growth, Spatial and material basis of growth, mechanism of differentiation. Genetic basis: Identity of a gene that control development in Arabidopsis; three stages of development from embryo, axial pattern, apical basal pattern, radial pattern and requirement of gene expression for the development of the above structure in Arabidopsis. The role of homeobox genes.	

MODULE 2	15Hrs
PLANT TISSUE CULTURE AND SOMATIC CELL GENETICS: Organogenesis and Somatic embryogenesis; Endosperm culture and triploid production; Anther and pollen culture, production of haploid and doubled haploid plants; Protoplast culture and fusion, Somatic hybrids; Organelle transfer and cybrids; Micropropagation, artificial seed and bioreactor technology, Virus-free plants by meristem culture; Use of somaclonal and gametoclonal variation for crop improvement; In vitro mutagenesis and mutant selection; Preservation of plant germ plasm in-vitro.	
MODULE 3	15Hrs
PLANT TRANSFORMATION VECTORS AND METHODS: Plant transformation vectors - T-DNA and viral vectors, direct gene transfer vectors; Selectable marker and reporter genes, Plant transformation by Agrobacterium sp., non-Agrobacterium sp., and in planta transformation, c) Molecular mechanism of T-DNA transfer; Direct gene transfer methods in plants - Gene gun and other methods; Chloroplast transformation; Transgene analysis, silencing and targeting; Marker-free and novel selection strategies, Multigene engineering; Gene tagging; Gene knock-down by ribozymes, antisense RNA and RNA interference. Comparative genomics and cloning, positional cloning	
MODULE 4	15Hrs
APPLICATIONS OF PLANT TRANSGENIC TECHNOLOGY: Transgenic crops for resistance against biotic and abiotic stresses; Engineering crops for male sterility and modification of flower colour, flowering, fruit ripening and senescence, GM crops for nutritional quality and quantity; RNAi-mediated crop improvement; Molecular pharming; Metabolic engineering and hairy root culture for secondary plant products; Global status and biosafety of transgenic plants.	

TEXT BOOK/ REFERENCES:

1. "Plant Biotechnology and Genetics: Principles, Techniques, and Applications" by C. Neal Stewart Jr.
2. "Plant Genes, Genomes and Genetics" by Erich Grotewold (Editor).
3. "Molecular Plant Breeding" by Yunbi Xu, Hongwei Cai (Editors)
4. "Genetics, Genomics, and Breeding of Vegetable Brassicas" by Yan Long, Guusje Bonnema (Editors)

EXPERIMENTS
1. Mendelian genetics and trait inheritance.
2. Genetic mapping with linkage and recombination.
3. Nucleic acids extraction and gel electrophoresis.
4. Extract chloroplast DNA from plant sources.
5. Amplify and sequence a specific plant gene.
6. Introduce foreign DNA into plant cells through transformation.

REFERENCES:
1. "Plant Genotyping: The DNA Fingerprinting of Plants" by Robert J. Henry
2. "Experiments in Plant Tissue Culture" by Dennis W. Gray
3. "Plant Genomics and Proteomics" by Christopher A. Cullis
4. "Plant Genetic Transformation and Gene Expression: A Laboratory Manual" by Peter M. Gresshoff.
5. "Molecular Biology Techniques in Plant Science" by John M. Walker and Ralph Rapley

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22GS4703					
TITLE OF THE COURSE	BEHAVIORAL GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	4	0	60	6

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To comprehend the complex relationship between genetic factors and behavioral traits, including the influence of genes, environmental factors, and gene-environment interactions.
- To critically evaluate the ethical considerations and societal implications of studying behavioral genetics, including the responsible use of genetic information and the potential for stigmatization.
- To analyze the role of genetics in the development of behavioral disorders, understanding how genetic variations contribute to conditions such as schizophrenia, depression, and ADHD.

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to apply knowledge of genetic and environmental influences to analyze specific behavioral traits and disorders. Analyze twin and adoption studies to estimate heritability and environmental influences on behavior.	L3
CO2	Students will be able to evaluate the genetic basis of complex behaviors such as intelligence and cognitive abilities. Synthesize information from evolutionary psychology and animal behavior to explain the adaptive significance of behaviors.	L4
CO3	Students will be able to design an ethical framework for using genetic information in educational and societal contexts. Reflect on the potential ethical dilemmas and social consequences of genetic testing for behavioral traits.	L5

COURSE CONTENT:

MODULE 1	15Hrs
INTRODUCTION TO BEHAVIORAL GENETICS: Definition and scope of behavioral genetics. Historical development and significance of the field. Nature vs. nurture debate. Genetics Basics for Behavioral Traits: Genes, alleles, and heritability. Identifying hereditary patterns. Gene-environment interactions. Twin and Family Studies: Twin studies: monozygotic vs. dizygotic twins. Family studies and heritability estimation. Limitations and interpretation of twin and family studies. Adoption studies and their insights. Combining adoption and	

twin studies to tease out genetic and environmental effects. <i>Drosophila</i> : genetics meets behaviour	
MODULE 2	15Hrs
BRAIN AND BEHAVIOR: Approaches and methods in study of behavior; Proximate and ultimate causation; Development of behavior; Social communication; Habitat selection, Social dominance, Mating systems, Parental investment and Reproductive success; Aggressive behavior, Migration, orientation and navigation, Photo-periodism, Circadian Rhythm– Sleep and arousal. Neural basis of Complex Behaviors: Learning, memory, Emotions, Stress and Adaptation, Altruism and evolution. , Identifying genes for controlling behavior, induced mutations, Quantitative trait loci, Synteny/orthology, Investigating the genetics of human behaviour, Twin and adoption study designs, interpreting heritability.	
MODULE 3	15Hrs
MOLECULAR AND EVOLUTIONARY ASPECTS: Molecular Mechanisms in Behavioral Genetics: Role of genes and proteins in neural development. Epigenetics and its influence on behavior. Evolutionary Psychology, Evolutionary explanations for human behaviors. Genetic basis of mating preferences, aggression, and altruism. Animal Behavior and Genetics: Genetic basis of animal behaviors: mating, parenting, social interactions. Comparing behavioral genetics across species. Genes, Environment, and Complex Traits: Genetic and environmental influences on complex behaviors. Gene-environment correlation and interaction. Genetic Counseling and Behavior: Role of genetic counseling in behavior-related issues. Discuss ethical considerations in genetic counseling.	
MODULE 4	15Hrs
GENETICS OF PSYCHIATRIC DISEASES: Neurodegenerative and Neurochemical Disorders Ageing Brain - Senile dementia - Dementia of Alzheimer's Type, Parkinson's disease, Reperfusion –Seizures and Epilepsy – Autism - Diseases involving myelin, Multiple Sclerosis. Chemical imbalances of the Brain: Personality Disorders - Anxiety disorders - Disorders of Mood, depression, bipolar disorder - Pharmacology of neuroleptics, anxiolytics, antidepressants – Disorders of thought - Schizophrenia, Pharmacology of antipsychotics, Narcotics and Addiction.	

TEXT BOOK/ REFERENCES: 1. "Behavioral Genetics" by Robert Plomin, John C. DeFries, Valerie S. Knopik, and Jenae M. Neiderhiser. 2. "Genetics of Psychological Well-Being: The Role of Heritability and Genetics in Positive Psychology" by Michael Pluess and Brendan M. Rooney. 3. "Genes, Behavior, and the Social Environment: Moving Beyond the Nature/Nurture Debate" by Institute of Medicine (U.S.) and Board on Health Sciences Policy.

4. "Genetic and Environmental Influences on Human Behavioral Differences" by Thomas J. Bouchard Jr. and Matt McGue.
5. "Evolutionary Behavioral Genetics" by David T. Lykken.
6. "The Genetics of Behavior" by John L. Fuller and Elizabeth C. Fullerton.

EXPERIMENTS

1. Aversive Phototaxis Suppression Assay using adult *Drosophila*
2. Larval Crawling Assay using *Drosophila* third instar larvae
3. Courtship and Mating Assay
4. Rapid Iterative Negative Geotaxis
5. Case studies on genetics of addiction.

TEXT BOOK/ REFERENCES:

1. Laboratory Exercises in Developmental Biology by William C. Gibson
2. Behavioral Genetics: A Practical Approach by Robert Plomin, John C. DeFries, Valerie S. Knopik, and Jenae M. Neiderhiser
3. Methods in Behavioral Research by Paul C. Cozby and Scott C. Bates
4. Methods for Behavioral Research: A Systematic Approach by Paul D. Cherulnik
5. Animal Behavior: Concepts, Methods, and Applications by Michael D. Breed and Janice Moore

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22BS4701					
TITLE OF THE COURSE	RESEARCH METHODOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	45	3
Perquisite Courses (if any)						
#	Sem/Year	Course Code	Title of the Course			
-	-	-	-			

COURSE OBJECTIVES:
To provide an overview of essential research steps to be followed when conducting research / project work.
To understand chief ingredients to be incorporated in conduct as well as writing of scientific reports/dissertation/thesis
To know the implication professional research ethics and common misconduct details of researcher and research work

COURSE OUTCOME		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Show and explain the concepts of meaning of research, scope of research including different types of research, scientific research process and research methodology steps	L1
CO2	Perform review of literature using electronic media, selecting research problem formulate research problem statement, writing hypothesis, explain criteria of forming objectives, materials and methods, results and discussion	L2
CO3	Identify and explain experimental research designs for both qualitative and quantitative research	L2
CO4	Explain different sampling methods and sampling design, basic statistical methods for treatment of data and observations	L2
CO5	Demonstrate ingredients and components of a research report, dissertation and thesis and explain integral components of research article and research proposal	L2
CO6	Explain professional research ethics and elaborate on misconduct in research	L2

COURSE CONTENT:	
MODULE 1:	12 hrs
INTRODUCTION TO RESEARCH: Meaning, Objectives and Characteristics of research – Scientific Method Types of research - Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical - Research process - Criteria of good research PROBLEM STATEMENT: Defining the research problem - Selecting the problem - Necessity of defining the problem - Techniques involved in defining the problem; LITERATURE SURVEY: Importance of literature review in defining a problem - Survey of literature - Primary and secondary sources - web as a source - searching the web - Identifying gap areas from literature review. HYPOTHESIS: Definition of hypothesis, Basic concepts, variables-Dependent and independent variables, Development of working hypothesis; Ingredients of Research Objectives, deriving objectives of research.	
MODULE 2:	12 hrs
Sampling, Material and Methods: Sample- Sampling - Types of sampling; Material - Experiments, Data – Basics of Analysis; Writing materials and method chapter of a research report Results and Discussion: Representation of results; Tables, graphs; Discussion, Purpose and Function of Discussion Research Designs: Research design; Need of research design - Basic Principles; Features of good design – Important concepts relating to research design; Max-min-con principle, Common Research Designs: Cross-sectional, Case-control, Longitudinal and Cohort research designs, advantages and disadvantages of each of research designs Summary and Conclusion: Writing of Summary, conclusions of research findings, Acknowledgement section of a research report and an article.	
MODULE 3:	10Hrs
Research Ethics: Values, Ethics and Morals, Research Professionalism, Tenets of Ethics; Conducting and reporting of science/engineering; Relationship in research groups; Hazards to good scientific practice; Scientific misconduct: Fabrication, Falsification and Plagiarism. Report and Article Writing: Structure and components of scientific reports; Abstract-Key words; Types of reports; Significance of reporting; Different steps in the preparation of reports; Layout, structure and Language of typical reports; References; Citation styles- APA and MLA styles of citation, intext and end text citations. Oral Presentation: Importance of effective communication. Planning; Preparation; Practice; Making presentation; Use of visual aids.	
MODULE 4:	11Hrs
Scientific Article Writing: Title preparation – Importance of title; need for specific titles; List of authors and addresses – order of names; defining the order with example; types of abstracts; economy of words; How to write introduction- Rules; exceptions; citations and abbreviations Materials and methods: Purpose; materials; methods; tables and figures; form and grammar; Result and Discussion writing: content of results; handling numbers; clarity; avoiding redundancy; Discussion writing: Components of discussion; factual relationships; strengths and limitations; significance of paper; Stating Acknowledgements: Ingredients of the acknowledgements; courtesy; Citation of the References: Rules; electronics aid; in-text citation; styles of referencing Research Proposal Fundamentals: What is a grant proposal? Why proposals fail?; Developing and writing of grant proposals; overview of steps to develop grant proposals; Proposal Development Process: Standard Proposal Parts; writing Budget section.	

Intellectual Property Rights: IPRs- Invention and Creativity- Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs); A brief summary of: Patents, Copyrights, Trademarks

REFERENCES:

1. Bruce Tuckman, Brian E Harper, Conducting Educational Research, 6th Edition, 2012 by Rowman & Littlefield Publishers, Inc. ISBN 978-1-4422-0965-7 (electronic)
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
4. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
5. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
6. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
7. Day, R.A., 1992. How to Write and Publish a Scientific Paper, Cambridge University Press.
8. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
9. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.

MINOR COURSES OFFERED

SEMESTER	IV					
YEAR	II					
COURSE CODE	22GS2404					
TITLE OF THE COURSE	GENOMICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	4	0	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To go through basic and specialized knowledge and understanding the aspects of genomics and proteomics is essential to understanding Genetics and its architecture. - To take the students through foundations in genomics and disease gene mapping.

COURSE OUTCOMES:		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Student will be able to understand how genomes are organised and contemplate on the mapping of monogenic and polygenic traits.	L1
CO2	Students should be endowed with strong theoretical knowledge of genomics.	L2
CO3	In conjunction with the practical in bioinformatics, the students should be able to take up biological research as well as find placement in the relevant biotech industry.	L3

COURSE CONTENT:	
MODULE 1:	15Hrs
PROKARYOTIC AND EUKARYOTIC GENOME ORGANIZATION: Prokaryotes: Bacteria and Bacteriophages. Eukaryotic nuclear genomes: Arabidopsis, rice, yeast, Drosophila, C. elegans and mouse genome. Eukaryotic organelle genomes - Chloroplast and Mitochondria.	
MODULE 2:	15Hrs
GENOME MAPPING TECHNIQUES: Genetic mapping: Cross breeding and pedigree analysis, DNA markers – RFLPs, SSLPs, SNPs. Physical mapping: Restriction mapping, Fluorescent in situ hybridization. germination.	

MODULE 3:	15Hrs
THE HUMAN GENOME : History, organization and goals of human genome project. DNA segment nomenclature, Human genome diversity, Organization of human genome, Mitochondrial genome, Gross base composition of nuclear genome, Gene density, CpG islands, RNA-encoding genes, Functionally identical genes, Diversity in size and organization of genes.	
MODULE 4:	15Hrs
COMPARATIVE GENOMICS: Whole genome analysis, Genome sequence, micro assay, molecular phylogeny, C-value, number of genes and complexity of genomes, Conservation and diversity of genomes, Comparative genomics as an aid to gene mapping and study of human disease genes. Comparative genomics of mitochondria and chloroplast genomes.	

TEXT BOOK/ REFERENCES:

1. "Developmental Biology" by Scott F. Gilbert and Michael J. F. Barresi (Sinauer Associates, Inc., 2016).
2. "Principles of Development" by Lewis Wolpert, Cheryll Tickle, and Alfonso Martinez Arias (Oxford University Press, 2015).
3. "Essential Developmental Biology" by Jonathan M. W. Slack (Wiley-Blackwell, 2012)
4. "From Egg to Embryo: Regional Specification in Early Development" by Rosa Beddington (Cambridge University Press, 1996).
5. "The Embryo: Normal and Abnormal Development and Growth" by Ronan O' Rahilly and Fabiola Muller (Wiley-Liss, 2001).
6. "Developmental Biology" by Carlos A. F. De Souza and Anna Lucia M. M. Junqueira (Springer, 2015).
7. "Developmental Biology: A Very Short Introduction" by Lewis Wolpert (Oxford University Press, 2011).
8. "Developmental Biology Protocols" edited by Rocky S. Tuan and Cecilia W. Lo (Humana Press, 2000).
9. Cell biology, Genetics, Molecular biology, evolution and ecology, Minkoff, E. C. (2083). Evolutionary biology. Reading, MA: Addison- Wesley Publishing Company.
10. Sober, E. (2004). Conceptual issues in evolutionary biology. Cambridge, MA:MIT Press.
11. Fundamentals of ecology by Eugene Odum,Cengage; 5 edition (2005).
12. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
13. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July2013).

EXPERIMENTS
1. Physical mapping by Restriction mapping of plasmid DNA
2. Genetic mapping by RFLP analysis
3. RAPD analysis
4. DNA isolation from blood/liver and electrophoresis
5. Primer Design and Polymerase chain reaction
6. Protein database study SCOP, DALIDD, CATH

REFERENCES
1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press.
3. Carlson, R. F. Patten's Foundations of Embryology.
4. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers.
5. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press.

SEMESTER	V					
YEAR	III					
COURSE CODE	22GS3503					
TITLE OF THE COURSE	GENETIC TESTING					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To Develop a Comprehensive Understanding of Genetic Testing Fundamentals - To Explore Molecular Techniques Used in Genetic Testing - To Analyze Clinical Applications and Ethical Considerations in Genetic Testing

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will be able to define and explain the concept of genetic testing, recognizing its importance in healthcare and various applications.	L1
CO2	Students will be capable of explaining the principles of polymerase chain reaction (PCR) and its applications in detecting mutations and variants in genetic testing.	L2
CO3	Students will be able to describe the role of genetic testing in identifying hereditary cancer syndromes and its application in assessing cancer risk.	L3

COURSE CONTENT:	
MODULE 1	15Hrs
INTRODUCTION TO GENETIC TESTING Overview of Genetic Testing: Definition and importance of genetic testing. Historical development and key milestones. Ethical, legal, and social implications of genetic testing. Types of Genetic Testing: Preconception and prenatal testing. Diagnostic testing vs. predictive testing. Carrier testing and newborn screening. Genetic Counseling and Informed Consent: Role of genetic counselors. Importance of informed consent in genetic testing. Regulatory Frameworks and Quality Assurance: FDA regulations for genetic testing. Accreditation and quality assurance in genetic testing labs.	

MODULE 2	15Hrs
MOLECULAR TECHNIQUES IN GENETIC TESTING PCR-Based Genetic Testing: Principles of polymerase chain reaction (PCR). Applications in detecting mutations and variants. Sequencing Technologies: Sanger sequencing and next-generation sequencing (NGS). Whole exome sequencing and whole genome sequencing. Microarray Analysis: Principles of microarray technology. Array comparative genomic hybridization (aCGH) and SNP arrays. Bioinformatics in Genetic Testing: Data analysis and interpretation of sequencing results. Variant annotation and classification.	
MODULE 3	15Hrs
CLINICAL APPLICATIONS OF GENETIC TESTING Cancer Genetic Testing: Hereditary cancer syndromes. Role of genetic testing in cancer risk assessment. Mendelian Disorders and Carrier Testing: Genetic testing for autosomal recessive, dominant, and X-linked disorders. Importance of carrier testing in family planning. Pharmacogenetic Testing: Personalized medicine and drug response prediction. Testing for genetic variants affecting drug metabolism. Non-Invasive Prenatal Testing (NIPT): Detection of fetal genetic abnormalities from maternal blood. Ethical considerations and limitations of NIPT.	
MODULE 4	15Hrs
EMERGING TRENDS AND PRACTICAL ASPECTS OF GENETIC TESTING Direct-to-Consumer Genetic Testing: Pros and cons of consumer genetic testing kits. Privacy and ethical concerns. Genome Editing and Gene Therapy: CRISPR-Cas9 technology for gene editing. Clinical applications and ethical considerations. Economic and Social Impact of Genetic Testing: Healthcare costs, insurance, and access to genetic testing. Genetic testing in public health and disease surveillance. Case Studies and Future Directions: Real-world examples of successful genetic testing applications. Exploration of emerging trends in the field.	

TEXT BOOKS/REFERANCES:

1. "Medical Genetics" by Lynn B. Jorde, John C. Carey, and Michael J. Bamshad.
2. "Genetics: Analysis and Principles" by Robert J. Brooker.
3. "Introduction to Genetic Analysis" by Anthony J. F. Griffiths et al.
4. "Essential Medical Genetics" by Edward S. Tobias and Michael Connor.
5. "Genetic Testing: Care, Consent, and Liability" by Angus J. Macdonald.
6. "Genomic Medicine: Principles and Practice" by Dhavendra Kumar.
7. "Genetic Testing and the Use of Information" by Martin Richards and Peter S. Harper.
8. "Genomic and Precision Medicine: Foundations, Translation, and Implementation" by Geoffrey S. Ginsburg and Huntington F. Willard.
9. "Clinical Genomics: Practical Applications in Adult Patient Care" by Michael J. Dougherty.
10. "Genomic Medicine: An Introduction and Application Guide" by Dhavendra Kumar.

EXPERIMENTS

1. DNA Extraction from Cheek Cells.
2. PCR Amplification of a Target Gene
3. Gel Electrophoresis of PCR Products
4. Restriction Fragment Length Polymorphism (RFLP) Analysis
5. Sanger Sequencing of a Genetic Variant
6. Microarray Analysis of Copy Number Variations
7. Bioinformatics Analysis of NGS Data

REFERENCES

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2002). Molecular Biology of the Cell (4th ed.). Garland Science. Chapter 5.
2. Innis, M. A., Gelfand, D. H., Sninsky, J. J., & White, T. J. (1990). PCR Protocols: A Guide to Methods and Applications. Academic Press.
3. Sambrook, J., Fritsch, E. F., & Maniatis, T. (1989). Molecular Cloning: A Laboratory Manual (2nd ed.). Cold Spring Harbor Laboratory Press. Chapter 7.
4. Russel, P. J. (2002). iGenetics: A Molecular Approach. Benjamin Cummings. Chapter 9.
5. Sanger, F., Nicklen, S., & Coulson, A. R. (1977). DNA sequencing with chain-terminating inhibitors. Proceedings of the National Academy of Sciences, 74(12), 5463-5467.
6. Wang, D. G., Fan, J. B., Siao, C. J., Berno, A., Young, P., Sapolsky, R., ... & Lander, E. S. (1998). Large-scale identification, mapping, and genotyping of single-nucleotide polymorphisms in the human genome. Science, 280(5366), 1077-1082.
7. Ashley, E. A., Butte, A. J., Wheeler, M. T., Chen, R., Klein, T. E., Dewey, F. E., ... & Bustamante, C. D. (2010). Clinical assessment incorporating a personal genome. The Lancet, 375(9725), 1525-1535.

SEMESTER	VI					
YEAR	III					
COURSE CODE	22GS3603					
TITLE OF THE COURSE	COMPLEX TRAITS AND GENE NETWORKS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
• To develop an understanding of the underlying genetic complexity of complex traits and diseases, including the role of quantitative traits, linkage disequilibrium, and the influence of various genetic elements on disease susceptibility. • To develop the skills to analyze the genetic architecture of complex traits through the study of non-coding DNA elements, polymorphisms, structural variations, and the application of quantitative trait locus (QTL) mapping and genome-wide association studies (GWAS). • To gain insights into gene regulatory networks (GRNs) by exploring genome evolution, understanding gene-level control mechanisms, and applying molecular techniques like CRISPR-based genome editing and chromatin immunoprecipitation (ChIP) assays.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will be able to explain the concepts of quantitative traits, linkage disequilibrium, and the genetic basis of complex diseases, demonstrating an understanding of the fundamental principles underlying complex traits.	L2
CO2	Students will be able to analyze genetic data, identify relevant polymorphisms, and perform statistical analyses for QTL mapping and GWAS. They will interpret results to draw conclusions about the genetic factors contributing to complex traits.	L3
CO3	Students will design and execute laboratory experiments, such as CRISPR-based genome editing and ChIP assays, to manipulate and study gene regulation. They will integrate information from various sources to infer gene regulatory networks and assess their impact on complex diseases.	L4
CO4	Students will design and propose novel experimental approaches to study the 3D chromatin conformation using techniques like 3C and Hi-C. They will synthesize information from different modules to propose potential therapeutic strategies for complex diseases based on their understanding of genetic and regulatory mechanisms.	L5

COURSE CONTENT:	
MODULE 1	15Hrs
COMPLEX TRAITS AND DISEASES Quantitative traits, linkage disequilibrium (LD), Quantitative Trait Locus. Complex diseases: Alzheimer's and Parkinson's disease, multiple sclerosis, and autoimmune diseases.	
MODULE 2	15Hrs
GENETIC ARCHITECTURE OF COMPLEX TRAITS Non-coding DNA elements and the junk genome, Structure of the Human polymorphic DNA: synonymous vs. nonsynonymous single nucleotide variant (SNV), Variable Number of Tandem Repeats (VNTRs, e.g., mini- and microsatellites), transposable elements (e.g., Alu repeats), structural alterations, and copy number variations, Single Nucleotide Polymorphisms (SNPs), haplotypes, QTL mapping and Genome wide association Studies (GWAS), LD plots	
MODULE 3	15Hrs
GENE REGULATORY NETWORKS Genome Evolution. Genome level control and introduction to Gene Regulatory Networks (GRNs). Genome Editing: Engineered Nucleases (Meganucleases, Zn-finger nucleases), Transcription Activator like Nucleases (TALEN), CRISPR in <i>Drosophila</i> .	
MODULE 4	15Hrs
CHARACTERIZATION OF COMPLEX DISEASE TRAITS Scaling the human genome: UCSC genome browser, RegulomeDB database, Dual Luciferase Reporter (DLR) assay. Estimating DNA-protein interactions: Chromatin Immunoprecipitation (ChIP) assay, Electrophoretic mobility Shift Assay (EMSA) and affinity pull down assays, 3D view of the Genome: Chromatin Conformation Capture (3C) and Hi-ChIP assays.	

TEXT BOOKS/REFERENCES:
1. "Genetics: A Conceptual Approach" by Benjamin A. Pierce 2. "Principles of Genetics" by D. Peter Snustad and Michael J. Simmons 3. "Statistical Methods in Genetic Epidemiology" by Duncan C. Thomas 4. "Essential Medical Genetics" by Edward S. Tobias and Michael Connor. 5. "Genome-Wide Association Studies and Genomic Prediction" by Cedric Gondro, Julius H.J. van der Werf, and Ben J. Hayes 6. "Molecular Biology of the Gene" by James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, and Richard Losick 7. "Epigenetics: How Environment Shapes Our Genes" by Richard C. Francis

EXPERIMENTS

- 1) EMSA assay via chemiluminescence (Virtual Demonstration)
- 2) CRISPR guide RNA and PAM site prediction tools: comparative analysis
- 3) Custom digestion of genome sequence using NEB cutter tool.
- 4) Chromatin Conformation Capture assay (Virtual Demonstration)
- 5) Primer design and in silico PCR
- 6) In silico study of UCSC genome browser.

REFERENCES

1. "Laboratory Manual for Human Genetics" by Michael R. Cummings and William S. Klug
2. "Genetics: A Laboratory Manual" by Benjamin A. Pierce
3. "Essential Techniques in Genetics: A Laboratory Manual" by Michael R. Cummings
4. "Molecular Biology Techniques: A Classroom Laboratory Manual" by Heather Miller, D. Scott Witherow, Sue Carson, and Michael L. Corbo
5. "Essential Genetics: A Genomic Perspective" by Daniel L. Hartl and Elizabeth W. Jones
6. "Experiments in Modern Genetics" by Charlotte A. Spencer, David F. Kelly, and Michael Hadfield
7. "Genetics Laboratory Investigations" by Thomas L. Vandergon
8. "Molecular Biology Techniques: An Intensive Laboratory Course" by Reinhard Lührmann and David S. J. Allan

SEMESTER	IV					
YEAR	II					
COURSE CODE	22MY2401					
TITLE OF THE COURSE	MICROBIAL PHYSIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
• To equip the students about the importance of microorganisms in our global society. • To create in-depth knowledge of the metabolic pathways, energetics in microorganisms. • To make students to learn basic microbiological techniques employed for biochemical tests and estimations of various molecules in prokaryotic and eukaryotic microorganisms.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will be acquainted with fundamental aspects of microbial physiology basically the metabolism and their energetics	L1
CO2	Enable the students to understand the diversity of microbial, structure, function and their environment	L2
CO3	Students will be able to understand the importance of microorganisms.	L3
CO4	Students will be equipped with fundamental knowledge of microbial growth patterns enabling them to apply the same in various allied fields.	L2

COURSE CONTENT:
MODULE 1: MICROBIAL METABOLISM 15Hrs Carbohydrate and Protein Metabolism: Glycolysis, Entner – Doudoroff. TCA cycle, Gluconeogenesis, Transamination, oxidative deamination, decarboxylation, Urea cycle. Photosynthesis: Photosynthetic microorganisms, photosynthetic pigments, Cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria. Carbon dioxide fixation pathways, Fungal and bacterial secondary metabolism: Brief account on biosynthesis and action of secondary metabolites antibiotics, fungal and bacterial toxins, pigments, Bioluminescence.
MODULE 2: ENZYMOLOGY 15Hrs Enzymes: Definition, classification, nomenclature, specificity, active sites, coenzymes, activators and inhibitors, activity unit-prosthetic groups. Effect of temperature, pH and substrate concentration on reaction rate. Isozymes, Enzyme Kinetics and co-enzyme action. Michaelis-Menten equation, Determination of kinetic parameters , hyperbolic and LB plot. Regulation of enzymes: Covalent and

noncovalent modification; Enzyme inhibition - types of inhibitors - competitive, noncompetitive and uncompetitive. Ribozymes and abzyme.

MODULE 3: MICROBIAL RESPIRATION AND BIOENERGETICS

15Hrs

Principles of thermodynamics, high energy compounds- ATP, NAD, FAD, FMN, quinones, components and mechanisms of respiratory chain. Bacterial aerobic respiration: Components of electron transport chain, free energy changes and electron transport, oxidative phosphorylation. Theories of ATP formation, generation and maintenance of PMF and inhibition of electron transport chain. Anaerobic respiration. Nitrate, carbonate and sulfate as electron acceptors.

MODULE 4: MICROBIAL CELL MEMBRANE PHYSIOLOGY

15Hrs

Metabolite transport: Passive diffusion, facilitated diffusion, different mechanisms of active diffusion (PTS, role of permeases in transport). Transport of amino acids and inorganic ions in microbes and their mechanisms.

Stress physiology: Osmotic stress and osmoregulation by glutamate. Aerobic to anaerobic transitions in facultative microorganisms (E. coli); Oxidative stress - superoxide dismutase and catalase, Regulation of the Oxidative Stress, Response, pH stress and acid tolerance; Thermal stress and heat shock response (genes); Nutrient stress and starvation stress.

TEXT BOOKS/REFERENCES:

1. Arora, D.K. and Seema Gupta. (1996). Bacterial Physiology. Anmol Publications. New Delhi.
2. Brun, Y.V. and Shimkets, L.J. (2000). Prokaryotic Development, ASM Press.
3. Byung Hong Kim and Geoffrey Michael Gadd. (2008). Bacterial Physiology. Cambridge.
4. Caldwell, D.R. (2000). Microbial Physiology and Metabolism, Brown Publishers.
5. Deb, A.C. (2006). Fundamentals of Biochemistry, New Central Book Agency Pvt. Ltd., Kolkata.
6. Donald Voet and Judith G. Voet. (2011). Biochemistry. Third Edition, John Wiley and Sons, Inc. New York.
7. Stryer, L. (2010). Biochemistry, Seventh Edition, W.H. Freeman and Company, New York.
8. El-Sharoud, Walid (Ed.) (2007). Bacterial Physiology a molecular approach. Springer.
9. Moat, A.G. & Foster, J.W. (1995). Microbial physiology, Wiley-Liss.
10. Moat, A.G. and Foster, W. (2002). Microbial Physiology, Fourth Edition, John Wiley and Sons, New York. Postgate, J. Nitrogen Fixation, third edition, Cambridge University Press.
11. Salisbury, F.W. and W. Ross, (1991). Plant Physiology, fourth edition, Wardsworth Publishing Company, California.
12. Smith and Wood (1991). Energy in Biological Systems. Chapman and Hall.
13. Srivastava, M.L. 2008. Microbial Biochemistry, Narosa Publishing House, New Delhi.

PRACTICALS

1. Biochemical test	(5 Units)
a) Catalase	
b) IMViC	
c) Starch hydrolysis	
d) Casein hydrolysis	
e) Sugar fermentation test (Acid / Gas)	
2. Estimation of DNA.	
3. Estimation of maltose by DNS method.	
4. Estimation of proteins	
5. Estimation of enzyme activity – amylase.	

REFERENCES

1. Aneja, K.R. (2014). Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atlas R.M. (1998). Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
3. Cappuccino, J.G., and Sherman, N. (1999). Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
4. Pelczar, M. J., Chan E.C.S. and Krieg N.R. (1993). Microbiology. McGraw Hill Book Company, New York.
5. Prescott, L.M., Harley, J.P. and Klein, D.A. (2011). Microbiology. WCB McGraw-Hill, NY.

SEMESTER	IV					
YEAR	II					
COURSE CODE	22MY2402					
TITLE OF THE COURSE	IMMUNOLOGY AND IMMUNO-TECHNIQUES					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
To demonstrate the basic knowledge of immunological processes at a cellular and molecular level
To outline, compare and contrast the key mechanisms and cellular players of innate and adaptive immunity and how they relate
To understand key events and cellular players in antigen presentation, and how the nature of the antigen will shape resulting effector responses
It will also provide opportunities for a student to develop diagnostic skills in microbiology, including the practical application and interpretation of laboratory tests

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	The course will provide the conceptual basis for understanding how the immune response works	L2
CO2	Students will acquire and demonstrate competency in routine and specialized microbiological laboratory skills applicable to immunological methods, including accurately reporting observations and analysis.	L3
CO3	The course will enable the student to apply the knowledge in various aspects of fermentation or industrial microbiology	L3

COURSE CONTENT:	
MODULE 1: ELEMENTS OF IMMUNE SYSTEM	15Hrs
History and scope of immunology, Definition and types of immunity (innate and adaptive). Structure, Functions and Properties of: Immune Cells (Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell and Dendritic cell) and Immune Organs– Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT. Immune responses- Primary and Secondary Immune Response, Humoral and cell mediated immunity. Complement system – Components, function and activation pathways, Major Histocompatibility Complex.	
MODULE 2: ANTIGENS AND ANTIBODIES	15Hrs
Characteristics of an antigen, Types, Haptens, Superantigens, Epitopes (T & B cell epitopes), Structure of T-cell and B-cell receptors. Structures of antigen presenting cells. Cluster of differentiation,	

Cytokines, Adjuvants. Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic). Immunoglobulin family and class switch mechanism. Clonal selection theory of antibody production.

MODULE 3: IMMUNOLOGICAL DISORDERS

15Hrs

Hypersensitivity reactions - Definition and types, Autoimmune disorders - Type-1 diabetics, Rheumatoid arthritis and Myasthenia gravis, Transplantation immunology – Graft, types and rejection of graft. Brief concept of cancer immunology.

MODULE 4: IMMUNOLOGICAL TECHNIQUES

15Hrs

Production and application of Monoclonal antibodies. Types and Principles of Ag-Ab reactions - Precipitation, Agglutination, Complement fixation and its applications. Immunodiffusion, Immunoelectrophoresis, ELISA, RIA, Immunofluorescence, Western Blotting (Immunoblotting), Flow cytometry and Immunoelectron microscopy.

TEXTBOOKS/REFERNCES:

1. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York.
4. Warren Levinson (2000) Medical Microbiology and Immunology, Examination and Board Review. 8th Edition. McGraw Hill.
2. Anathnarayana and Panikar (2013) Text Book of Microbiology, 9th Edition. University press.
3. Richard A, Goldsby, Thomas J, Kindt, Barbara A and Osborne (2000). Kuby Immunology. 4th Edition. W.H. Freeman and Company, New York.
4. Tortora, Funke, Case (2009) Microbiology, 9th Edition. Benjamin Cummings.
5. Fritz H Kayser (2005) Medical microbiology. ThiemeVerlag.
6. Funke, B. R., Tortora, G. J., Case, C. L. (2013). Microbiology: An Introduction. United Kingdom: Pearson.
7. Frank and Steven A (2002). Immunology and evolution of Infectious Diseases. Princeton University Press.
8. Kenneth Murphy, Casey Weaver, and Paul Travers Janeway. (2020). Immunobiology. Garland 9th Edition.
9. Abul K. Abbas, Andrew H. Lichtman, and Shiv Pillai. (2020). "Cellular and Molecular Immunology" Elsevier, (10th Edition).

PRACTICALS

1	Serological reactions: a) Agglutination - Blood grouping and Rh typing b) Precipitation reactions: Radial ImmunoDiffusion, c) (c) Ouchtlerlony Double Diffusion
2	Identification of various Blood cells.
3	Counting of WBC using Hemocytometer.
4	Dot ELISA.
5	Measurement of blood cells using micrometry.

REFERENCES:

1. Mackie and McCarthy. (1973). Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchill Livingstone.
2. Frank and Steven A. (2002). Immunology and evolution of Infectious Diseases. Princeton University Press.
3. Wadher and Bhoosreddy. (2005). Manual of Diagnostic Microbiology. Himalaya Publisher.
4. Leslic Collier, John Oxford. (2000). Human virology a text book for students of medicine, dentistry and microbiology. 2nd edition. Oxford University Press.
5. Jenson, Wright Robinson. (1973). Microbiology Vol 1, Microbial Infection Vol 2, Practical Medical Microbiology, Churchill Living Stone.

SEMESTER	IV					
YEAR	II					
COURSE CODE	22MY2403					
TITLE OF THE COURSE	PHARMACEUTICAL MICROBIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To make students understand the applications of microorganisms in production of pharmaceutically active compounds. - To know the importance of microbiology knowledge in maintaining the microbial standards in pharmaceutical productions.

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Should be able to identify different antimicrobial agents, antibiotics produced by them and it's mode of action.	L1
CO2	Should be able to outline the process involved in drug discovery and development	L2
CO3	Should be able to understand regulatory guidelines in pharmaceuticals product production.	L2

COURSE CONTENT:
MODULE 1: ANTIBIOTICS 15Hrs History of Chemotherapy, classification of antibiotics - β -lactam, aminoglycosides, tetracyclines, ansamycins, macrolides. Antifungal antibiotics: Griseofulvin; Antiviral drugs: Amantidines; Nucleoside analogues, Interferons, Peptide antibiotics. Synthetic antibiotics: Sulphonamides; Chloramphenicol; Quinolone. Chemical disinfectants, antiseptics and preservatives. Therapeutic and prophylactic usage of drugs. Adverse reactions of drugs. Drug resistance – mechanism and consequences. Development of new therapeutics - Antimicrobial peptides, phage therapy, plant-based therapeutics. Immobilization procedures for pharmaceutical applications (liposomes). Macromolecular, cellular and synthetic drug carriers.
MODULE 2: MICROBIAL FORMULATION AND APPLICATIONS OF MICROBIAL ENZYMES 15Hrs Biochemical and molecular basis of screening for the active ingredients from microbes. Application of microbial enzymes in therapeutics. Microbial fermentation for the production of pharmaceutical compounds (Streptomycin, Influenza vaccine). Formulation of drugs, Packaging of products. Preservation of pharma – ideal preservatives, antimicrobial preservatives. Database for Drug designing; Preclinical, clinical trials and

Toxicology (LD50 and ED50).

Regulatory Aspects in Pharmaceuticals

FDA regulations, GMP and GLP in pharmaceuticals, Quality control through WHO; Good Regulatory Practices, Clinical Research Regulations. Regulation and legislation for drugs, cosmetics, medical devices, biologicals and herbals formulation.

TEXT BOOKS/REFERENCES:

1. Hugo, WB and Russell, AD. Pharmaceutical Microbiology, (2003). Blackwell Science, Oxford, UK.
2. Krogsgaard L, Lilijefors T. and Madsen, U. (2004). Textbook of Drug Design and Discovery, Taylor and Francis, London.
3. Geoffrey Hanlon and Norman Hodges. (2013). Essential Microbiology for pharmacy and pharmaceutical science. Wiley Blackwell.
4. S. P. Vyas & V. K. Dixit. (2003). Pharmaceutical Biotechnology. CBS Publishers & Distributors, New Delhi.
5. Bhatia R and Ichhpujani RL. (1995). Quality Assurance in Microbiology. CBS Publishers, New Delhi.
6. Gregory Gregoriadis. (2001). Drug Carriers in biology & Medicine. Academic Press New York.
7. Davis, B. D., Dulbecco, R, Eisen, H. N., Ginsberg, R. S. (1990). Microbiology. Harper and Row Publishers, Singapore.

SEMESTER	IV					
YEAR	II					
COURSE CODE	22BS2401					
TITLE OF THE COURSE	BIOSAFETY AND GOOD LABORATORY PRACTICE					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To introduce the students to the concepts of biosafety regulatory frameworks concerning genetically modified organisms at national and international levels.
- To impart knowledge of the principles of GLP and their practical applications.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Gain knowledge of the various safety procedures to be followed in laboratory.	L2
CO2	Gain the skills and knowledge necessary to understand and work in GLP compliant environment.	L2
CO3	This course should generate interest for avenues for pursuing higher studies and careers in these areas	L2

MODULE I – BIOSAFETY	18 Hrs
Introduction, Historical Background; risk assessment and lab acquired infections, Introduction to Biological Safety Cabinets& their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms. Recommended Biosafety Levels for Infectious Agents and Infected Animals. Biosafety Guidelines: Biosafety guidelines and regulations (National and International); Definition of GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Recombinant DNA Guidelines (1990); Rules for the manufacture, use/import/export and storage of hazardous microorganisms/ genetically engineered organisms or cells (Ministry of Environment and Forests Notification,1989); Environmental release of GMOs; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.	
MODULE II – GOOD LABORATORY PRACTICE	12 Hrs
Introduction to GLP, WHO guidelines on GLP, History, Scope (Resources Characterization, Rules, Results, Quality assurance); Levels of Laboratories; General Rules/Protocols for Lab Safety measures; Precaution and Safety in handling of chemicals, Laboratory tools, glasswares and instruments; Sample storage and disposal; Log Book maintenance, Basic SOPs for instrument handling and Maintenance.	

Keeping data records, its analysis by using statistical and mathematical tools. Result analysis and its interpretation. GLP as given by OECD, FDA etc (International perspective); Internal and External Audits.

REFERENCES:

1. Handbook Good Laboratory Practices-World health organization (WHO).
2. Life science protocol manual (2018). DBT star college scheme.
3. Guidelines for good laboratory practices-Indian council of medical research, New Delhi (2008).
4. Handbook: Good Laboratory Practices (GLP): quality practices for regulated non-clinical research and development-2nd ed.

SEMESTER	V					
YEAR	III					
COURSE CODE	22MY3501					
TITLE OF THE COURSE	MEDICAL AND CLINICAL MICROBIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
This course provides an overview on the role of microbiome in human health and disease
To introduce basic principles and application relevance of clinical disease for students
The course will provide the conceptual basis for understanding pathogenic microorganisms and particularly address the fundamental mechanisms of their pathogenicity
It will also provide opportunities for a student to develop diagnostic skills in microbiology, including the practical application and interpretation of laboratory tests for the diagnosis of infectious diseases

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Enable the students to understand the normal microbiome and its relevance to human health.	L2
CO2	The course will provide the conceptual basis for understanding pathogenic microorganisms and particularly address the fundamental mechanisms of their pathogenicity.	L1
CO3	Students will acquire and demonstrate competency in laboratory safety and in routine and specialized microbiological laboratory skills applicable to microbiological research or clinical methods, including accurately reporting observations and analysis.	L3

COURSE CONTENT:	
MODULE 1: NORMAL MICROBIAL FLORA	15Hrs
Factors determining the nature of the normal flora. Normal flora of skin, respiratory system, nervous system, digestive system and urinary and reproductive systems. Beneficial effects of the normal flora. Attributes of microbial pathogenicity: Pathogenicity, Virulence factors, invasion. Toxins: Exotoxins, Enterotoxins and Endotoxins. Types of infections (non-communicable and communicable infections. Nosocomial infection, zoonotic diseases, opportunistic pathogens). Routes of transfer. Factors affecting host susceptibility to disease. Immune response to infection.	
MODULE 2: ANTIBIOTICS AND VACCINES	15Hrs

Mode of antimicrobial action – antibacterial, antimycobacterial, antifungal, antiviral, antiprotozoal, antihelminthic. Microbial resistance to antibiotics. Molecular principles of drug targeting; Drug delivery system in gene therapy. Vaccine: Inactivated Attenuated, Conjugated, Recombinant vaccines - synthetic peptide vaccines, Multivalent subunit vaccines, DNA vaccines. Immunisation schedule and its significance. Secondary metabolites from microorganisms.	
MODULE 3: INFECTIOUS DISEASES	15Hrs
Type study: symptoms, Epidemiology, etiology, pathogenesis, diagnosis, treatment and prophylaxis of the following: Bacteria – <i>Staphylococcus aureus</i> , <i>Salmonella typhi</i> Viruses – Rabies, HIV Fungi – <i>Aspergillosis</i> , <i>Candida albicans</i> Protozoa – <i>Leishmania donovani</i> , <i>Entamoeba histolytica</i>	
MODULE 4: DIAGNOSTICS AND BIOMEDICAL MANAGEMENT	15Hrs
Diagnostic Microbiology: Collection, transport and storage guidelines; biosafety in diagnostic laboratory and regulations, specific procedures for collection of specimens, processing of specimens. Molecular diagnosis: RT-PCR, RAT (Rapid Antigen Test), TrueNat (TB and Covid-19). Biomedical waste segregation, treatment and management.	

REFERENCES:
1. Anathnarayana and Panikar. (2013). Text Book of Microbiology, 9th Edition. University press.
2. Warren Levinson. (2000). Medical Microbiology and Immunology, Examination and Board Review. 8th Edition. McGraw Hill. 5. Tortora, Funke, Case (2009) Microbiology, 9th Edition. Benjamin Cummings.
3. Connie R Mahon. (2010). Text book of diagnostic Microbiology. 3rd edition, Pearson.
4. Kayser FH. (2005). Medical Microbiology.
5. Mackey, T. J., & McCarthey, J. Y. (1989). Practical Medical Microbiology.
6. Frank and Steven A. (2002). Immunology and evolution of Infectious Diseases. Princeton University Press.
7. Kufe, D. W., Pollock, R. E., Weichselbaum, R. R., Bast, R. C., Gansler, T. S., Holland, J. F., & Frei, E. (2003). Cancer Medicine; ed.; BC Decker. Inc.: <i>Lewiston, NY</i> . Leslic Collier, John Oxford (2000) Human virology a text book for students of medicine, Dentistry and Microbiology. 2 nd Edition. Oxford University Press.
8. Jenson, Wright Robinson. (1973). Microbiology Vol 1, Microbial Infection Vol 2, Practical Medical Microbiology, Churchill Living Stone.
9. Credric, A Mims. (2004). Medical Microbiology, 3 rd Edition. Mohshy Inc.
10. Nester Roberts Pearsall Anderson. (2021). Microbiology- A Human Perspective, 2 nd Edition, McGraw-Hill.

PRACTICALS	
1	Isolation and identification of normal microflora on simple, selective and enrichment media (throat, skin and nasal sample). (3 units)
2	Dental caries susceptibility assay by Snyder's agar test.
3	Determination of effectiveness of antiseptics by thumb impression method.
4	WIDAL Test
5	VDRL

REFERNCES:

1. Funke, B. R., Tortora, G. J., Case, C. L. (2013). Microbiology: An Introduction. United Kingdom: Pearson.
2. Mackie and McCarthey. (1996). Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchil Livingstone.
3. Frank and Steven A. (2002). Immunology and evolution of Infectious Diseases. Princeton University Press.
4. Wadher and Bhoosreddy. (2005). Manual of Diagnostic Microbiology. Himalaya Publisher.
5. Credric, A Mims. (2004). Medical Microbiology, 3rd Edition. Mohshy Inc.
6. James G. Cappuccino, Natalie Sherman. (2014). Microbiology: A Laboratory Manual. Pearson.

SEMESTER	V					
YEAR	III					
COURSE CODE	22MY3502					
TITLE OF THE COURSE	MICROBIAL GENETICS AND GENETIC ENGINEERING					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-		-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To understand the genetic basis of microbial life. Also, to use that knowledge in fields of molecular biology, applied microbiology and genetic engineering. - To learn about the tools involved in gene manipulation and apply it in the process of genetic engineering.

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Should be able to understand genetic elements that govern microbial life processes.	L2
CO2	Should be able to use gene manipulation techniques in various fields of applied biology	L3
CO3	Should be able to demonstrate experiment in microbial genetics concerned with clarifying phenotype and their relationship with the genotype.	L2

COURSE CONTENT:	
MODULE 1	15Hrs
MICROBIAL GENETICS Morphology of Prokaryotic and Eukaryotic genetic material. Chemical basis of heredity: Evidence for DNA and RNA as genetic material (Griffith's experiment and Hershey and Chase experiment and Singer's experiment). Properties of genetic code and Wobble hypothesis. Transformation, Conjugation and Transduction. Transposons in recombination. Extra chromosomal genetic elements and their importance. Classical Microbial Genetics: complementation, recombination, and mapping.	
MODULE 2	15Hrs
Concept of Gene – Muton, Recon, Cistron. One gene-one enzyme, One gene- One polypeptide, One gene – One product hypothesis. Types of RNA and their functions. Outline of RNA biosynthesis in prokaryotes. Genetic code. Structure of ribosomes and protein synthesis in prokaryotes. Types of genes - structural, constitutive and regulatory. Operon concept. <i>Lac</i> operon. Molecular basis of mutations: Nature, types of mutations (point and frame shift mutations), DNA repair mechanisms.	

MODULE 3**15Hrs****INTRODUCTION AND TOOLS FOR GENETIC ENGINEERING**

Introduction to Genetic Engineering: Overview of major steps involved. Tools for Genetic Engineering: Enzymes: Restriction endonucleases, DNA ligases. Other enzymes: A brief account of Alkaline phosphatase, Polynucleotide kinase, Exonuclease III, DNase I, DNA polymerase and Klenow fragment, Terminal nucleotidyl transferase, RNA dependent DNA Polymerase. Vectors – plasmids (pBR 322, pUC 18), bacteriophages, cosmids, YAC, shuttle vectors. cDNA, PCR.

Gene transfer - Chemical methods, Lipofection, Electroporation, Microinjection, Ballistic method (Particle shot gun method). Selection and screening of recombinants: Identification and selection of transformed cells: Direct methods - Insertional inactivation, Visual screening method, Plaque formation, Complementation of mutation nutrition Indirect methods - Colony hybridization, Immunochemical detection.

MODULE 4**15Hrs****GENETIC ENGINEERING TECHNIQUES**

Technique for Genetic Engineering: Gel electrophoresis: Agarose Gel Electrophoresis, SDS-PAGE, Hybridization: Southern, Northern, Western. Dot blots, Autoradiography. DNA sequencing: Sanger's Dideoxy method, Molecular probes.

APPLICATIONS: Transgenics - Resistance to diseases (Pathogen resistant-viral, fungal and bacterial); insects (Bt gene transfer); Fertilizer management- Nif gene transfer.

TEXT BOOKS/REFERENCES:

1. Sandhya M. (2008). Genetic engineering: Principles and practice, MacMillan India Ltd.
2. Primrose, S. B., and R. M. Twyman. (2006). Principles of gene manipulation and Genomics, Blackwell Publishing MA. USA.
3. Nicholl D. S. T. (2008). An introduction to Genetic engineering (2nd ED), Cambridge University Press.
4. Satyanarayana U. (2008). Biotechnology, Books and Allied (P) Ltd., Kolkata.
5. Purohit S. S. (2003). Biotechnology Fundamentals and applications, student Edition, Jodhpur.
6. Channarayappa. (2006). Molecular Biotechnology- Principles and practices, University press (India) Private Limited.
7. Hartwell, L. H., L. Hood, M. L. Goldberg, A. E. Reynolds, L. M. Silver and R. G. Veres. (2004). Genetics from Genes to Genomes. McGraw Hill.
8. Lewin B. Genes VIII. (2003). Oxford University Press. Oxford,
9. Watson, J. D., T. A. Baker S. P. Bell, A Cann, M. Levine and R. Losick. (2004). Molecular Biology of Gene V Edition, Pearson Education RH Ltd. India.
10. Brown T. A. (2007). Genomes 3. Garland Science Publishing, New York.

PRACTICALS
1. DNA isolation from microbial source. 2. RNA isolation from microbial source. 3. Plasmid isolation from microbial source. 4. Restriction digestion 5. DNA ligation 6. Bacterial transformation

REFERENCES
1. Hugo, WB and Russell, AD. (2003). Pharmaceutical Microbiology. Blackwell Science, Oxford, UK. 2. Aneja, K.R. (2014). Laboratory Manual of Microbiology and Biotechnology. Medtec 3. Atlas R.M. (1998). Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York. 4. Cappuccino, J.G., and Sherman, N. (1999). Microbiology - A Laboratory Manual. Fourth Edition. Addison Wesley Longman, Inc England. 6. Pelczar, M. J., Chan E.C.S. and Krieg N.R. (1993). Microbiology. McGraw Hill Book Company, New York. 7. Prescott, L.M., Harley, J.P. and Klein, D.A. (2011). Microbiology. WCB McGraw-Hill, NY.

SEMESTER	V					
YEAR	III					
COURSE CODE	22BS3501					
TITLE OF THE COURSE	BIOETHICS AND IPR					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

To recognize, compare, and contrast the general "ways of thinking" of science (biology) and of philosophy (ethics).
To recognize, compare, and contrast the general "ways of thinking" of science (biology) and of philosophy (ethics).
To give elementary essential concepts of Bioethics, IPR and patent laws.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student should develop basic understanding of the concepts of Bioethics, IPR and Patent Laws	L2
CO2	This course should generate interest for avenues for pursuing higher studies and careers in these areas	L2
CO3	General knowledge should create awareness necessary for higher studies in biotechnological fields	L2

COURSE CONTENTS

MODULE I – BIOETHICS	15 Hrs
Bioethics- The environmental, legal and socioeconomic impacts of biotechnology; Ethical concerns of biotechnology in research and innovation-The GM crop debate – safety, ethics, perception and acceptance of GM crops; Bioethics of Genetically modified organism; Bioethics of CRISPR technique- for editing human embryos; Bioethics of Gene therapy; Bioethics of Stem cell research; Reproductive medicine and ethics; Use of Animals in Research and Testing, and Alternatives for Animals in Research, Animal Cloning, Human Cloning, and their Ethical Aspects; Public education of the process of biotechnology involved in generating new forms of life for informed decision-making.	
MODULE II – INTELLECTUAL PROPERTY RIGHTS AND REGULATIONS	15 Hrs
Introduction to Intellectual Property and History. Patents, Trademarks, Copyright, Trade secrets, Industrial Design and Rights, Traditional Knowledge, Geographical Indications - importance of IPR – patentable and non-patentable – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO), Pros and Cons of IP protection. Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. Agreements and Treaties: GATT, TRIPS Agreements; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.	

REFERENCES
1. Beier, F.K., Crespi, R.S. and Straus, T. (1985). Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi. 2. Ganguli Prabuddha. (1998). Gearing up for Patents. The Indian Scenario , Universities Press. 3. H S Chawla. (2011). Introduction to Plant Biotechnology. 4. M K Sateesh. Bioethics and Biosafety. Kindle Edition 5. Shomini Parashar, Deepa Goel. (2013). IPR, Biosafety and Bioethics Pearson, India. 6. F. H. Erbisich and K. M. Maredia. (2003). Intellectual property rights in agricultural Biotechnology, University Press. 7. Sivamiah Shantharam, Jane F. (1999). Montgomery. Biotechnology, Biosafety and Biodiversity, Oxford & IBH Publ. New Delhi. 8. Jecker Nany S, Jones & Barlet. 1997. Bioethics: An Introduction to the History Methods and Practice, New Delhi. 9. Private Power, Public Law: The Globalization of Intellectual Property Rights By Susan 10. K. Sell. (2000). Cambridge University Press. 11. Essentials of Intellectual Property: Law, Economics, and Strategy By Alexander I. 12. Poltorak; Paul J. Lerner. (2011). Wiley, (2nd edition). 13. Diane O. Fleming, Debra L. (2006). Hunt Biological Safety: Principles and Practices, 4th Edition. ASM.

SEMESTER	V					
YEAR	III					
COURSE CODE	22BS3502					
TITLE OF THE COURSE	BIONFORMATICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To get introduced to the basic concepts of Bioinformatics and its significance in biological data analysis. - To get an overview about biological macromolecular structures and structure prediction methods.

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Will be able to demonstrate mastery of the core concepts of bioinformatics	L1
CO2	The student will be able to apply basic principles of biology, computer science and mathematics to address complex biological problem	L2
CO3	Should be able to plan basic experiments in microbial genetics concerned with clarifying phenotypes and their relationship with the genotype	L3

COURSE CONTENT:
MODULE 1 BIOLOGICAL DATA TYPES AND SOURCE 07Hrs Introduction to population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Virus data bank (UICTVdb).
MODULE 2 SIMILARITY SEARCHING 10Hrs Global and Local sequence alignment, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs

MODULE 3 INTERPRETTING the SEQUENCE	07Hrs
Reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank libraries, annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files.	
MODULE 4 SCALING THE HUMAN GENOME	06Hrs
UCSC genome browser, RegulomeDB database, ENCODE-ChIA-PET database, transcription factors binding sites. SNP, EST, STS. Regular Expression (REGEX), Hierarchies and Graphical models (including Markov chain and Bayes algorithm). Genetic variability and connections to clinical data.	

TEXT BOOKS/REFERENCES:

1. Bioinformatics. Keith, J. (2008). Humana Press.
2. R.F. Doolittle. (1996). Computer methods for macromolecular sequence analysis., Academic Press.
3. Bioinformatics. (2004). Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. Press.
4. J. Pevsner. (2003). Bioinformatics and functional genomics. Wiley-Liss.
5. Jorde et al., (2005). Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, John Wiley and Sons.
6. Baxavanis (2004). Bioinformatics.
7. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Rosenbloom KR. (2015). The UCSC Genome Browser database: update. Nucleic Acids Res.

SEMESTER	VI					
YEAR	III					
COURSE CODE	22MY3601					
TITLE OF THE COURSE	INDUSTRIAL MICROBIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-		-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To equip the students about the importance of microorganisms in our global society. - To relate microbes in interdisciplinary connections with other sciences, in particular to productions, food sciences. - To exhibit depth of knowledge by demonstrating microbial sciences in the field of applied fields industrial microbiology.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will be acquainted with depth of understanding on fermentation technology, modern microbial techniques and analysis relating to industrial microbiology.	L1
CO2	Enable the students to understand the diversity of microbial, structure, function and their environment	L2
CO3	Students will be able to demonstrate a knowledge and understanding of: Concept of Industrial waste management system.	L3
CO4	It will develop problem solving capabilities in practical working in teams in laboratory/industries based on virtual experiments to gather and evaluate microbial data using a range of current analysis techniques relating to microbial productions in industries.	L4

COURSE CONTENT:	
MODULE I:	15 Hrs
INTRODUCTION TO INDUSTRIAL MICROBIOLOGY: Concepts and scope of microbes in industry. Screening, isolation of industrially important microbes. Strain improvement- mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centres. Basic components and design of typical fermenter. Types of fermenter - Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed, fluidized bed bioreactors and air-lift fermenter. Types of fermentation - Batch, chemostat, submerged and solid-state fermentation. Different parameters affecting fermentation.	

MODULE 2:	15 Hrs
UPSTREAM PROCESSING: Nutrients: growth factors, carbon, nitrogen, mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents, hops, malt, malt adjuncts etc. Methods of media and air sterilization. Culturing techniques of microbial strains; inoculum preparation and inoculum development.	
MODULE 3:	15 Hrs
DOWNSTREAM PROCESSING: Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid extraction, Solvent recovery, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing. Production economics and IPR: Concept of Patenting law, Copyrights, and Trademarks. Patent regulations and filing, processes, products and microorganisms.	
MODULE 4:	15 Hrs
MICROBIAL PRODUCTIONS AND APPLICATIONS: Alcohol production, organic acids (citric acid), enzymes: amylases-(Fungal and Bacterial). Amino acid - L-Glutamic acid. Vaccines (Hepatitis B), hormones (human insulin), antibiotic (Penicillin). Mushroom production. Applications of genetic engineering in industrial bioprocessing.	

TEXT BOOKS/REFERNCES:

1. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi. 37
2. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2013). *Principles of fermentation technology*. Elsevier.
3. Michael J. Waites, Neil Morgan, John S. Rockey, Gray A. Higton. (2001). Industrial Microbiology: An Introduction, Blackwell Science.
4. Robert H. (2006). Microbiology and Technology of Fermented Foods. Blackwell Publishers.
5. Matthew Rimmer. (2008). Intellectual Property and Biotechnology: Biological Inventions Edward Elgar. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Limited, New Delhi.
6. James M.J. (2005). Modern Food Microbiology. CBS Publishers and Distributors, Delhi.
7. Bibek R. (2001). Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press.
8. Adams M.R. and Moss M.O. (2000). Food Microbiology. Royal Publishing Corporation.
9. John G. (1997). Essentials of Food Microbiology. Arnold International Students Edition.
10. Wulf Crueger. (2016). A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
11. Robert Mellor. (2009). Entrepreneurship for Everyone: A student Textbook. SAGE Publication.

PRACTICALS

1. Isolation of microorganisms from vegetables and fruits. **(2 UNITS)**
2. Study of different types of fermenters (Models/ Charts)
3. Production of wine.
4. Production of alcohol from different sources and estimation by specific gravity method.
5. Production and estimation of amylase from microbial sources
6. Detection and quantification siderophore produced by *Pseudomonas* spp.

REFERNCES:

1. K. R. Aneja. 2008. Textbook of Basic and Applied Microbiology. New Age International,
2. Michael J. Waite, Neil Morgan, John S. Rockey, Gray A. Higton. (2001) Industrial Microbiology: An Introduction" Practical Manual Author: Blackwell Science.
3. Michael J. Waite, Richard E. Heal, Ann-Mari Mountfort. "Industrial Microbiology: A Laboratory Manual" Bioprocess Technology Consultants Ltd.
4. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2013). *Principles of fermentation technology*. Elsevier.
5. Michael J. Waite, Neil Morgan, John S. Rockey, Gray A. Higton. 2001. Industrial Microbiology: An Introduction, Blackwell Science.

SEMESTER	VI					
YEAR	III					
COURSE CODE	22MY3602					
TITLE OF THE COURSE	NANO MICROBIOLOGY AND EXTREMOPHILES					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To introduce concepts of nanotechnology and its applications - The course will provide the conceptual basis of ubiquity of microbes in extreme environment - To enable the students to understand the commercial relevance of extremophiles

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will acquire and demonstrate competency in nano science by learning synthesis of nano particles and its characterization	L3
CO2	Enable the students to describe the primitive life form and adaptation of microbes to it	L2
CO3	The course will help the students to describe distribution, classification of Extremophiles	L1
CO4	Students will be able to use the application of Extremophiles	L4

COURSE CONTENT:	
MODULE 1	15Hrs
INTRODUCTION TO NANOTECHNOLOGY: Introduction and Classification: What is nanotechnology? Classification of Nanostructures as 1D, 2D and 3D nanomaterials. Nanoscale Architecture. Characterization of nanoparticles UV-Vis spectroscopy, Electron Microscopy – HRTEM, SEM, AFM, EDS, XRD. Classification of NPs: Organic, inorganic and biological sources. Nano-materials in biological systems: Proteins, Lipids, RNA and DNA Protein Targeting - Small Molecule/Nanomaterial - Protein Interactions Nanomaterial-Cell Interactions- Manifestations of Surface Modification (Polyvalency).	
MODULE 2	15Hrs

MICROBIAL NANOTECHNOLOGY: Different sources of microbes as NPs. Microbial synthesis of Nanoparticles.

Synthesis of nanodrugs –Nanoparticles as drug systems. Diagnostic applications of nanotechnology. Biomedical nanotechnology (diagnostics, delivery and therapeutics), nano toxicology: Cyto-toxicity, Geno-toxicity In vivo tests/assays etc.

Applications of microbial NPs in agriculture, food, environmental and other sectors.

MODULE 3	15Hrs

EXTREMOPHILES: Extreme Habitats. Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, radiation, oxygen concentration and low nutrient levels. Life on other planets.

Extremophiles - bacteria, archaea and eukaryotes. Classification and salient features of archaea. Genetic and Metabolic diversity.

MODULE 4	15Hrs

ADAPTATIONS AND COMMERCIAL USE OF EXTREMOPHILES: Habitat, mechanism of survival and applications of extremophiles – temperature (thermophiles, psychrophiles), pH (acidophiles, alkalophiles), pressure (piezophiles, barophiles), xerophiles, radiations, methanogens.

TEXT BOOKS:

1. Mick Wilson, Kamali Kannagara, Geoff Smith, Michelle Simmons, Burkhard Raguse, (2005). NANOTECHNOLOGY: Basic science and emerging technologies, Overseas Press, First Indian Edition.
2. Pradeep T. (2012). Textbook of Nanoscience and Nanotechnology. McGraw Hill Education (India) Private Limited.
3. Murty B.S., Shankar P., Baldev Raj, Rath B. B., James Murday. (2013). Textbook of Nanoscience and Nanotechnology. Springer, Berlin, Heidelberg.
4. Horikoshi, K., Antranikian, G., Bull, A. T., Robb, F.T., Stetter, K.O. (2011) Extremophiles Handbook, Springer Publications
5. Horikoshi, K., Grant W. (1998). Extremophiles: Microbial Life in Extreme Environments. Wiley Publications.
6. Ramplelto, Paulo H. (2016). Biotechnology of Extremophiles: Advances ad Challenges. Springer Publications.

PRACTICALS

1. Synthesis of Au/Ag metal nanoparticles by chemical route.
2. Optical properties of Au/Ag nanoparticles by using UV-Vis spectroscopy.
3. Determination of antimicrobial properties of silver nanoparticles.
4. Studies on halophiles isolated from high salt habitat. (Study its pigmentation and salt tolerance phenomenon).
5. Studies on alkalophiles and its enzymes (any one) isolated form extreme alkaline environment.

REFERENCES:

1. Raveendran, P., & Fu, J. (2017). "Microorganisms and Nanotechnology: A Powerful Combination." Journal of Nanomaterials, 2017, 8252804.
2. Mukherjee, P., Roy, M., Mandal, B. P., Dey, G. K., Mukherjee, P. K., Ghatak, J., & Tyagi, A. K. (2008). "Green synthesis of highly stabilized nanocrystalline silver particles by a non-pathogenic and agriculturally important fungus T. asperellum." Nanotechnology, 19(7),

075103.

3. Bhushan, B., & Hoque, M. E. (2019). "Microbial Nanotechnology: Recent Advances and Emerging Applications." Springer.
4. Prasad, R., & Patra, J. K. (2018). "Nanobiotechnology: Microbial Biotechnology." CRC Press.

SEMESTER	VI					
YEAR	III					
COURSE CODE	22BS3601					
TITLE OF THE COURSE	PRINCIPLES OF ‘MULTI-OMICS’					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To acquaint students with various aspects of biotechnology and bio-engineering using omics technologies - To provide key insights into omics approaches in personalized and precision medicine	

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will have knowledge in specific methods used in genomics, proteomics and metabolomics used in analytical processes.	L1
CO2	Students will be able to perform statistical analysis crucial for interpretation of experimental results	L2
CO3	Students will be able to apply specialized research methods necessary for the analysis of proteins, genes and metabolites	L3

COURSE CONTENT:	
MODULE 1 Genome & Genomics	07Hrs
Genome mapping: Physical and Genetic Map, Genome Sequencing, Next generation sequencing methods ,Genome Annotation, Functional Genomics	
MODULE 2 Transcriptomics	07Hrs
Search for transcription factor binding sites, RNA-Seq, Microarrays, Regulatory RNAs: small or large, Computational prediction of miRNA target genes, RNA Darkmatter	

MODULE 3 Proteomics and Metabolomics	10Hrs
Basic concepts , Tools of proteomics- SDS PAGE, 2D PAGE , Liquid chromatography , Mass Spectrometry (ESI and MALDI) ,Protein identification by peptide mass fingerprinting ,Applications of proteomics. Fundamental concept, Tools of metabolomics- Capillary electrophoresis, Gas chromatography, Electrochemical detectors, Case studies	
MODULE 4 ‘OMICS’: applications and future perspectives	06Hrs
Multi-omics in disease prediction and health. Multi-omics technologies for crop improvement and sustainable agriculture. Applications in Biomedical and Environmental sciences	

TEXT BOOKS/REFERANCES:

1. Keith, J. (2008). Bioinformatics. Humana Press.
2. R.F.Doolittle. (1996). Computer methods for macromolecular sequence analysis. Academic Press.
3. Daniel C. Liebler. (2002). Introduction to Proteomics -Tools for the New Biology. Humana Press.
4. J. Pevsner. (2003). Bioinformatics and functional genomics. Wiley-Liss.
5. Jorde et al., (eds.). (2005). Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics John Wiley and Sons.
6. Metabolomics- Methods and Protocols by Wolfram Weckwerth, Humana Press.
7. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Virendra Gomase, Somnath Tagore. (2009). Transcriptomics: Expression Pattern Analysis,; VDM Publishing.

SEMESTER	VI					
YEAR	III					
COURSE CODE	22BS3602					
TITLE OF THE COURSE	TOXICOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

1. To learn various toxicants present and their exposure level on day-to-day basis.
2. To study the effects of toxins on the physiologic, metabolic, reproductive, and developmental processes.

COURSE OUTCOMES

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will learn and understand all substances can be toxic depending on the means and level of exposure	L1
CO2	Students will learn the basic concepts of cellular toxicity and chemical actions on cells and body organs	L2
CO3	Students will learn the importance and diversity of drug interactions with various organs	L3

COURSE CONTENT:

MODULE 1	10 Hrs
INTRODUCTION OF TOXICOLOGY: Classification of toxic agents, natural toxins, animal toxins, plant toxins, food toxins, genetic poisons and chemical toxins. Factors affecting toxicity – species and strain, age, sex, nutritional status, hormones, environmental factors, circadian rhythms. Toxicant proceeding <i>in vivo</i> : Absorption, Distribution, Excretion and Metabolism of foreign/toxic compounds.	
MODULE II	5 Hrs
ENVIRONMENTAL TOXICOLOGY: Environmental pollution- Sources and types of pollution, Important pollution events, Priority pollutants. Air pollution- Classification and properties of air pollutants, Behaviour and fate of air pollutants, Photochemical smog, Acid Rain, health effects of air pollution. Water pollution- origin of Wastewater, Domestic Water Pollution, Industrial water pollution, Agricultural water pollution, Toxic water pollutants and their health effects, Groundwater pollution, marine pollution	

MODULE III	5 Hrs
INDUSTRIAL TOXICOLOGY: Industrial Chemicals: Government Regulation of Chemicals, Ways of exposure, Toxic effects, Long-term consequences and developmental toxicity. Food Additives and Contaminants types of food additives, Preservatives, Saccharin. Toxicity of trace elements- Iodine, iron, zinc, copper, manganese, selenium, molybdenum, and cobalt Cyto-toxicity of heavy metals- Cadmium, mercury, arsenic, chromium and lead. Brief introduction to toxicity of pesticides and insecticides.	
MODULE IV	10 Hrs
ORGAN TOXICOLOGY: Basics of organ toxicity- Target organs, Organ selectivity and specificity, gender specific diversity of toxins. Hepatotoxicity - Actions of toxins on the liver, Chronic liver injury; Cardiotoxicity - pathology of cardiac toxicity, mechanisms of cardiotoxicity; Respiratory Toxicity - Systemic lung toxins, Lung pathology; Reproductive System – Teratogenicity; Neurotoxicity- Effect of toxic agents on neurons, Ion channel neurotoxins and Nephrotoxicity- susceptibility of kidney to toxic insult, chemically induced renal injury.	

REFERENCES:

1. Whalen, Finkel, and Panavelil. (2015). Pharmacology, 6th ed. (Lippincott Williams & Wilkins).
2. Lieberman and Peet. (2018). Mark's Basic Medical Biochemistry: A Clinical Approach, 5th ed. (Wolters Kluwer).
3. Hodgson, A. (2010). Textbook of Modern Toxicology, 4th ed. J Wiley & Sons.
4. Smart and Hodgson. (2008). Molecular and Biochemical Toxicology, 4th ed., eds. J Wiley & Sons.
5. Frank and Ottoboni. (2011). The Dose makes the Poison: A Plain-language Guide to Toxicology, 3rd ed. eBook, (J Wiley & Sons).
6. Ottoboni. (1997). The Dose makes the Poison: A Plain-language Guide to Toxicology, 2nd ed., (J Wiley & Sons).
7. A-Z Guide to Drug-Herb-Vitamin Interactions, 2nd ed., Gaby, Batz, Chester and Constantine, eds. (Three Rivers Press: 2006).
8. Gilbert. (2004). A Small Dose of Toxicology: The health effects of common chemicals, (CRC Press).
9. Gibson. (2000). Multiple Chemical Sensitivities: A survival guide, (New Harbinger Publications).
10. Cupp and Karch. (2000). Toxicology and Clinical Pharmacology of Herbal Products, eds. (Springer-Verlag).
11. Lawson. (2000). Staying Well in a Toxic World, (Lynwood Press).

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22MY4701					
TITLE OF THE COURSE	FOOD AND DIARY MICROBIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
• To equip the students about the importance of microorganisms in our global society. • To relate microbes in interdisciplinary connections with other sciences, in particular to productions, food sciences and dairy products • To exhibit depth of knowledge by demonstrating microbial sciences in the field of applied fields of food and dairy microbiology.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will be acquainted with depth of understanding on fermentation technology, modern microbial techniques and analysis relating to food and dairy microbiology.	L1
CO2	Enable the students to understand the diversity of microbial, structure, function and their environment	L2
CO3	Students will be equipped with fundamental knowledge of microbial growth patterns and kinetic studies enabling them to apply the same in various allied fields.	L3
CO4	It will develop problem solving capabilities in practical working in teams in laboratory/industries based on virtual experiments to gather and evaluate microbial data using a range of current analysis techniques relating to productions, food sciences and dairy products and their waste management.	L4

COURSE CONTENT:
MODULE 1: 15 Hrs BASICS OF FOOD MICROBIOLOGY: Scope and Development of Food Microbiology, Food as a substrate for microorganisms. Principles and methods of food preservation by Physical, Chemical and food Additives, Bio-preservation. Microbial spoilage of food: Causes and sources of food spoilage. Food borne Infections and Intoxications. Bacteria – Clostridium. Virus-

HepatitisA, Sea toxicants; Mycotoxins (Aflatoxins, Ochratoxins, and others).	
MODULE 2:	15 Hrs
FERMENTED FOODS: Fermented Vegetables, Meat Sausages, Beverages, Bread and Idli. Nutritional and therapeutic importance of Edible mushrooms, Single cell Protein, Probiotics and Symbiotics; Nutraceuticals, Quorn and their industrial production. Food control Agencies: HACCP, Employees Health standards, GMP. Industrial effluents treatment, Criteria of microbiological quality control.	
MODULE 3:	15 Hrs
BASIC OF DAIRY MICROBIOLOGY: Nutritional level and microbial flora of milk. Sterilization of milk; predominant types of microorganisms in chilled and refrigerated milk and their importance; heat resistant bacteria and their role in milk spoilage; principles of quality control tests for milk; bacteriological grading, antimicrobial properties in milk, Microbiology of fermented milk - Starter lactic cultures.	
MODULE 4:	15 Hrs
MICROBIOLOGY OF DAIRY PRODUCTS: Production and role of microbes in lactic acid, Cream, butter, ice-cream and indigenous dairy products such as yogurt, acidophilus milk, dahi, kefir, koumiss, Shrikhand, cultured butter milk, cheese, and acidophilus milk. Biosensors in Food Industry: Principle, types and applications; Genetically modified foods; Food fortification.	

TEXT BOOKS/REFERNCES:

1. Robert H. (2006). Microbiology and Technology of Fermented Foods. Blackwell Publishers.
2. Matthew Rimmer. (2008). Intellectual Property and Biotechnology: Biological Inventions Edward Elgar. Betty C. Hobbs. Food Microbiology, Arnold-Heinemann Publishing Private Limited, New Delhi.
3. Frazier and Wasthoff. (2008). Food Microbiology, Tata McGraw-Hill Publishing Company Limited, New Delh Frazier, C.W. and Westhoff, C.W. Food Microbiology. 4th Edition, Tata McGraw Hill Education Private Limited, New Delhi.
4. Mary E.T and Richard E. I. (2003). Microbial Food Safety Animal Agriculture: Current Topics, Iowa state University Press.
5. Bibek R. (2001). Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press.
6. Adams M.R. and Moss M.O. (2000). Food Microbiology. Royal Publishing Corporation.
7. John G. (1997). Essentials of Food Microbiology. Arnold International Students Edition.
8. Stanbury PF, Whitakar A and Hall SJ. (2013). Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
9. Robert Mellor. (2009). Entrepreneurship for Everyone: A student Textbook. SAGE Publication.
10. M.P. Dayle et al. (2001). Food Microbiology: Fundamentals & Frontiers, 2nd edition, ASM press. 8
11. Adams, M.R. and Moss M.O. (1995). Food Microbiology, Royal Society of Chemistry Publication, Cambridge.

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| <ol style="list-style-type: none">12. James M. Jay, Martin J. Loessner, David A. Golden, David Allen Golden (2005).
Modern Food Microbiology. Springer.13. Casida L.E.J.R (2015). Industrial Microbiology, New Age International, New Delhi. |
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PRACTICALS

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| 1. Production and estimation of lactic acid from microbes. |
| 2. Production and estimation of citric acid from microbes. |
| 3. Determination of quality of raw milk by methylene blue reduction test and SPC method. |
| 4. Immobilization technique: whole cell or enzyme- sodium alginate gel method |
| 5. Isolation and characterization of yeast from food samples. |

REFERENCES:

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| <ol style="list-style-type: none">1. K. R. Aneja. (2008). Textbook of Basic and Applied Microbiology. New Age International.2. Casida L.E.J.R. (2015). Industrial Microbiology, New Age International, New Delhi.3. Prescott S.C and Dunn C.C. (2005). Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.4. Stanbury PF, Whitakar A and Hall SJ (2013). Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.5. McNeil B and Harvey LM. (2008). Fermentation. A Practical Approach, IRL press, New York. |
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SEMESTER	VII					
YEAR	IV					
COURSE CODE	22MY4702					
TITLE OF THE COURSE	ENVIRONMENTAL MICROBIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

To equip the students about the importance of microorganisms in our global society.
To create in-depth knowledge of the distribution of microorganisms in nature, their habitat and interaction with other organisms.
Helps enable the students to understand the importance of microorganisms in the environment, their role in the biogeochemical cycles and also their applications. The beneficial and harmful microorganisms are studied which helps them to know the impact of microbes in the environment.

COURSE OUTCOMES:

CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will have fundamental understanding of the distribution and habitat of microorganisms in nature. They can apply the knowledge in studying microbial diversity in various environmental niches.	L1
CO2	Enable the students to understand the diversity of microbial, structure, function and their environment	L2
CO3	Students are aware of the role of microorganisms in the environment. They will have knowledge about both positive and negative aspects of microorganisms and their interaction with other organisms.	L3
CO4	Students can apply knowledge in employing these microbes in various applications like microbial remediation etc. Concept of xenobiotics and their management, Concept of environmental monitoring of air pollution and their management.	L2

COURSE CONTENT:

MODULE 1: SOIL MICROBIOLOGY	15 Hrs

Soil morphology; Biotic and abiotic interactions; Habitat and niche; Diversity and distribution (Rhizosphere, Mycorrhizosphere, Actinorhizae); Soil erosion and soil conservation; Microbial interaction in soil; Soil pathogens and soil microflora and human health. Biogeochemical cycles - Carbon cycle, Nitrogen cycle and Sulphur cycle; Hg transformation. Diversity in anoxic eco system.	
MODULE 2: AQUATIC BIOLOGY AND SEWAGE TREATMENT	15 Hrs
Aquatic Microbiology: Microbial flora of aquatic environment, Upwelling; Marine microbiology; Hydrothermal vents, Nutrients in aquatic environments; Water pollution and water borne diseases; Eutrophication; Water purification; Water quality assays and public health (SPC, MPN, MFT, ONPG and MUG). Sewage treatment: Primary, Secondary and Tertiary treatment. Solid waste treatment (Landfills and Composting); Biogas production; Methanogens and methylotrophs. Newer approaches to sewage treatment and Enzyme technology for treating Industrial waste water.	
MODULE 3: AEROBIOLOGY	15 Hrs
Air microflora in different layers of atmosphere, bioaerosol; Microbiology of indoor and outdoor air; Significance of microorganisms in air; Enumeration of microorganisms in air: Impingement in liquids, Impingement in solids, suction and filtration. Molecular methods of air quality assessment; The Greenhouse effect, Ozone depletion, UV radiation and Acid rain. Aeroallergens and Allergies: Causes and tests for detection of aero allergens.	
MODULE 4: BIOLEACHING AND BIODEGRADATION	15 Hrs
Bioremediation: Principles, microorganisms and microbe-mineral interactions. Bioremediation of copper, uranium and gold; Dump, heap and bioreactor operations. Role of acidophilic microorganisms in environmental pollution. Biodegradation: Biodegradation of xenobiotic compounds and Recalcitrant compounds, Mechanism and enzymes involved. Role of plasmids in biodegradation. Biodegradation of cellulose, lignin and plastic. Hazards from xenobiotics. Microbiology of environmental remediation. Bioremediation of soil and water 'in-situ' remediation. Bioremediation of oils, Biosorption; Phytoremediation	

TEXT BOOKS/REFERNCES:

1. Bhatia A.L. (2009). Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi.
2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition, Benjamin/Cummings Science Publishing, USA
3. Francis H Chapelle. (2000). Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press.
4. Barton LL & Northup DE. (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
5. Baker K.H and Herson D.S. (2016). Bioremediation. Mc Graw Hill Inc., New York.
6. Jabir Singh Solid Waste Management. (2010). I. K. International Publishing House Ltd. New Delhi.
7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
9. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
10. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition,

Springer, New York.

11. Singh A, Kuhad, RC & Ward OP. (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg
12. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
13. Jogdand. (2006). Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 9. Robert L Tate, Soil Microbiology, 2nd Edition, John Wiley and Sons.
14. Christopher S Cox, Christopher M Wathes. (2020). Bioaerosols Handbook. Lewis Publishers.
15. Grant W.D and Long P.E. (1981). Environmental Microbiology. Kluwer Academic Publisher.
16. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills. (2007). ASM Press.

PRACTICALS

1. Determination of Total solids and Dissolved Oxygen in water samples.
2. Determination of Biological Oxygen Demand (BOD) in water samples.
3. Determination of Chemical Oxygen Demand (COD) in water samples.
4. MPN test for potability of water.
5. Study of microbial interactions in soil (antagonism).

TEXT BOOKS/REFERNCES:

1. K.R. Aneja (2007). Experiments in Microbiology, Plant Pathology and Biotechnology
2. R.C Dubey, D.K Maheshwari (2002), Practical Microbiology. S Chand and Company, New Delhi.
3. James G. Cappuccino, Natalie Sherman. 2014, Microbiology: a laboratory manual. Pearson Education, Boston [Massachusetts]
4. Pepper, I., Gerba, C. P., Gentry, T., & Maier, R. M. (Eds.). (2011). *Environmental microbiology*. Academic press.
5. Cindy H. Nakatsu, Richard L. Cerniglia, and Ian L. (1962). Manual of Environmental Microbiology by Pepper: A practical guide that provides detailed protocols and methods for studying microorganisms in various environmental samples, including soil, water, and air.
6. Bitton, G. (2014). *Microbiology of drinking water: production and distribution*. John Wiley & Sons.

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22MY4703					
TITLE OF THE COURSE	MICROBIAL PLANT INTERACTIONS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :
1. The course aims to impart knowledge about the interaction of microorganisms with plants, mainly crop plants. The beneficiary aspects of the microbes by helping the plant growth and also increasing the plant health by avoiding diseases and disorders are studied.
2. The course also deals with the plant diseases caused by microorganisms, where microorganisms play a major role in plant health and yield. Collectively, the course helps students to gain fundamental knowledge of role of microorganisms in agriculture.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will be equipped with knowledge about the importance of microorganisms in agricultural field.	L3
CO2	They can understand how to employ microorganisms to enhance agricultural productivity.	L4
CO3	The knowledge of plant pathology will help students to understand microbial diseases in plants, so they understand disease predictions and the prevention measures.	L2
CO4	They will have knowledge about both positive and negative aspects of microorganisms and their interaction with other organisms.	L1
CO5	The course helps them to apply knowledge in employing microbes in various fields.	L4

COURSE CONTENT:	
MODULE I: PLANT-MICROBE INTERACTIONS	15 Hrs
Distribution of microorganisms in soil, soil fertility evaluation and improvement. Role of microorganisms in soil fertility. Decomposition of organic matter by microorganisms: cellulose, hemicellulose, lignin, xylan and pectin. Biological nitrogen fixation: Symbiotic nitrogen fixation, (<i>Rhizobium</i> , <i>Frankia</i>), non-symbiotic nitrogen fixation <i>Azotobacter</i> , <i>Azospirillum</i>). Concepts of siderophores and VAM with suitable examples. Application of nitrogen fixing genes in rDNA technology in agriculture research.	
MODULE II: HOST PATHOGEN INTERACTION AND DEFENSE MECHANISM	15Hrs
Host Pathogen Interaction: Infectious diseases, non-infectious diseases, Koch's postulates. Parasitism and pathogenicity, Host range of pathogens, Disease triangle, Diseases cycle/Infection cycle, Relationship between disease cycles and epidemics; Mode of entry into the host plant-mechanical forces, microbial enzymes, toxins and growth regulators. Defense Mechanisms: Plant Disease Pre-existing structural and chemical defenses. Induced structural (histological-cork layer, abscission layer, tyloses, gums) and biochemical defenses (hypersensitive response), systemic acquired resistance phytoalexins, pathogenesis related (PR) proteins, PGPR and plantibodies.	
MODULE III: PLANT DISEASES AND THEIR MANAGEMENT	15Hrs
Plant diseases- Red rust of tea (Algae), Grain and head smut of Sorghum (Fungi), Root knot of mulberry (Nematode). Papaya ring spot (Virus), Sandal Spike Disease (Mycoplasma), Citrus canker (Bacteria). Plant disease control: Classification of plant diseases and plant diseases control. Principles and methods in disease control – Legislative methods (quarantine, crop certification), cultural methods (host eradication, crop rotation, and sanitation), soil and sand treatment (Controlling water flow, adding fertilisers, filtering water.), biological control (Suppressive soil and microbial antagonism) and chemical control (fungicides) Control through resistant varieties and quarantine. Plant disease epidemics and forecasting, plant clinic and plant doctor concept. Diagnosis of plant diseases, regulatory, farming education and awareness.	
MODULE IV: BIOINOCULANTS AND PRODUCTION	15Hrs
Biofertilizer - types, production and quality control. Cultivation and mass production of bioinoculants- <i>Rhizobium</i>, <i>Azotobacter</i>. Phosphate solubilizing microorganisms. Carrier-based inoculants–production, applications and limitations. Nano formulations. Biopesticides: Types and mechanism of application of different varieties. <i>Pseudomonas fluorescens</i>, <i>Bacillus thuringiensis</i>, <i>Trichoderma harzianum</i>, Nuclear Polyhedrosis Virus. Production, applications and limitations. Nano formulations.	

REFERENCES

1. Alexander M. (1977). Introduction to Soil Microbiology. Wiley Eastern Limited, New Delhi.

2. Alexopoulos C.J and Mims C.W. (1979). Introductory Mycology. New Age International, New Delhi.
3. Aneja K.R. (2007). Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. (2005). Plant Pathology, Fifth Edition, Elsevier Academic Press.
5. Mehrotra R.S. (2003). Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbaroa N.S. (2017). Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.
7. Bhatia A.L. (2009). Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi.
8. Atlas R.M. (2000). Handbook of media for environmental microbiology. CRC press.
9. Francis H Chapelle. (2000). Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press.
10. Baker K.H and Herson D.S. (1994). Bioremediation. McGraw Hill Inc., New York.
11. Indu Shekhar Thakur. (2011). Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi
12. Singh A and Ward O.P. (2004). Applied Bioremediation, Springer.
13. Singh A, Kuhad R.C. Ward O.P. (2009). Advances in Applied Bioremediation. Springer.
14. K.R. Aneja. (2007). Experiments in Microbiology, Plant Pathology and Biotechnology.
15. R.C Dubey, D.K Maheshwari, S Chand. (2012). Practical Microbiology. New Delhi.
16. Microbiology Laboratory Manual - Cappuccino, Sherman, Pearson Education.
17. Manual of Microbiology Kanika Sharma Ane Books Pvt. Ltd.

PRACTICALS

1. Isolation of symbiotic and non-symbiotic nitrogen fixing microorganisms.
2. Effect of seed borne fungi on seed germination and seed vigor.
3. Estimation of total phenols in diseased and healthy plant tissues.
4. Isolation of phosphate solubilizing bacteria.
5. Study of microbial interactions in soil (antagonism).

REFERENCES:

1. Nicholl DST. (2002). An Introduction to Genetic Engineering. Cambridge University Press.
2. Sandhya M. (2008). Genetic Engineering: Principles and Practice. MacMillan India. 2008.
3. Primrose SB and RM Twyman. (2006). Principles of Gene Manipulation and Genomics, Blackwell Publishing MA. USA.
4. K.R. Aneja. (2007). Experiments in Microbiology, Plant Pathology and Biotechnology
5. R.C Dubey, D.K Maheshwari, S Chand. (2012). Practical Microbiology. New Delhi.

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22BS4701					
TITLE OF THE COURSE	RESEARCH METHODOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
To provide an overview of essential research steps to be followed when conducting research / project work.
To understand chief ingredients to be incorporated in conduct as well as writing of scientific reports/dissertation/thesis
To know the implication professional research ethics and common misconduct details of researcher and research work

COURSE OUTCOME		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Show and explain the concepts of meaning of research, scope of research including different types of research, scientific research process and research methodology steps	L1
CO2	Perform review of literature using electronic media, selecting research problem formulate research problem statement, writing hypothesis, explain criteria of forming objectives, materials and methods, results and discussion	L2
CO3	Identify and explain experimental research designs for both qualitative and quantitative research	L2
CO4	Explain different sampling methods and sampling design, basic statistical methods for treatment of data and observations	L2

CO5	Demonstrate ingredients and components of a research report, dissertation and thesis and explain integral components of research article and research proposal	L2
CO6	Explain professional research ethics and elaborate on misconduct in research	L2

COURSE CONTENT:

MODULE 1:	12 hrs
INTRODUCTION TO RESEARCH: Meaning, Objectives and Characteristics of research – Scientific Method Types of research - Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical - Research process - Criteria of good research PROBLEM STATEMENT: Defining the research problem - Selecting the problem - Necessity of defining the problem - Techniques involved in defining the problem; LITERATURE SURVEY: Importance of literature review in defining a problem - Survey of literature - Primary and secondary sources - web as a source - searching the web - Identifying gap areas from literature review. HYPOTHESIS: Definition of hypothesis, Basic concepts, variables-Dependent and independent variables, Development of working hypothesis; Ingredients of Research Objectives, deriving objectives of research.	
MODULE 2:	12 hrs
Sampling, Material and Methods: Sample- Sampling - Types of sampling; Material - Experiments, Data – Basics of Analysis; Writing materials and method chapter of a research report Results and Discussion: Representation of results; Tables, graphs; Discussion, Purpose and Function of Discussion Research Designs: Research design; Need of research design - Basic Principles; Features of good design – Important concepts relating to research design; Max-min-con principle, Common Research Designs: Cross-sectional, Case-control, Longitudinal and Cohort research designs, advantages and disadvantages of each of research designs Summary and Conclusion: Writing of Summary, conclusions of research findings, Acknowledgement section of a research report and an article.	
MODULE 3:	10Hrs
Research Ethics: Values, Ethics and Morals, Research Professionalism, Tenets of Ethics; Conducting and reporting of science/engineering; Relationship in research groups; Hazards to good scientific practice; Scientific misconduct: Fabrication, Falsification and Plagiarism. Report and Article Writing: Structure and components of scientific reports; Abstract-Key words; Types of reports; Significance of reporting; Different steps in the preparation of reports; Layout, structure and Language of typical reports; References; Citation styles- APA and MLA styles of citation, intext and end text citations. Oral Presentation: Importance of effective communication. Planning; Preparation; Practice; Making presentation; Use of visual aids.	
MODULE 4:	11Hrs

Scientific Article Writing: Title preparation - Importance of title; need for specific titles; List of authors and addresses - order of names; defining the order with example; types of abstracts; economy of words; How to write introduction- Rules; exceptions; citations and abbreviations Materials and methods: Purpose; materials; methods; tables and figures; form and grammar; Result and Discussion writing: content of results; handling numbers; clarity; avoiding redundancy; Discussion writing: Components of discussion; factual relationships; strengths and limitations; significance of paper; Stating Acknowledgements: Ingredients of the acknowledgements; courtesy; Citation of the References: Rules; electronics aid; in-text citation; styles of referencing

Research Proposal Fundamentals: What is a grant proposal? Why proposals fail?; Developing and writing of grant proposals; overview of steps to develop grant proposals; Proposal Development Process: Standard Proposal Parts; writing Budget section.

Intellectual Property Rights: IPRs- Invention and Creativity- Intellectual Property- Importance and Protection of Intellectual Property Rights (IPRs); A brief summary of: Patents, Copyrights, Trademarks

REFERENCES:

1. Bruce Tuckman, Brian E Harper. (2016). Conducting Educational Research, 6th Edition, 2012 by Rowman & Littlefield Publishers, Inc. ISBN 978-1-4422-0965-7 (electronic)
2. Kothari, C.R. (1990). Research Methodology: Methods and Techniques. New Age International. 418p.
3. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K. (2002). An introduction to Research Methodology, RBSA Publishers.
4. Anderson, T. W. (2003). An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
5. Sinha, S.C. and Dhiman, A.K. (2002). Research Methodology, EssEss Publications. 2 volumes.
6. Trochim, W.M.K. (2005). Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
7. Day, R.A. (1992). How to Write and Publish a Scientific Paper, Cambridge University Press.
8. Fink, A. (2009). Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
9. Coley, S.M. and Scheinberg, C. A. (1990). Proposal Writing. Sage Publications.

MINOR COURSES OFFERED

SEMESTER	IV					
YEAR	II					
COURSE CODE	22MY2404					
TITLE OF THE COURSE	MICROBIAL FERMENTATION					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To equip the students about the importance of microorganisms in our global society.
- To exhibit depth of knowledge by demonstrating microbial sciences in the field of applied fields of industrial, food and dairy microbiology.
- To relate microbes in interdisciplinary connections with other sciences, in particular to industrial productions, food sciences and dairy products.

COURSE OUTCOMES:

CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will be acquainted with fundamental aspects of basic fermentation microbiology and techniques	L1
CO2	Enable the students to understand the diversity of microbes to be used in various applications	L2
CO3	Students will be able to understand the importance of microorganisms	L3
CO4	Students will be equipped with fundamental knowledge of microbial fermentation with parameters, productions, applications enabling them to apply in various fields.	L2
CO5	The course will enable the student to apply the knowledge in various aspects of fermentation or industrial microbiology	L2

COURSE CONTENT:	
MODULE 1: INTRODUCTION TO INDUSTRIAL MICROBIOLOGY	15Hrs
Screening, isolation of industrially important microbes. Strain improvement- mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centers. Basic components and design of typical fermenter. Types of fermenter-Laboratory, pilot- scale and production fermenters; tower fermenter, fluidized bed bioreactors and air-lift fermenter. Types of fermentation - Batch, chemostat, submerged and solid-state fermentation. Different parameters affecting fermentation.	
MODULE 2: INDUSTRIAL BIOPROCESSING	15Hrs
Upstream Processing: Nutrients: growth factors, carbon, nitrogen, mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization; inoculum preparation. Downstream processing: Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid extraction, Solvent recovery, chromatography, Membrane processes, Drying, Crystallization. Productions and Applications: Alcohol production, organic acids (citric acid). Vaccines (Hepatitis B), hormones (human insulin), antibiotic (Penicillin). Applications of genetic engineering in industrial bioprocessing.	
MODULE 3: FOOD MICROBIOLOGY AND FOOD PRESERVATION	15Hrs
Food as a substrate for microorganisms; Principles and methods of food preservation by Physical, Chemical and food Additives, Bio-preservation. Microbial spoilage of food: Causes and sources of food spoilage. Food borne Infections (E. coli) and Intoxications. Bacteria – Clostridium botulinum. Virus- Hepatitis A, Mycotoxins (Aflatoxins). Fermented foods: Sauerkraut, Beverages, Bread and Idli. Nutritional and therapeutic importance: Single cell Protein, Prebiotics, Probiotics and Synbiotics; Nutraceuticals. Food control Agencies: HACCP, GMP. Industrial effluents treatment (Biological treatment).	
MODULE 4: DAIRY MICROBIOLOGY	15Hrs
Nutritional level and microbial flora of milk. Sterilization of milk; predominant types of microorganisms in chilled and refrigerated milk and their importance; heat resistant bacteria and their role in milk spoilage; principles of quality control tests for milk; bacteriological grading. Microbiology of dairy products: yogurt, acidophilus milk, curd, kefir, koumiss, cheese. Biosensors in Food Industry; Food fortification.	

TEXT BOOKS/REFERNCES:	
1. Casida L.E.J.R. (2015). Industrial Microbiology, New Age International, New Delhi. 37 2. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2013). <i>Principles of fermentation technology</i>. Elsevier. 3. Michael J. Waites, Neil Morgan, John S. Rockey, Gray A. Higton. (2001). Industrial Microbiology: An Introduction, Blackwell Science. 4. Robert H. (2006). Microbiology and Technology of Fermented Foods. Blackwell Publishers. 5. Matthew Rimmer. (2008). Intellectual Property and Biotechnology: Biological Inventions Edward Elgar. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Limited, New Delhi. 6. James M.J. (2005). Modern Food Microbiology. CBS Publishers and Distributers, Delhi. 7. Bibek R. (2001). Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press. 8. Adams M.R. and Moss M.O. (2000). Food Microbiology. Royal Publishing Corporation. 9. John G. (1997). Essentials of Food Microbiology. Arnold International Students Edition.	

10. Wulf Crueger. (2016). A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
11. Robert Mellor. (2009). Entrepreneurship for Everyone: A student Textbook. SAGE Publication.
12. Frazier and Wasthoff. (2008). Food Microbiology, Tata McGraw-Hill Publishing Company Limited, New Delh Frazier, C.W. and Westhoff, C.W. Food Microbiology. 4th Edition, Tata McGraw Hill Education Private Limited, New Delhi.
13. Mary E.T and Richard E. I. (2003). Microbial Food Safety Animal Agriculture: Current Topics, Iowa state University Press.
14. Bibek R. (2001). Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press.
15. Robert Mellor. (2009). Entrepreneurship for Everyone: A student Textbook. SAGE Publication.
16. M.P. Dayle et al. (2001). Food Microbiology: Fundamentals & Frontiers, 2nd edition, ASM press. 8
17. Casida L.E.J.R. (2015). Industrial Microbiology, New Age International, New Delhi.

PRACTICALS

1. Isolation of microorganisms from fruits or vegetables.
2. Production and determination of amylase activity.
3. Preparation of wine.
4. Study of different types of fermenters (Models/ Charts).
5. Cell immobilization techniques (yeast cells).
6. Determination of quality of raw milk by methylene blue reduction test.
7. Estimation of lactic acid from different diary product.
8. Estimation of alcohol by specific gravity method.

REFERNCES:

1. K. R. Aneja. (2008). Textbook of Basic and Applied Microbiology. New Age International.
2. Casida L.E.J.R. (2015). Industrial Microbiology, New Age International, New Delhi.
3. Prescott S.C and Dunn C.C. (2005). Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
4. Stanbury PF, Whitaker A and Hall SJ. (2013). Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
5. McNeil B and Harvey LM. (2022). Fermentation. A Practical Approach, IRL press, New York.

SEMESTER	V					
YEAR	III					
COURSE CODE	22MY3503					
TITLE OF THE COURSE	MEDICAL MICROBIOLOGY AND DIAGNOSTICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-		-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
This course provides an overview on the role of microbiome in human health and disease
To introduce basic principles and application relevance of clinical disease for students
The course will provide the conceptual basis for understanding pathogenic microorganisms and particularly address the fundamental mechanisms of their pathogenicity
It will also provide opportunities for a student to develop diagnostic skills in microbiology, including the practical application and interpretation of laboratory tests for the diagnosis of infectious diseases

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Enable the students to understand the normal microbiome and its relevance to human health.	L2
CO2	The course will provide the conceptual basis for understanding pathogenic microorganisms and particularly address the fundamental mechanisms of their pathogenicity.	L3

CO3	Students will acquire and demonstrate competency in laboratory safety and in routine and specialized microbiological laboratory skills applicable to microbiological research or clinical methods, including accurately reporting observations and analysis.	L3

COURSE CONTENT:

MODULE 1: NORMAL MICROBIAL FLORA	15Hrs
Factors determining the nature of the normal flora. Normal flora of skin, respiratory system, nervous system, digestive system and urinary and reproductive systems. Beneficial effects of the normal flora. Attributes of microbial pathogenicity: Pathogenicity, Virulence factors, invasion. Toxins: Exotoxins, Enterotoxins and Endotoxins. Types of infections (non communicable and communicable infections. Nosocomial infection, zoonotic diseases, opportunistic pathogens). Routes of transfer. Factors affecting host susceptibility to disease. Immune response to infection.	
MODULE 2: ANTIBIOTICS AND VACCINES	15Hrs
Mode of antimicrobial action – antibacterial, antimycobacterial, antifungal, antiviral, antiprotozoal, anthelmintic. Microbial resistance to antibiotics. Molecular principles of drug targeting; Drug delivery system in gene therapy. Vaccine: Inactivated Attenuated, Conjugated, Recombinant vaccines - synthetic peptide vaccines, Multivalent subunit vaccines, DNA vaccines. Immunization schedule and its significance. Secondary metabolites from microorganisms.	
MODULE 3: IMMUNOLOGICAL TECHNIQUES	15Hrs
Production and application of Monoclonal antibodies. Types and Principles of Ag-Ab reactions - Precipitation, Agglutination, Complement fixation and its applications. Immunodiffusion, Immunoelectrophoresis, ELISA, RIA, Immunofluorescence, Western Blotting (Immunoblotting), Flow cytometry and Immunoelectron microscopy.	
MODULE 4: DIAGNOSTICS AND BIOMEDICAL MANAGEMENT	15Hrs
Diagnostic Microbiology: Collection, transport and storage guidelines; biosafety in diagnostic laboratory and regulations, specific procedures for collection of specimens, processing of specimens. RT-PCR, RAT (Rapid Antigen Test), TrueNat (TB and Covid-19). Biomedical waste segregation, treatment and management.	

TEXT BOOKS/REFERNCES:

1. Anathnarayana and Panikar. (2013). Text Book of Microbiology, 9th Edition. University press.
2. Richard A, Goldsby, Thomas J, Kindt, Barbara A and Osborne. (2000). Kuby Immunology. 4th Edition. W.H. Freeman and Company, New York.
3. Kuby J. (2006). Immunology 6th Edition. W.H. Freeman and company, New York.
4. Warren Levinson. (2000). Medical Microbiology and Immunology, Examination and Board Review. 8th Edition. McGraw Hill.
5. Tortora, Funke, Case. (2009). Microbiology, 9th Edition. Benjamin Cummings.
5. Connie R Mahon. (2010). Text book of diagnostic Microbiology. 3rd edition, Pearson.
6. Fritz H Kayser. (2005). Medical microbiology. ThiemeVerlag.
8. Mackie and McCarthey Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology,

Churchil Livingstone.

7. Frank and Steven A. (2002). Immunology and evolution of Infectious Diseases. Princeton University Press.
8. Wadher and Bhoosreddy. (2005). Manual of Diagnostic Microbiology. Himalaya Publisher.
9. Kufe. (2003). Cancer Medicine. BC Decker Inc.
10. Leslic Collier, John Oxford. (2000). Human virology a text book for students of medicine, dentistry and microbiology. 2nd edition. Oxford university press.
11. Credric, A Mims. (2004). Medical Microbiology, 3rd Edition. Mohshy Inc.
12. Nester Roberts Pearsall Anderson. (2004). Microbiology- a human perspective, 2nd Edition, McGraw-Hill.

PRACTICALS

1. Isolation and identification of normal microflora on simple, selective and enrichment media (throat, skin and nasal sample). **(3 units)**
2. Dental caries susceptibility assay by Snyder's agar test
3. Determination of effectiveness of antiseptics by thumb impression method.
4. Serological reactions: **(3 UNITS)**
 - a) Agglutination - Blood grouping and Rh typing
 - b) Precipitation reactions: Radial ImmunoDiffusion,
 - (c) Ouchterlony Double Diffusion

REFERNCES:

1. Funke, B. R., Tortora, G. J., Case, C. L. (2013). Microbiology: An Introduction. United Kingdom: Pearson.
2. Mackie and McCarthy. (1996). Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchill Livingstone.
3. Frank and Steven A. (2002). Immunology and evolution of Infectious Diseases. Princeton University Press.
4. Wadher and Bhoosreddy. (2005). Manual of Diagnostic Microbiology. Himalaya Publisher.
5. Credric, A Mims. (2004). Medical Microbiology, 3rd Edition. Mohshy Inc.
6. James G. Cappuccino, Natalie Sherman (2014) Microbiology: A Laboratory Manual. Pearson.
7. Leslic Collier, John Oxford. (2000). Human virology a text book for students of medicine, dentistry and microbiology. 2nd Edition. Oxford university press.

SEMESTER	VI					
YEAR	III					
COURSE CODE	22MY3603					
TITLE OF THE COURSE	MICROBIOME AND EXTREMOPHILES					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
To equip the students with the basics of Metagenomics.	
The course will provide the conceptual basis of ubiquity of microbes in extreme environment	
To enable the students to understand the commercial relevance of extremophiles	

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Enable the students to describe the primitive life form and adaptation of microbes to it	L2
CO2	The course will help the students to describe distribution, classification of Extremophiles	L3
CO3	Techniques and approaches in the exploration of uncultured microbial majority and Microbiome Biology	L1
CO4	Applications can be variedly used by students in different fields.	L2

COURSE CONTENT:	
MODULE 1: MICROBIOME AND ITS APPROACHES	15 Hrs

Microbiome: History of microbiome perspective, environmental genomics-microbiomes of oceans and terrestrial ecosystems, Microbiome ecology, Microbiome evolution. Earth Microbiome project. Approaches in Microbiome analysis, Metagenomics (open and closed formats), Metatranscriptomics, Pan-genomics, Epigenomics, Microfluidics technology in human microbiome, single cell genomics. Metagenomics of archeological samples, Sargasso Sea project. Advance culturing techniques to study microbiomes.

MODULE 2: HUMAN MICROBIOME AND DISEASE BIOLOGY

15 Hrs

Human microbiome: biodiversity and major genera of human-microbiome, human- microbiome system as a "holobiont" or "superorganism. Microbiome distributions in healthy individuals; composition of specific body sites 'microbiome: nose, skin, oral, urogenital, etc. Fecal transplants. Designer probiotics, Symbiosis- Dysbiosis -Rebiosis. Personnel microbiome concepts.

Microbiome and disease biology: gut-brain conversation, obesity and gut microbiome, infectious diseases and gut microbiome, non-infectious diseases and gut microbiome, microbiome's role in diseases -Inflammatory bowel disease (IBD), obesity. Effects of diet on microbiome.

MODULE 3: EXTREMOPHILES

15 Hrs

Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, radiation & low nutrient levels; life on other planets. Difference between bacteria, archaea and eukaryotes. Classification and salient features of each Archaeal group. Genetic and Metabolic diversity of extremophiles.

MODULE 4: ADAPTATIONS AND APPLICATIONS OF EXTREMOPHILES

15 Hrs

Microbial diversity and its application in modern science.

THERMOPHILES and PSYCHROPHILES: Basic concept, classification, adaptations and significance.

ALKALIPHILES and ACIDOPHILES: Basic concept, classification, adaptations and significance.

PIEZOPHILES/ BAROPHILES: Basic concept, classification, adaptations and significance.

XEROPHILES AND RADIATION resistant microbes and applications.

TEXTBOOKS/ REFERENCES:

1. David N. Fredricks and David A. Relman (2012). "The Human Microbiota: How Microbial Communities Affect Health and Disease" Wiley-Blackwell
2. Lesley Hoyles, Harry J. Flint, and Elaine E. Vaughan (2018). "The Gut Microbiome: An Introduction" John Wiley & Sons
3. Lisa A. Murdock and Nicholas P. Money. (2017). The Microbiome Handbook: Current Research and Applications. CRC Press.
4. Robynne Chutkan. (2015). The Microbiome Solution: A Radical New Way to Heal Your Body from the Inside Out. Avery.
5. Rob DeSalle and Susan L. Perkins. (2015). Welcome to the microbiome. getting to know the trillions of bacteria and other microbes in, on, and around you. Yale University Press.
6. Horikoshi, K., Antranikian, G., Bull, A. T., Robb, F.T., Stetter, K.O. (2011). Extremophiles Handbook, Springer Publications.
7. Horikoshi, K., Grant W. (1998). Extremophiles: Microbial Life in Extreme Environments. Wiley Publications.
8. Ramplotto, Paulo H. (2016). Biotechnology of Extremophiles: Advances and Challenges. Springer Publications.

9. Angela E. Douglas (2018). Fundamentals of Microbiome Science – how microbes shape animal biology, Princeton University Press, New Jersey, United States.

PRACTICALS

1. Retrieval of Metagenome data such as ribosomal RNA and whole genome shotgun from biological databases.
2. Bioinformatics tools and softwares used in the analysis of metagenomic data.
3. Taxonomic and Functional annotation of metagenomic data.
4. Studies on halophiles isolated from high salt habitat. (Study its pigmentation and salt tolerance phenomenon).
5. Studies on alkalophiles and its enzymes (any one) isolated from extreme alkaline environment.

REFERENCES:

1. Catherine A. Lozupone and Dan Knights. (2010). Introduction to the Human Microbiome Publisher Name: Wiley-Blackwell.
2. Jacques Ravel and Zamin Iqbal. (2017). Microbiome Analysis: Methods and Protocols Publisher Name: Humana Press.
3. Rob Knight, Jeffrey I. Gordon, and Jeffrey I. Gordon (2011). Microbes and Health Sackler Colloquium: The Human Microbiomes. National Academies Press
4. Camilla L. Nesbø, Roy M. Daniel, and Karl O. Stetter. (2008). "Methods in Microbiology, Volume 37: Extremophiles" Academic Press.
5. Aharon Oren and Friedhelm Meinhardt. (2012). "Methods in Microbiology, Volume 41: Extremophiles Handbook" Academic Press.
6. Yanhe Ma, R. Thane Papke, and Qiang He. (2020). "Methods in Microbiology, Volume 47: Extremophiles" Academic Press.

SEMESTER	IV					
YEAR	II					
COURSE CODE	22CY2401					
TITLE OF THE COURSE	INORGANIC CHEMISTRY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

COURSE OBJECTIVES:

- To introduce the specialized subject of the chemistry of polymers
- To understand in detail the mechanisms of the reactions that lead to the formation of polymers.
- To familiarize the students with the types of polymers, the significance of their molecular mass.

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Will be able to demonstrate the composition and structure of polymers	L1
CO2	Should be able to correlate the structure of polymers to their properties and application	L2
CO3	Should be able to demonstrate the significance of polymer molecular mass.	L3

COURSE CONTENT:

MODULE 1	15 Hrs
Noble gases Introduction, isolation of Helium from Natural gas, applications of Noble gases. Preparation properties and structures of fluorides and oxides of Xenon (XeF₂, XeF₄, XeF₆, XeO₃, XeO₄). Transition elements: electronic configuration, atomic and ionic radii, ionisation energy, oxidation states, redox potentials, spectral and magnetic properties, catalytic activity, interstitial compound formation. Lanthanoids and Actinoids Electronic Configuration, Oxidation States, Spectral and Magnetic Properties, Lanthanide Contraction, Separation of Lanthanides	
MODULE 2	15 Hrs
Compounds of some Nonmetals. i) Boron and its compounds: Synthesis, structure and applications of Diborane, Borazole and Boron trifluoride. ii) Halogens and its Compounds: Bleaching powder: manufacture and its applications. Silicates : Structure of SiO₄⁴⁻, Classification of silicates based on the structure. Zeolites: their structure and applications. Inorganic Polymers: Types of Inorganic Polymers, Comparison with Organic Polymers Synthesis Structural Aspects of Silicones and Siloxanes Applications of Silicones and Siloxanes, Borazines, Silicates, Polysulphates and Phosphazenes	
MODULE 3	15 Hrs

Bioinorganic Chemistry: Metal Ions Present in Biological Systems, Geochemical Effect on the Distribution of Metals Sodium / K-Pump, Carbonic Anhydrase and Carboxypeptidase, Excess and Deficiency of Some Trace Metals, Toxicity of Metal Ions, Use of Chelating Agents in Medicine, Iron and Its Application in Bio-Systems, Haemoglobin, Storage and Transfer of Iron

Chemical Toxicology: Toxic chemicals in the environment – effects of toxic chemicals – cyanide and its toxic effects – pesticides and its biochemical effects – toxicity of lead, mercury, arsenic and cadmium.

MODULE 4

15 Hrs

Hard and soft acid and base (HSAB): Introduction, Classification of acids and bases as hard and soft, Pearson's HSAB concept: acid base strength, hardness and softness, Symbiosis, Theoretical basis of hardness and softness

Organometallic compounds: Preparation and synthetic applications of Grignard reagents, Organolithium compounds and lithium dialkylcuprates.

Fertilizers: Introduction (need of fertilizers), functions of essential plant nutrients (N,P,K), Classification of fertilizers with examples. Nitrogenous, Phosphatic and mixed fertilizers with suitable examples. Manufacture of urea and Super phosphate of lime, and their uses. Fertilizer industries in India.

TEXT BOOKS/REFERANCES:

1. A New Concise Inorganic Chemistry”, J. D. Lee, 5th Ed, Chapman & Hall, London (1996).
2. Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
3. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002.
4. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
5. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi.

EXPERIMENT
1. Systematic semi-micro qualitative analysis of a mixture of two simple salts (At least seven mixtures of salts with no interfering radicals).
2. Separation of metal ions (Cu^{2+} , Co^{2+} , Ni^{2+} , Fe^{2+}) using paper chromatography and calculation of R_f values.
3. Separation of $\text{Mg}(\text{II})$ and $\text{Fe}(\text{II})$ by solvent extraction technique.
TEXT BOOKS/REFERENCES: 1. Vogel's Text Book of Practical Organic Chemistry, 5 th Edition, A.J. Hannford, A.R. Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication. 2. Chemistry Practical Inorganic Qualitative Analysis For Under Graduate Students, M.J. Mamtara, S.C. Karad, J.S. Makasana, Lap Lambert Academic Publishing. 3. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication.

SEMESTER		IV				
YEAR		II				
COURSE CODE		22CY2402				
TITLE OF THE COURSE		PHYSICAL CHEMISTRY - I				
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4		4		60	5

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

Students should gain a deep understanding of the basic concepts of thermodynamics, including the laws of thermodynamics, internal energy, heat, work, entropy, and the different thermodynamic functions.
Through a variety of exercises and real-world examples, students should develop strong problem-solving skills related to thermodynamics in chemistry, enabling them to tackle complex thermodynamic problems.
Students should be able to apply kinetic theories and concepts to analyse and predict the behaviour of chemical reactions, including reaction mechanisms, reaction order, and the effects of temperature, concentration, and catalysts on reaction rates.
Students should be able to identify and understand the relevance of chemical kinetics in various real-world applications, such as industrial processes, environmental chemistry, and pharmaceutical research.
Students should be able to understanding of ionic equilibria in aqueous solutions and their role in chemical reactions.
To make students understand the principles of surface chemistry and its relevance in various chemical and material systems.

COURSE OUTCOMES:

CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students should be able to articulate and explain the laws of thermodynamics, including the first, second, and third laws, and understand their significance in the context of energy and chemical systems.	L1
CO2	Students should be proficient in performing calculations involving thermodynamic quantities, such as heat transfer, work done, changes in internal energy, entropy changes, and Gibbs free energy changes.	L2
CO3	Students should be able to apply kinetic theories and concepts to analyze and predict the behavior of chemical reactions, including reaction mechanisms, reaction order, and the effects of temperature, concentration, and catalysts on reaction rates.	L3

CO4	Students should be able to identify and understand the relevance of chemical kinetics in various real-world applications, such as industrial processes, environmental chemistry, and pharmaceutical research.	L2
CO5	Students should be able to apply the principles of ionic equilibria to predict the behavior of weak acids and bases in aqueous solutions, including calculating pH, determining the relative strengths of acids and bases, and identifying the dominant species present at different pH levels. They should be able to predict the direction of these equilibria and calculate equilibrium constants under different conditions.	L1
CO6	Students should be able to explain the fundamental principles underlying surface chemistry, including surface tension, adsorption, catalysis, and the behavior of colloids. They should be able to apply these principles to analyze and interpret surface-related phenomena in different chemical and material systems.	L2

COURSE CONTENT:

MODULE 1	15Hrs
Thermodynamics I Exact and inexact differentials. Review of terms, I law of Thermodynamics. Work done (derivation with problems) in isothermal and adiabatic expansion and compression of an ideal gas (IUPAC sign conventions to be used). Heat capacity of a gas at constant pressure and constant volume: relation between P, V and T in an adiabatic process to be derived. Derivation of Kirchoff's equation. Numerical problems. Spontaneous and non-spontaneous processes. <i>Second law of thermodynamics:</i> Limitations of I law of thermodynamics with illustrations. Need for II law of thermodynamics, different ways of stating II law with respect to heat and spontaneity. Other forms of II law of thermodynamics. Concept of entropy and its physical significance-illustrations with order, disorder, physical and chemical processes and probability.	
MODULE 2	15Hrs
Thermodynamics II <i>Heat engine</i> -Carnot's cycle and derivation of the expression for its efficiency. Problems based on efficiency equation. II law in terms of efficiency (η). Change in entropy in reversible and irreversible processes (derivations required). Calculation of entropy changes in reversible isothermal and reversible adiabatic processes. Phase transitions in terms of Entropy (Fusion, vaporization, sublimation and polymorphic changes) in terms of entropy. Limitations of the entropy concept of spontaneity. Problem on Phase transitions Gibb's free energy: Work function, chemical potential. Definition and relationship between free energy and work function. Criteria for equilibrium and spontaneous processes. Gibb's-Helmholtz equation-Derivation. Change of free energy with respect to temperature and pressure. Mention of temperature coefficient, van't Hoff isotherm (derivations included), $\Delta G^\circ = -RT \ln K_p$. Problems. Derivation of van't Hoff reaction isochore and Clausius-Clapeyron equation. Its applications to ΔT_b and ΔT_f determination (thermodynamic derivation not required). Qualitative treatment of Nernst heat theorem and III law of thermodynamics-statement only. Elementary concept of residual entropy.	
MODULE 3	15Hrs
Chemical Kinetics Review of terms –Rate, Order and Molecularity, Derivation of expression for the rate constant of a second order reaction with $a = b$ and $a \neq b$. Expression for half-life of a second order reaction. Mean life for first order reaction to be mentioned. Problems on rate constant, half-life period, mean life period and order of reaction.	

Determination of order of reaction: differential method, method of integration, method of half-life period and isolation method.

Theories of reaction rates: Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Problems. Simple collisions theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects. Steady state approximation and Lindemann's hypothesis. Experimental determination of kinetics of: (i) inversion of cane sugar by polarimetric method, (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.

MODULE 4

15Hrs

Ionic equilibria

Hydrolysis of salts of weak acids and weak bases. Ionic product of water. Relationship between K_h , K_w , K_a and K_b . Degree of hydrolysis and its relationship with K_h . Effect of temperature and dilution on degree of hydrolysis. pH of salt solutions. Problems. Common-ion effect, buffers, buffer action and buffer capacity. pH of buffers. Henderson's equation and its derivation. Solubility product and ionic product in precipitation and in qualitative analysis. Analytical and biological applications of buffers. Theories of indicators.

Surface chemistry

Review of surface phenomena.

Theories of adsorption. Adsorption isotherms and BET equation (derivation included), Adsorption indicators. Surface film on liquids. Catalysis –Types and theories ((intermediate compound theory and adsorption theory). Heterogeneous catalysis: surface reactions, unimolecular, bi-molecular surface reactions. pH dependence of rate constant of catalysed reactions. Autocatalysis.

TEXT BOOKS/REFERENCES:

1. Physical Chemistry, 7th Edition P. W. Atkins and Julio de Paula, Oxford Univ. Press, 2002.
2. The Elements of Physical Chemistry, 3rd Edition Peter Atkins, Oxford Univ. Press, 2000.
3. Physical Chemistry – A molecular Approach Donal A. McQuarrie and John D. Simon, Viva Low-priced Student Edition, 2001.
4. Introduction to Physical Chemistry, 3rd Edition Mark Ladd, Cambridge Low-Priced Edition, 1999.
5. Text Book of Physical Chemistry S. Glasstone, MacMillan India Ltd., 1998.
6. Principles of Physical Chemistry, 4th Edition B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987
7. Text Book of Physical Chemistry P. L. Soni., S. Chand & Co., 1993.
8. Physical Chemistry Alberty R. A. and Silbey R. J. John Wiley & Sons, 1992.
9. Physical Chemistry G. M. Barrow, McGraw Hill, 1986.
10. Physical Chemistry, 3rd Edition Gibert W. Castellan, Narora Publishing House, 1985.

EXPERIMENTS

1. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation.
2. To determine the heat capacity of a solid and to study heat exchange in chemical reactions.
3. The study of kinetics of potassium persulphate and potassium iodide.
4. To determine the enthalpy change when a solute dissolved in a solvent.
5. Determination of pKa of a weak acid by pH metric method.
6. Effect of surfactants on the surface tension of water (Stock solution to be given).

TEXT BOOKS/ REFERENCES

1. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford, A.R.Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C.Publication.
3. Advanced Practical Chemistry, K. Chelladurai, K. Subbian, Lap Lambert Academic Publishing.
4. Experiments in Physical Chemistry 8th edition, Carl W. Garland, Joseph W. Nibler, and David P. Shoemaker, McGraw-Hill Education.

SEMESTER			IV			
YEAR			II			
COURSE CODE			22CY2403			
TITLE OF THE COURSE			PHARMACEUTICAL CHEMISTRY			
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- Understand the fundamental principles of medicinal chemistry and drug design. - Explore the mechanisms of drug action and interaction with biological targets. - Examine the pharmaceutical development process, including formulation and quality assurance. - Discuss the regulatory aspects and ethical considerations in pharmaceutical research and development.	

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students should be able to explain how the chemical structure of a drug affects its biological activity, selectivity, and pharmacokinetic properties.	L1
CO2	Students should be able to describe the molecular mechanisms by which drugs interact with receptors, enzymes, ion channels, and other biological targets. They should be able to explain the concepts of agonists, antagonists, and allosteric modulators in the context of drug action.	L2
CO3	Students should be familiar with the principles of pharmaceutical dosage form design, including factors that influence drug solubility, stability, and bioavailability. They should be able to discuss the various types of dosage forms and the rationale behind their selection.	L3
CO4	Students should have an understanding of the regulatory requirements for drug development, including preclinical testing, clinical trials, and post-marketing surveillance. They should be aware of the ethical considerations involved in conducting pharmaceutical research, including patient safety, informed consent, and compliance with regulatory guidelines.	L2

COURSE CONTENT:	
MODULE 1	10Hrs
Introduction to historical development of pharmaceutical chemistry, Common diseases Infective diseases - insect-borne, air-borne and water-borne – hereditary diseases. Terminology Drug, pharmacology, pharmacognosy, pharmacodynamics, pharmacokinetics, anti-metabolites. Absorption of drugs - routes of administration of drugs, factors affecting absorption.	
MODULE 2	10Hrs
Designation of drugs based on physiological action; Definition and two examples with structure each of: Anesthetics-General and local. Analgesics - Narcotic and synthetic. Antipyretics and anti-inflammatory agents. Antibiotics - penicillin, streptomycin, chloramphenicol, tetracyclins. Antivirals. AIDS - symptoms, prevention, treatment. Cancer and neoplastic agents.	
MODULE 3	10Hrs
Health promoting medicines-I: Nutraceuticals-Vitamins A B C D E and K (structure expected) micronutrients such as Na K Ca Cu Zn I -Medicinally important inorganic compounds of Al, P, As, Hg, Fe – Organic Pharmaceutical acids. Health promoting medicines-II: Agents for kidney function (Aminohippuric acid); Agents for liver function (Sulfobromophthalein); Agents for pituitary function (metyrapone)	

TEXT BOOKS/REFERENCE BOOKS

1. Jayashree Ghosh, Pharmaceutical chemistry, S.Chand and Company Ltd., 2006, New Delhi.
2. Lakshmi S., Pharmaceutical chemistry, S. Chand & Sons, 1995, New Delhi.
3. Ashutosh Kar, Medicinal chemistry, Wiley Eastern Ltd., 1993, New Delhi.
4. David William & Thomas Lemke, Foyes principles of medicinal chemistry, 5th editon 2005, BI Publishers.

SEMESTER	IV					
YEAR	II					
COURSE CODE	22BS2401					
TITLE OF THE COURSE	BIOSAFETY AND GOOD LABORATORY PRACTICE					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:		
- To introduce the students to the concepts of biosafety regulatory frameworks concerning genetically modified organisms at national and international levels. - To impart knowledge of the principles of GLP and their practical applications.		
CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Gain knowledge of the various safety procedures to be followed in laboratory.	L2
CO2	Gain the skills and knowledge necessary to understand and work in GLP compliant environment.	L2
CO3	This course should generate interest for avenues for pursuing higher studies and careers in these areas	L2

MODULE I – BIOSAFETY	18 Hrs
Introduction, Historical Background; risk assessment and lab acquired infections, Introduction to Biological Safety Cabinets& their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms. Recommended Biosafety Levels for Infectious Agents and Infected Animals. Biosafety Guidelines: Biosafety guidelines and regulations (National and International); Definition of GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Recombinant DNA Guidelines (1990); Rules for the manufacture, use/import/export and storage of hazardous microorganisms/ genetically engineered organisms or cells (Ministry of Environment and Forests Notification, 1989); Environmental release of GMOs; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.	
MODULE II – GOOD LABORATORY PRACTICE	12 Hrs
Introduction to GLP, WHO guidelines on GLP, History, Scope (Resources Characterization, Rules, Results, Quality assurance); Levels of Laboratories; General Rules/Protocols for Lab Safety measures; Precaution and Safety in handling of chemicals, Laboratory tools, glasswares and instruments; Sample	

storage and disposal; Log Book maintenance, Basic SOPs for instrument handling and Maintenance. Keeping data records, its analysis by using statistical and mathematical tools. Result analysis and its interpretation. GLP as given by OECD, FDA etc (International perspective); Internal and External Audits.

REFERENCES:

- Handbook Good Laboratory Practices-World health organization(WHO)
- Life science protocol manual (2018)-DBT star college scheme
- Guidelines for good laboratory practices-Indian council of medical research, NewDelhi (2008).
- Handbook: Good Laboratory Practices (GLP): quality practices for regulated non-clinical research and development-2nd ed.

SEMESTER		V				
YEAR		III				
COURSE CODE		22CY3501				
TITLE OF THE COURSE		ORGANIC CHEMISTRY - I				
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4		4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- Master the fundamental principles of organic reaction mechanisms. - Understand the relationship between molecular structure and reactivity in organic compounds. - Explore the application of organic chemistry concepts in real-world contexts. - Develop problem-solving skills and laboratory techniques in organic chemistry.	

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students should be able to explain the mechanisms of various organic reactions, understand electron flow in chemical reactions (e.g., nucleophilic and electrophilic reactions), and predict the products of typical organic transformations. They should be familiar with key reaction intermediates and reaction pathways.	L1
CO2	Students should be able to relate the structure of organic compounds to their chemical reactivity, acidity, basicity, and physical properties such as solubility and boiling points. They should be able to identify factors that influence the reactivity of organic molecules.	L2
CO3	Students should understand the role of organic chemistry in various fields, including pharmaceuticals, agrochemicals, materials science, biochemistry, and environmental chemistry. They should be able to appreciate how organic chemistry impacts everyday life.	L3
CO4	Students should be proficient in solving a range of organic chemistry problems, including synthesis challenges, retrosynthetic analysis, and spectroscopic identification of organic compounds. They should also be comfortable with common laboratory techniques used in organic chemistry, including synthesis, purification, and analysis of organic molecules.	L2

COURSE CONTENT:	
MODULE 1	15Hrs
Aliphatic Hydrocarbons Alkanes: Sources, Nomenclature of branched chain alkanes, preparation of symmetrical and unsymmetrical alkanes- Corey- House reaction and Wurtz reaction - their merits and demerits. Conformational analysis of n-butane - Sawhorse and Newman projection formulae to be used- Energy profile diagram. Cycloalkanes: Nomenclature. Method of formation. Explanation for stability based on heat of hydrogenation data, Baeyer's strain theory and its limitation, Sachse - Mohr theory of strain-less rings; cyclopropane ring - banana bonds. Alkenes: Preparation of alkenes by Wittig reaction-stereoselectivity. Addition of HX to unsymmetrical alkene - Markownikov's rule and Antimarkownikov's rule with mechanism. Reactions: Hydroboration- oxidation, reduction, oxymercuration - demercuration, epoxidation. Mechanism of oxidation with KMnO_4 and OsO_4 . Ozonolysis- mechanism and importance. Dienes: Classification- isolated, conjugated, cumulated. Structure of allene and butadiene. 1,2 addition and 1,4 addition reactions. Diels Alder reaction-1,3-butadiene with maleic anhydride. Alkynes: Methods of preparation - Dehydrohalogenation of vicinal and geminal dihalides; and higher alkynes from terminal alkynes. Reactions - metal ammonia reduction-significance. Oxidation with KMnO_4 , acidic nature of terminal alkynes.	
MODULE 2	15Hrs
Organic halogen compounds Aromatic nucleophilic substitution <i>via</i> benzyne intermediate, mechanism with evidences for the formation of benzyne by trapping with anthracene, Birch reduction. Side chain oxidation of toluene to benzaldehyde and benzoic acid. Oxidation of naphthalene, anthracene and phenanthrene. Diels- Alder reaction of anthracene with 1,2-dichloroethene. Alkenyl benzenes: Styrene, <i>cis</i> - and <i>trans</i> - stilbenes and their preparations. Biphenyl: Preparation-Ullmann reaction. Alkyl halides: Nomenclature. Nucleophilic substitution reactions - $\text{S}_{\text{N}}1$ and $\text{S}_{\text{N}}2$ mechanisms with energy profile diagrams. Effect of (i) nature of alkyl groups, (ii) nature of leaving groups, (iii) nucleophiles and (iv) solvents on $\text{S}_{\text{N}}1$ and $\text{S}_{\text{N}}2$ mechanisms. Elimination reactions - $\text{E}1$ and $\text{E}2$ mechanisms; Hofmann and Saytzeff eliminations with mechanism. Aryl halides: Preparation by halogenation. Relative reactivity of alkyl, allyl, vinyl, aryl and aralkyl halides towards nucleophilic substitution.	
MODULE 3	15Hrs
Alcohols and Thiols Alcohols: Introduction and classification. Methods of preparation - (i) From carbonyl compounds - reduction of aldehydes and ketones (by Meerwein-Ponndorf-Verley reaction); (ii) from acids and esters (by reduction with LiAlH_4); (iii) From alkenes (by hydroboration-oxidation with alkaline peroxide); (iv) hydration of alkenes. Reactions of alcohols: Acidic nature, esterification, oxidation of alcohols with KMnO_4 . Comparison of the reactivity of 1° , 2° and 3° alcohols- Lucas test, oxidation with $\text{K}_2\text{Cr}_2\text{O}_7$. Glycols: Preparation from alkenes using OsO_4 , KMnO_4 and from epoxides. Oxidation of glycols by periodic acid and lead tetraacetate with mechanisms. Pinacol-pinacolone rearrangement. Glycerol: Preparation from propene and from oils/fats. Uses. Reactions of glycerol: (i) nitration, (ii) action of concentrated H_2SO_4 and (iii) oxidation by periodic acid. Thiols: Nomenclature. Methods of formation and chemical reactions (with sodium, NaOH , metal oxides, formation of thioesters and oxidation with mild and strong oxidizing agents). Uses of dithianes. Introduction of umpolung character (reversal of polarity) in carbonyl compounds.	

MODULE 4	15Hrs
Phenols, Ethers, Epoxides and Organometallic compounds Classification. Acidic nature - Comparison of acidic strength of phenol with alcohols and monocarboxylic acids. Effect of electron withdrawing –NO ₂ group and electron donating –CH ₃ group on acidity of phenols at <i>o</i> -, <i>m</i> -, <i>p</i> - positions. Pechmann reaction, Mechanisms of Reimer- Tiemann and Kolbe-Schmidt reactions. Industrial applications of phenols: Conversion of phenol to (i) aspirin, (ii) methyl salicylate, (iii) salol, (iv) salicyl salicylic acid. Ethers: Methods of preparation – (i) dehydration of alcohols, (ii) Williamson's ether synthesis. Reactions – Ethers as Lewis bases (complexation with metal ions), cleavage and auto-oxidation. Ziesel's method. Epoxides: Preparation using per acids, Darzen's reaction. Reactions of mono and 1,2- disubstituted epoxides with (i) carbon nucleophiles, (ii) nitrogen nucleophiles, (iii) reduction with LiAlH ₄ . Preparation and synthetic applications of Grignard reagents, Organolithium compounds and lithium dialkylcuprates.	

List of Laboratory/Practical Experiments to be conducted:
1. Recrystallisation and determination of melting point of solids (mixed melting point determination and its importance may be mentioned).
2. Simple distillation and determination of boiling point of liquids.
3. Purification of solids by sublimation.
4. Preparation of aspirin from salicylic acid.
5. Preparation of dibenzalacetone from benzaldehyde (using acetone-alcoholic sodium hydroxide).
6. Preparation of paracetamol from p-aminophenol.

TEXT BOOKS/REFERENCE BOOKS
1. Vogels Textbook Of Practical Organic Chemistry 5Th Edition, FURNISS and BRIAN S and HANNAFORD and ANTONY J, PEARSON INDIA. 2. Microscale Organic Laboratory: With Multistep and Multiscale Syntheses" by Dana W. Mayo, Ronald M. Pike, and David C. Forbes, J. Wiley & Sons. 3. Experimental Organic Chemistry: A Miniscale and Microscale Approach" by John C. Gilbert and Stephen F. Martin, Cengage Learning Publisher. 4. A Small Scale Approach to Organic Laboratory Techniques" 3rd edition, Donald L. Pavia, George S. Kriz, and Gary M. Lampman, Cengage Learning Publisher.

SEMESTER			V			
YEAR			III			
COURSE CODE			22CY3502			
TITLE OF THE COURSE			PHYSICAL CHEMISTRY - II			
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- Understand the fundamental principles of electrochemistry and its applications in chemical systems. Learn the principles of electrode processes and kinetics. - Develop practical and problem-solving skills in electrochemical measurements and data analysis. - Develop a deep understanding of the principles and applications of phase equilibria in chemical systems. - Develop a comprehensive understanding of the structure, properties, and behavior of solid materials. - Develop a thorough understanding of the principles of nuclear chemistry and its applications in various scientific and industrial contexts. - Develop a comprehensive understanding of the properties, behavior, and applications of colloidal systems in chemistry.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students should be able to describe the components of electrochemical cells, understand the role of electrodes and electrolytes, and explain how redox reactions occur at the electrode surfaces.	L1
CO2	Students should be proficient in conducting electrochemical measurements, such as cyclic voltammetry, potentiostatic/galvanostatic experiments, and impedance spectroscopy. They should be able to analyze experimental data and interpret electrochemical results.	L2
CO3	Students should be proficient in applying the principles of phase equilibria to analyze and predict the behavior of multiple-phase systems, including vapor-liquid, liquid-liquid, and solid-liquid equilibria. They should be able to explain the factors that influence phase transitions, such as temperature, pressure, and composition.	L3

CO4	Students should be proficient in analyzing crystal structures of various solid materials, including simple and complex crystal lattices, and understand the relationship between crystal structures and material properties.	L2
CO5	Students should be proficient in understanding and analyzing nuclear reactions, including radioactive decay, nuclear stability, nuclear fission, and nuclear fusion, as well as the concepts of half-life, decay constant, and radioactivity.	L3
CO6	Students should be proficient in understanding the unique properties and behavior of colloids, including stability, surface phenomena, Brownian motion, Tyndall effect, and coagulation/precipitation processes.	L1

COURSE CONTENT:

MODULE 1	15Hrs
Electrochemistry I Review of electrolytes and Conductance related terms, Methods of determination of molar conductance. Conductometric titrations (only acid-base type). Transport numbers: definition – determination by moving boundary method. Causes of abnormal transport numbers observed in certain systems. Ionic mobility. Problems on transport numbers. Conductivity of water. Kohlrausch's law and its applications: (i) evaluation of Λ_{∞} from Λ_{+} and Λ_{-} (ii) evaluation of degree of dissociation of a weak electrolyte (iii) evaluation of Λ_{∞} of a weak electrolyte (iv) determination of solubility from conductance of saturated solutions of sparingly soluble salts (AgCl and BaSO ₄). Problems based on these. Limitations of Arrhenius theory: qualitative account of Debye-Huckel theory, Debye-Huckel-Onsagar equation for aqueous solutions of 1:1 electrolytes. Verification of DHO equation. Galvanic cell: conventions of representing galvanic cells-reversible and irreversible cells, derivation of Nernst equation for single electrode potential (free energy concept).	
MODULE 2	15Hrs
Electrochemistry II Weston-cadmium cell: Determination of emf of a cell by compensation method. Determination of E° of Zn/Zn ²⁺ and Cu/Cu ²⁺ electrodes. Liquid junction potentials, elimination of liquid junction potential. Types of electrodes: Metal and gas electrodes (chlorine), metal/metal insoluble salt electrodes, redox electrodes. Reference electrodes-standard hydrogen electrode, calomel electrode, quinhydrone electrode and glass electrode. Determination of pH using these electrodes. Numerical problems. Concentration cells: (i) emf of concentration cells (ii) determination of solubility of sparingly soluble salts and numerical problems. Redox electrodes, emf of redox electrodes. Potentiometric titration involving only redox systems. Photochemistry Laws of photochemistry. Grotthus-Draper law, Stark-Einstein law, differences between photophysical and photochemical processes with examples. Comparison of photochemical and thermal reactions. Quantum yield of photochemical combination of (i) H ₂ and Cl ₂ (ii) H ₂ and Br ₂ (iii) dissociation of HI (iv) dimerisation of anthracene. Photosensitization, photostationary equilibrium. Singlet and triplet states. Fluorescence, phosphorescence, luminescence, bioluminescence and chemical sensors. Beer-Lambert's law and its applications. Numerical problems on absorption coefficient and molar extinction coefficient.	

MODULE 3	15Hrs
Phase Equilibria Statement and explanation of the terms with examples for phase (P), component (C) and degree of freedom (F), Definition and significance of phase rule. Derivation of phase rule. Application of phase rule to one component systems-water and sulphur, -modified form of phase rule to two component systems. Water-potassium iodide and lead-silver systems. Eutectic mixtures and their applications (examples: freezing mixtures, desilverisation of lead by Patterson's method). Solid state Crystalline state, Laws of crystallography. Symmetry elements in crystals, crystal systems. Weiss and Miller indices. X-ray diffraction of crystals-derivation of Bragg's equation, Problems Liquid crystals-Types with examples. Applications Superconducting Solids-High temperature superconductors. Applications.	
MODULE 4	15Hrs
Nuclear and Radiochemistry Nucleus: Structure and stability, binding energy calculations. Instability of the nuclei, radioactive decay law, half life: numerical problems. Radioactive equilibrium, radioactive series. Artificial radioactivity: Nuclear reactions induced by γ -radiation, α , n, p, and d particles. Nuclear fission and fusion. Nuclear reactors, Breeder reactors, Isotopes- separation of isotopes, use of radio isotopes in tracer technique, agriculture, medicine, food preservation and Carbon dating-Numerical problems. Colloids Introduction, Classification of colloids, Methods of Preparation of Colloidal Solutions, Purification of Colloidal Solution, Precipitation of colloids by electrolytes, Stabilization of colloidal state, Emulsions, Gels, Application of colloids.	

TEXT BOOKS/REFERANCES:

1. Physical Chemistry, 7th Edition P. W. Atkins and Julio de Paula, Oxford Univ. Press, 2002.
2. The Elements of Physical Chemistry, 3rd Edition Peter Atkins, Oxford Univ. Press, 2000.
3. Physical Chemistry – A molecular Approach Donal A. Mcquarrie and John D. Simon, Viva Low-priced Student Edition, 2001.
4. Introduction to Physical Chemistry, 3rd Edition Mark Ladd, Cambridge Low-Priced Edition, 1999.
5. Text Book of Physical Chemistry S. Glasstone, MacMillan India Ltd., 1998.
6. Principles of Physical Chemistry, 4th Edition B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987
7. Text Book of Physical Chemistry P. L. Soni., S. Chand & Co., 1993.
8. Physical Chemistry Alberty R. A. and Silbey R. J. John Wiley & Sons, 1992.
9. Physical Chemistry G. M. Barrow, McGraw Hill, 1986.
10. Physical Chemistry, 3rd Edition Gibert W. Castellan, Narora Publishing House, 1985.

List of Laboratory/Practical Experiments to be conducted:

1. Conductometric titration of hydrochloric acid with sodium hydroxide.
2. Potentiometric titration of potassium dichromate with ferrous ammonium sulphate.
3. Determination of equivalent conductivity of 0.1 N sodium chloride and verification of DHO equation.
4. To construct the phase diagram of two component system (Ex. diphenylaminebenzophenone) by cooling curve method.
5. Preparation and Characterization of Colloidal Silver Sol.
6. Radiation Detection and Measurement using radiation detectors (e.g., Geiger-Müller counters)

TEXT BOOKS/ REFERENCES

1. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford, A.R. Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication.
3. Advanced Practical Chemistry, K. Chelladurai, K. Subbian, Lap Lambert Academic Publishing.
4. Experiments in Physical Chemistry 8th edition, Carl W. Garland, Joseph W. Nibler, and David P. Shoemaker, McGraw-Hill Education.

SEMESTER	V					
YEAR	III					
COURSE CODE	22BS3501					
TITLE OF THE COURSE	BIOETHICS AND IPR					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

To recognize, compare, and contrast the general "ways of thinking" of science (biology) and of philosophy (ethics).
To recognize, compare, and contrast the general "ways of thinking" of science (biology) and of philosophy (ethics).
To give elementary essential concepts of Bioethics, IPR and patent laws.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student should develop basic understanding of the concepts of Bioethics, IPR and Patent Laws	L2
CO2	This course should generate interest for avenues for pursuing higher studies and careers in these areas	L2
CO3	General knowledge should create awareness necessary for higher studies in biotechnological fields	L2

COURSE CONTENTS	
MODULE I – BIOETHICS	15 Hrs
Bioethics- The environmental, legal and socioeconomic impacts of biotechnology; Ethical concerns of biotechnology in research and innovation-The GM crop debate – safety, ethics, perception and acceptance of GM crops; Bioethics of Genetically modified organism; Bioethics of CRISPR technique- for editing human embryos; Bioethics of Gene therapy; Bioethics of Stem cell research; Reproductive medicine and ethics; Use of Animals in Research and Testing, and Alternatives for Animals in Research, Animal Cloning, Human Cloning, and their Ethical Aspects; Public education of the process of biotechnology involved in generating new forms of life for informed decision-making.	

MODULE II – INTELLECTUAL PROPERTY RIGHTS AND REGULATIONS	15 Hrs
Introduction to Intellectual Property and History. Patents, Trademarks, Copyright, Trade secrets, Industrial Design and Rights, Traditional Knowledge, Geographical Indications - importance of IPR – patentable and non-patentable – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO), Pros and Cons of IP protection. Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. Agreements and Treaties: GATT, TRIPS Agreements; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.	

REFERENCES:

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBHPublishingCo. New Delhi.
2. Ganguli Prabuddha Gearing up for Patents. The Indian Scenario” , Universities Press (1998)
3. Introduction to Plant Biotechnology, H S Chawla
4. M K Sateesh. Bioethics and Biosafety. Kindle Edition
5. Shomini Parashar, Deepa Goel IPR, Biosafety and Bioethics Pearson India 2013
6. F. H. Erbisch and K. M. Maredia. Intellectual property rights in agricultural Biotechnology, UniversityPress.
7. SivamiahShantharam, Jane F. Montgomery. Biotechnology, Biosafety and Biodiversity, Oxford & IBHPubl. New Delhi.
8. Jecker Nany S, Jones & Barlet Bioethics: An Introduction to the History Methods and Practice, NewDelhi.
9. Private Power, Public Law: The Globalization of Intellectual Property Rights By Susan
10. K. Sell Cambridge University Press, 2000.
11. Essentials of Intellectual Property: Law, Economics, and Strategy By Alexander I.
12. Poltorak; Paul J. Lerner Wiley, 2011 (2nd edition).
13. Diane O. Fleming, Debra L. Hunt Biological Safety: Principles and Practices, 4th Edition. ASM 2006.

SEMESTER	V					
YEAR	III					
COURSE CODE	22BS3502					
TITLE OF THE COURSE	BIONFORMATICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To get introduced to the basic concepts of Bioinformatics and its significance in biological data analysis. - To get an overview about biological macromolecular structures and structure prediction methods.

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Will be able to demonstrate mastery of the core concepts of bioinformatics	L1
CO2	The student will be able to apply basic principles of biology, computer science and mathematics to address complex biological problem	L2
CO3	Should be able to plan basic experiments in microbial genetics concerned with clarifying phenotypes and their relationship with the genotype	L3

COURSE CONTENT:
MODULE 1 BIOLOGICAL DATA TYPES AND SOURCE 07Hrs Introduction to population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Virus data bank (UICTVdb).
MODULE 2 SIMILARITY SEARCHING 10Hrs Global and Local sequence alignment, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs

MODULE 3 INTERPRETTING the SEQUENCE	07Hrs
Reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank libraries, annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files.	
MODULE 4 SCALING THE HUMAN GENOME	06Hrs
UCSC genome browser, RegulomeDB database, ENCODE-ChIA-PET database, transcription factors binding sites. SNP, EST, STS. Regular Expression (REGEX), Hierarchies and Graphical models (including Markov chain and Bayes algorithm). Genetic variability and connections to clinical data.	

TEXT BOOKS/REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
1. 5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
5. Baxavanis (2098). Bioinformatics.
6. Fry, J.C. (2093). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
2. 8. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81

SEMESTER			VI			
YEAR			III			
COURSE CODE			22CY3601			
TITLE OF THE COURSE			ORGANIC CHEMISTRY - II			
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4		4		60	6
Perquisite Courses (if any)						
#	Sem/Year	Course Code	Title of the Course			
-	-	-	-			

COURSE OBJECTIVES:	
•	Understand the structure, reactivity, and synthesis of aldehydes and ketones, and their significance in organic chemistry.
•	Explore the properties, reactions, and applications of carboxylic acids and their derivatives.
•	Analyze the structure, generation, stability, reactivity, and significance of heterocyclic compounds.
•	Master the principles of stereochemistry and their role in organic reactions.
•	Examine the properties, reactions, and significance of amines in organic chemistry.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students should be proficient in explaining the mechanisms of reactions involving aldehydes and ketones, including nucleophilic addition, oxidation, reduction, and condensation reactions. They should understand the importance of these compounds in both synthetic organic chemistry.	L1
CO2	Students should be able to explain the structure and reactivity of carboxylic acids, as well as their derivatives (esters, amides, acid chlorides, etc.), including hydrolysis, esterification, and acylation reactions.	L2
CO3	Students should be proficient in identifying common heterocyclic rings, such as furans, pyrroles, and pyridines, and explaining their reactivity, aromaticity, and significance in pharmaceuticals, bioactive molecules, and materials science.	L3
CO4	Students should be proficient in explaining stereochemistry, including chiral molecules, enantiomers, diastereomers, and the basics of optical activity. They should be able to apply these concepts to predict stereochemical outcomes in organic reactions and to analyze the three-dimensional arrangement of molecules.	L2
CO5	Students should be able to explain the structure, reactivity, and synthesis of amines, including nucleophilic substitution, amidation, and reactions of aromatic amines. They should understand the role of amines in biological systems, drug design, and synthetic methodologies.	L3

COURSE CONTENT:**MODULE 1****15Hrs****Aldehydes and Ketones**

Nomenclature. Preparation of aldehydes: from acid chlorides (Rosenmund reaction), Gattermann-Koch aldehyde synthesis. Preparation of Ketones: From nitriles, from carboxylic acids with alkyl lithium, from acid chlorides with metal alkyls. Mechanisms of: Aldol condensation, Perkin condensation, Knoevenagel condensation, Benzoin condensation and Acetal formation. General mechanism of condensation with ammonia and its derivatives ($\text{NH}_2\text{-R}$; $\text{R} = \text{-NH}_2, \text{-OH}, \text{-NH-CO-NH}_2$). Reduction: Reduction by LiAlH_4 and NaBH_4 . Mannich reaction. Mechanisms of Clemmensen and Wolff-Kishner reductions.

Tautomerism and Enolates

Tautomerism in carbonyl compounds – Keto-Enol tautomerism. Acidity of α -hydrogen atoms in aldehydes, ketones and active methylene compounds (example diethyl malonate, ethyl acetoacetate and acetyl acetone). Preparation of (from acetic acid) and synthetic applications of diethyl malonate (preparation of monocarboxylic acids - butanoic acid, dicarboxylic acid - Adipic acid, unsaturated acids - cinnamic acid, ketones - butanone, cyclic compounds - barbituric acid) Preparation of ethyl acetoacetate (from ethyl acetate). Synthetic applications of ethyl acetoacetate (preparation of monocarboxylic acids - butanoic acid, dicarboxylic acid –succinic acid, unsaturated acids- crotonic acid, ketones - butanone).

MODULE 2**15Hrs****Carboxylic acids and their derivatives.**

Nomenclature. Preparation: Acid hydrolysis of nitriles with mechanism. Acidic strength (pK_a values) - Effect of substituents on the strength of aliphatic and aromatic carboxylic acids. (comparison of acidic strength of formic and acetic acids; acetic acid and monochloro, dichloro, trichloro acetic acids ; benzoic and p-nitrobenzoic acid; benzoic acid and p-aminobenzoic acid) Reactions: Formation of esters, acid chlorides, amides and anhydrides. Hell-Vollhardt-Zelinski reaction, Decarboxylation and reduction (using LiAlH_4). (already included under preparation of alcohols from acid) Di and tri carboxylic acids: Action of heat on dicarboxylic acids (Oxalic to Adipic acids) Reactions of tartaric acid and citric acid. (action of heat, reduction with HI). Reactions of acid chlorides (hydrolysis, reaction with alcohol, ammonia and lithium dialkylcuprates). Acid anhydrides (hydrolysis, reaction with alcohol, ammonia). Esters (alkaline hydrolysis, ammonolysis and alcoholysis). Amides (hydrolysis, reduction, Hoffmann rearrangement). Mechanism of ester hydrolysis - acid and base catalysed (acyl O-cleavage: BAC_2 , AAC_2 ; alkyl O-cleavage: AAL_1 mechanisms).

MODULE 3**15Hrs****Stereochemistry**

Elements of symmetry in chiral and achiral molecules, chirality, stereogenic centre. Fischer projection formulae.

Enantiomers: Optical activity; use of $+/-$, d/l and D/L notations. Properties of enantiomers, chiral and achiral molecules with two stereogenic centers. Meso compounds. Cahn-Ingold-Prelog sequence rules: R, S system of nomenclature.

Diastereomers: Threo and Erythro isomers. Racemisation and resolution. Relative and absolute configuration.

Optical isomerism due to restricted rotation about single bonds- diphenyl systems.

Geometric isomerism: Determination of configuration of geometric isomers. Cis & trans, E, Z system of nomenclature. Geometric isomerism in oximes.

Alicyclic compounds: Conformations of four to eight membered cycloalkanes and disubstituted cyclohexanes.

Bicyclic systems: Nomenclature and conformations of decalins and norbornane.

MODULE 4	15Hrs

Amines

Classification. Preparation of alkyl and aryl amines-reductive amination of carbonyl compounds, Gabriel phthalimide synthesis. Basicity of amines in aqueous solution: Inductive, resonance, steric and solvation effects on the basicity of amines. Reaction of amines as nucleophiles – Methylation, quaternary salts, Hoffmann elimination with mechanism. Distinguishing reactions of 1°, 2° and 3° amines. Diazotization and synthetic applications of diazonium salts. Sandmeyer's reaction. (conversion to chlorobenzene, bromobenzene and benzonitrile), hydrolysis, reduction (to phenylhydrazine and aniline), coupling reactions to give azo dyes (*p*-hydroxyazobenzene and 1-phenylazo-2-naphthol).

Heterocyclic compounds

Introduction, classification, structures, resonance and aromatic character of furan, pyrrole, thiophene and pyridine. Methods of preparation and reactions of pyrrole, furan, thiophene, pyridine. Mechanism of electrophilic substitution reactions. Comparison of basicity of pyrrole, pyridine and piperidine. Preparation and reactions of indole, quinoline and isoquinoline.

List of Laboratory/Practical Experiments to be conducted:

1. Organic qualitative analysis of mono functional organic compounds through functional group analysis. (At least 5 organic functional groups)
2. Isolation of lycopene from tomatoes.
3. Isolation of caffeine from tea leaves.

TEXT BOOKS/REFERENCE BOOKS

1. Vogel's Textbook Of Practical Organic Chemistry 5Th Edition, FURNESS and BRIAN S and HANNAFORD and ANTONY J, PEARSON INDIA.
2. Microscale Organic Laboratory: With Multistep and Multiscale Syntheses" by Dana W. Mayo, Ronald M. Pike, and David C. Forbes, J. Wiley & Sons.
3. Experimental Organic Chemistry: A Miniscale and Microscale Approach" by John C. Gilbert and Stephen F. Martin, Cengage Learning Publisher.
4. A Small Scale Approach to Organic Laboratory Techniques" 3rd edition, Donald L. Pavia, George S. Kriz, and Gary M. Lampman, Cengage Learning Publisher.

SEMESTER			VI			
YEAR			III			
COURSE CODE			22CY3602			
TITLE OF THE COURSE			SPECTROSCOPY			
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4		4		60	6

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Understand the principles of spectroscopic techniques used in chemical analysis. - Understand the theoretical background and limitations of spectroscopy. - Analyze spectroscopic data and interpret spectra. - Explore the applications of spectroscopy in chemical research and industry. - Develop practical skills in spectroscopy and experimental design.

COURSE OUTCOMES:

CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students should understand the underlying principles of various spectroscopic techniques, such as UV spectroscopy, Raman spectroscopy, nuclear magnetic resonance (NMR), and infrared spectroscopy (IR). They should be able to describe how these techniques provide information about molecular structure and behavior.	L1
CO2	Students should understand the theoretical foundations of spectroscopy, including the interaction of radiation with matter, selection rules, and the factors that affect spectral features. They should also be aware of the limitations and potential sources of error in spectroscopic measurements.	L2
CO3	Students should be proficient in analyzing spectroscopic data, including understanding peak positions, intensities, shapes, and patterns in spectra. They should be able to extract meaningful information from spectra, such as identifying functional groups, determining molecular structures, and analyzing chemical environments.	L3
CO4	Students should be able to identify and explain the various applications of spectroscopic techniques in chemistry, including materials analysis, pharmaceutical research, environmental monitoring, forensic science, and process control in industry. They should understand the role of spectroscopy in advancing scientific knowledge and solving practical problems.	L2
CO5	Students should be proficient in using spectroscopic instruments, setting up experiments, collecting data, and analyzing results. They should be able to design experiments to answer specific research questions or solve analytical challenges using spectroscopic techniques.	L3

COURSE CONTENT:	
MODULE 1	15Hrs
Fundamentals of Spectroscopy and Ultra-Violet and Visible Spectroscopy Fundamentals of Spectroscopy: Electromagnetic radiation, interaction of electromagnetic radiation radiation with matter. Regions of electromagnetic spectrum and associated spectroscopic techniques. Ultra-Violet and Visible Spectroscopy: The Absorption Laws, Measurement of Absorption Intensity, Instrumentation, Formation of Absorption Bands, Theory of Electronic Spectroscopy, Types of Electronic Transitions, Transition Probability, The Chromophore Concept, Auxochrome, Absorption and Intensity shifts, Types of Absorption bands, Solvent Effects, Effect of Temperature and Solvent on the Fineness of Absorption Band, Conjugated dienes, Woodward-fieser Rules for Calculating Absorption Maximum in Dienes, Distortion of the Chromophore, Poly-enes and Poly-ynes, Ultra-violet Absorption in α , β -unsaturated Carbonyl Compounds, Woodward-fieser rules for Calculating Absorption Maximum in, α , β -unsaturated carbonyl compounds, Compounds with N to O Bonds, Benzene and its Derivatives, Applications of ultra-violet Spectroscopy.	
MODULE 2	15Hrs
Infra-Red Spectroscopy Principle of infra-red spectroscopy, Theory—Molecular Vibrations, Vibrational Frequency, Number of Fundamental Vibrations, Selection Rules (Active and Forbidden Vibrations), Factors Influencing Vibrational Frequencies, Scanning of Infra-red Spectrum (Instrumentation), Sampling Techniques, Finger Print Region, Spectral Features of Some classes of organic, Important Features in Infra-red Spectroscopy, Applications of infra-red spectroscopy.	
MODULE 3	15Hrs
Raman Spectroscopy Introduction, Quantum theory of Raman Effect, Theory of Raman spectra-Stoke's and anti-stoke's lines, Instrumentation, Conditions for Raman spectroscopy, Equivalence of Beer Lambert law of, absorption in Raman Scattering, Characteristic Parameters of Raman lines, Raman spectra of diatomic molecules, Rotational-Vibrational Raman Spectra, Vibrational Raman Spectra of Polyatomic, Molecules, Rule of Mutual Exclusion Principle, Moment of Inertia of diatomic molecules, and Raman Spectroscopy, Infra-red and Raman Spectra are, Complementary, Structure elucidation of Raman Spectroscopy, Importance of Raman Spectra, Applications of Raman Spectroscopy.	
MODULE 4	15Hrs
Nuclear Magnetic Resonance (NMR) Spectroscopy Introduction, Theory Instrumentation, Positions of Signals (Chemical Shift), Internal Standards, Shielding and Deshielding Effects, Factors Influencing Chemical Shift, Solvents Used, Peak area and Proton Counting, Splitting of the Signals, Spin-spin Coupling, NMR Absorption by other Nuclei, Calculating the Ratio in the Heights of the Signals, Coupling Constant (J), Some Important Nmr Spectra, C13-NMR Spectroscopy, Applications of NMR Spectroscopy, Important Features in Nuclear Magnetic Resonance Spectroscopy, Simple Problems on Nuclear Magnetic.	

TEXT BOOKS/REFERENCE BOOKS

1. Elementary Organic Spectroscopy Principle and Principle and Chemical Applications 5th Edition, YR Sharma, S. Chand Publication
2. Introduction to Spectroscopy 5th edition, Donald L. Pavia, Cengage India Private Limited.
3. Spectrometric Identification of Organic Compounds 8th edition, David J. Kiemle, David L. Bryce, Francis X. Webster, Robert M. Silverstein, John Wiley & Sons Inc.
4. Organic Spectroscopy V. R. Dani, Tata McGraw Hill, 1998.
5. Organic Spectroscopy W. Kemp, ELBS IV Edition, 1998

EXPERIMENTS	
1. Measurement of Iron in Egg Yolk: An UV Instrumental Analysis Experiment Using Biochemical Principles	
2. Determination of log Kow Values for Four Drugs	
3. Determination of Phosphorus in Cola Drinks	
4. Analysis of Aspirin Tablets	
5. Measuring Breath Alcohol Concentrations with an FTIR Spectrometer	

TEXT BOOKS/REFERENCES

- | |
|--|
| 1. Vogels Textbook Of Practical Organic Chemistry 5Th Edition, FURNISS and BRIAN S and HANNAFORD and ANTONY J, PEARSON INDIA. |
| 2. Maloney, Kevin & Quiazon, Emmanuel & Indralingam, Ramee. (2008). Measurement of Iron in Egg Yolk: An Instrumental Analysis Experiment Using Biochemical Principles. Journal of Chemical Education - J CHEM EDUC. 85. 10.1021/ed085p399. |
| 3. Harris, Mark & Logan, Jennifer. (2014). Determination of log Kow Values for Four Drugs. Journal of Chemical Education. 91. 915–918. 10.1021/ed400655b. |
| 4. ozano-Calero, Diego & Martìn-Palomeque, Pilar & Madueño-Lorguillo, Silvia. (1996). Determination of Phosphorus in Cola Drinks. Journal of Chemical Education - J CHEM EDUC. 73. 10.1021/ed073p1173. |
| 5. Method development for analysis of aspirin tablets, Kenneth W. Street Journal of Chemical Education 1988 65 (10), 914 |
| 6. Kniesel, A. & Bellamy, M.K. (2003). Measuring breath alcohol concentrations with an FTIR spectrometer. Journal of Chemical Education. 80. 1448-1450. |

SEMESTER	VI					
YEAR	III					
COURSE CODE	22BS3601					
TITLE OF THE COURSE	PRINCIPLES OF ‘MULTI-OMICS’					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To acquaint students with various aspects of biotechnology and bio-engineering using omics technologies - To provide key insights into omics approaches in personalized and precision medicine

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will have knowledge in specific methods used in genomics, proteomics and metabolomics used in analytical processes.	L1
CO2	Students will be able to perform statistical analysis crucial for interpretation of experimental results	L2
CO3	Students will be able to apply specialized research methods necessary for the analysis of proteins, genes and metabolites	L3

COURSE CONTENT:	
MODULE 1 Genome & Genomics	07Hrs
Genome mapping: Physical and Genetic Map, Genome Sequencing, Next generation sequencing methods ,Genome Annotation, Functional Genomics	
MODULE 2 Transcriptomics	07Hrs
Search for transcription factor binding sites, RNA-Seq, Microarrays, Regulatory RNAs: small or large, Computational prediction of miRNA target genes, RNA Darkmatter	

MODULE 3 Proteomics and Metabolomics	10Hrs
Basic concepts , Tools of proteomics- SDS PAGE, 2D PAGE , Liquid chromatography , Mass Spectrometry (ESI and MALDI) ,Protein identification by peptide mass fingerprinting, Applications of proteomics. Fundamental concept, Tools of metabolomics- Capillary electrophoresis, Gas chromatography, Electrochemical detectors, Case studies	
MODULE 4 ‘OMICS’: applications and future perspectives	06Hrs
Multi-omics in disease prediction and health. Multi-omics technologies for crop improvement and sustainable agriculture. Applications in Biomedical and Environmental sciences	

TEXT BOOKS/REFERANCES:
1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Introduction to Proteomics -Tools for the New Biology by Daniel C. Liebler, Humana Press..
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Metabolomics- Methods and Protocols by Wolfram Weckwerth, Humana Press.
7. Fry, J.C. (2093). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Transcriptomics: Expression Pattern Analysis, Virendra Gomase, Somnath Tagore; VDM Publishing, 2009 – Science

SEMESTER	VI					
YEAR	III					
COURSE CODE	22BS3602					
TITLE OF THE COURSE	TOXICOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
1. To learn various toxicants present and their exposure level on day-to-day basis.
2. To study the effects of toxins on the physiologic, metabolic, reproductive, and developmental processes.

COURSE OUTCOMES

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will learn and understand all substances can be toxic depending on the means and level of exposure	L1
CO2	Students will learn the basic concepts of cellular toxicity and chemical actions on cells and body organs	L2
CO3	Students will learn the importance and diversity of drug interactions with various organs	L3

COURSE CONTENT:	
MODULE 1	10 Hrs
INTRODUCTION OF TOXICOLOGY: Classification of toxic agents, natural toxins, animal toxins, plant toxins, food toxins, genetic poisons and chemical toxins. Factors affecting toxicity – species and strain, age, sex, nutritional status, hormones, environmental factors, circadian rhythms. Toxicant proceeding <i>in vivo</i> : Absorption, Distribution, Excretion an Metabolism of foreign/toxic compounds.	
MODULE II	5 Hrs
ENVIRONMENTAL TOXICOLOGY: Environmental pollution- Sources and types of pollution, Important pollution events, Priority pollutants. Air pollution- Classification and properties of air pollutants, Behaviour and fate of air pollutants, Photochemical smog, Acid Rain, health effects of air pollution. Water pollution- origin of Wastewater, Domestic Water Pollution, Industrial water pollution, Agricultural water pollution, Toxic water pollutants and their health effects, Groundwater pollution, marine pollution	

MODULE III	5 Hrs
INDUSTRIAL TOXICOLOGY: Industrial Chemicals: Government Regulation of Chemicals, Ways of exposure, Toxic effects, Long-term consequences and developmental toxicity. Food Additives and Contaminants types of food additives, Preservatives, Saccharin. Toxicity of trace elements- Iodine, iron, zinc, copper, manganese, selenium, molybdenum, and cobalt Cyto-toxicity of heavy metals- Cadmium, mercury, arsenic, chromium and lead. Brief introduction to toxicity of pesticides and insecticides.	
MODULE IV	10 Hrs
ORGAN TOXICOLOGY: Basics of organ toxicity- Target organs, Organ selectivity and specificity, gender specific diversity of toxins. Hepatotoxicity - Actions of toxins on the liver, Chronic liver injury; Cardiotoxicity - pathology of cardiac toxicity, mechanisms of cardiotoxicity; Respiratory Toxicity - Systemic lung toxins, Lung pathology; Reproductive System – Teratogenicity; Neurotoxicity- Effect of toxic agents on neurons, Ion channel neurotoxins and Nephrotoxicity- susceptibility of kidney to toxic insult, chemically induced renal injury.	

REFERENCE BOOKS:

1. Whalen, Finkel, and Panavelil, Pharmacology, 6th ed. (Lippincott Williams & Wilkins: 2015).
2. Lieberman and Peet, Mark's Basic Medical Biochemistry: A Clinical Approach, 5th ed. (Wolters Kluwer: 2018).
3. Hodgson, A Textbook of Modern Toxicology, 4th ed. (J Wiley & Sons: 2010).
4. Molecular and Biochemical Toxicology, 4th ed., Smart and Hodgson, eds. (J Wiley & Sons: 2008).
5. Frank and Ottoboni, The Dose makes the Poison: A Plain-language Guide to Toxicology, 3rd ed. eBook, (J Wiley & Sons: 2011).
6. Ottoboni, The Dose makes the Poison: A Plain-language Guide to Toxicology, 2nd ed., (J Wiley & Sons: 1997).
7. A-Z Guide to Drug-Herb-Vitamin Interactions, 2nd ed., Gaby, Batz, Chester and Constantine, eds. (Three Rivers Press: 2006).
8. Gilbert, A Small Dose of Toxicology: The health effects of common chemicals, (CRC Press: 2004).
9. Gibson, Multiple Chemical Sensitivities: A survival guide, (New Harbinger Publications: 2000).
10. Toxicology and Clinical Pharmacology of Herbal Products, Cupp and Karch, eds. (Springer-Verlag: 2000).
11. Lawson, Staying Well in a Toxic World, (Lynwood Press: 2000).

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22CY4701					
TITLE OF THE COURSE	POLYMER CHEMISTRY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

COURSE OBJECTIVES:

- To introduce the specialized subject of the chemistry of polymers
- To understand in detail the mechanisms of the reactions that lead to the formation of polymers.
- To familiarize the students with the types of polymers, the significance of their molecular mass.

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Will be able to demonstrate the composition and structure of polymers	L1
CO2	Should be able to correlate the structure of polymers to their properties and application	L2
CO3	Should be able to demonstrate the significance of polymer molecular mass.	L3

COURSE CONTENT:

MODULE 1	12Hrs
Basic principles of polymer chemistry	
Historical development of polymer chemistry. Monomers, polymers, repeating units, functionality. Nomenclature of polymers. Importance and applications of polymers –acrylic, vinyl, cellulose, fluorinated, poly ethylene, & SAN copolymer. Classification of polymers. Ladder and spiral polymers. Cis- trans configuration. DL isomers and tacticity. Inorganic polymers- importance, advantages and applications- structure, preparation and properties of silicones and polyphosphazenes. Comparison with organic polymers.	
MODULE 2	12Hrs
Free radical addition polymerization	
Chain growth polymerization. Mechanism of chain growth polymerization. Initiation, propagation and termination. Types of free radical initiators (peroxo, azo and redox initiators).Initiator efficiency. Inhibitors and retarders – functions and examples. Chain transfer reactions. Kinetics of chain growth polymerization. Kinetic chain length. Auto acceleration, thermal &electrochemical polymerization.	

MODULE 3	12Hrs
Ionic & stereoregular polymerization Ionic polymerization – anionic and cationic catalysts, Solvent effects in ionic polymerizations. Mechanism and kinetics of anionic and cationic polymerizations. Counter ions. Termination modes. Living polymers. Coordination polymerization: stereo regularity, Ziegler-Natta catalysts. Metallocene catalysts. Bimetallic and monometallic mechanisms.	
MODULE 4	12Hrs
Condensation or step growth polymerization Step growth polymerization, -Average functionality, basic characteristics, extent of reaction, degree of polymerization, Carother's equation. Gel and gel point. Mechanism of self-catalysed and non-catalysed esterification. Ring-opening & interfacial polymerization, Copolymerization: random, alternate, block and graft. Copolymerization involving two monomers (free radical mechanism). Reactivity ratio, its determination. Q-e scheme. Polymerisation techniques (bulk, solution, suspension and emulsion). Melt, solution and interfacial condensation.	
MODULE 5	12Hrs
Molecular mass and size of polymers Degree of polymerization and molecular weight. Practical significance of molecular weight. Threshold molecular weight. Concept of average molecular mass and molecular mass distribution. Number average, weight average and z average molecular mass and their calculation. Viscosity average molecular mass. Molecular mass distribution curve. Polydispersity and polydispersity index of polymers. Examples of monodispersed and polydispersed polymers. Molecular mass & mechanical properties. Size of polymer molecules.	

TEXT BOOKS/REFERANCES:

1. Malcon P. Steves, Polymer chemistry-An introduction, 3rd edition, Oxford University Press.
2. F. W. Billmayer, Text book of Polymer Science, 3rd edition, John Wiley & Sons
3. V. R. Gowariker, N. V. Viswanathan & J. Sreedhar, Polymer Science, New Age International Publishers.
4. P. Bahadur & N. V. Sastry, Principles of Polymer Science, Narrora Publishing House, 2nd Edition, New Delhi.
5. Premamoy Ghosh, Polymer Science & Technology, 3rd edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi.
6. G. Odian, Principles of polymerization, 3rd edition, John Wiley & Sons.
7. G. S. Misra, Introductory Polymer Chemistry New age International Publishers & Distributors, New Delhi
8. V. K. Ahluwalia & A. Misra, Polymer Science-A Text Book, AneBooks, India, New Delhi.
9. J. R. Fried, Polymer Science & Technology, Prentice Hall of India Pvt. Ltd, New Delhi.

EXPERIMENTS
1. Determination of molecular weight of polymer by Viscosity.
2. Synthesis of Nylon.
3. Free Radical Polymerization of Styrene.
4. Preparation of Polyvinyl Chloride
5. Synthesis of polyurethane foam.
6. Synthesis of Polymer Nanoparticles.
 TEXT BOOKS/REFERANCES: 1. Malcon P. Steves, Polymer chemistry-An introduction, 3rd edition, Oxford University Press. 2. F. W. Billmayer, Text book of Polymer Science, 3rd edition, John Wiley & Sons 3. V. R. Gowariker, N. V. Viswanathan & J. Sreedhar, Polymer Science, New Age International Publishers.

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22CY4702					
TITLE OF THE COURSE	INORGANIC CHEMISTRY- II					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

COURSE OBJECTIVES:

- To make students understand about co-ordination compounds their synthesis, reactions and applications
- To impart knowledge about organometallic compounds.

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Will understand the mechanism of reaction of transition metal complexes.	L1
CO2	Should be able to correlate the structure of Transition Metal complexes with their magnetic properties.	L2
CO3	Will be able to gain knowledge organo-metallic compounds and its significance as a catalyst.	L3

COURSE CONTENT:

MODULE 1	15 Hrs
CO-ORDINATION COMPOUNDS Coordination compounds, terminologies, ligands and their classification (mono, bi, tri, tetra, penta and hexa dentate ligands) and ambidentate ligands, coordination number, nomenclature of coordination compounds. Theories of structure and bonding (Explanation for the formation of complexes by Werner's Theory taking cobalt amine complexes). EAN rule, Valence bond theory-postulates, low spin and high spin complexes with examples (cobalt and nickel-based complexes), limitations of VBT. Crystal field theory (octahedral, tetrahedral and squareplanar complexes). Magnetic properties of $[\text{CoF}_6]^{3-}$, $[\text{Fe}(\text{CN})_6]^{4-}$ Spectral properties of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$, $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$ Isomerism-Structural: ionization, linkage, hydrate and coordination isomerism with examples. Stereoisomerism : geometrical and optical isomerism in cobalt amine complexes.	
MODULE 2	15 Hrs
REACTION MECHANISM IN TRANSITION METAL COMPLEXES Energy profile of a reaction inert and labile complexes, kinetics of octahedral substitution and mechanistic aspects. Acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism and evidence in its favour. Substitution reactions of square planar complexes - Trans effect and applications of trans effect, substitution reactions of tetrahedral complexes, isomerization and racemisation reactions of coordination compounds. Electron transfer reaction- inner sphere and outer sphere reactions, complementary and noncomplementary reactions.	

MODULE 3	15 Hrs
MAGNETIC PROPERTIES OF TRANSITION METAL COMPLEXES Types of magnetic behaviour, orbital contributions, spin orbital coupling, spin cross over system, methods of determining magnetic susceptibility, diamagnetic corrections, ferro and antiferro magnetic coupling, super paramagnetism. spin-only formula. Electron Spectra of Transition Metal Complexes Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series. Orgel-energy level diagram for d1 and d9 states, discussion of the electronic spectrum of [Ti(H ₂ O) ₆] ³⁺ complex ion.	
MODULE 4	15 Hrs
ORGANOMETALLIC COMPOUNDS Ligands, classification (hapticity). Synthesis and structure of K ₂ [PtCl ₃ (η ² -C ₂ H ₄)] Metal carbonyls – Cr(CO) ₆ , Mn ₂ (CO) ₁₀ ; eighteen electron rule and its deviations with examples. Applications of coordination/organometallic compounds: cis-platin in cancer therapy, Na ₂ Ca, EDTA in the treatment of heavy metals (Pb, Hg) poisoning, Wilkinson's Catalyst in alkene, hydrogenation, decarbonylation reaction, Rh-catalyst reaction, Ziegler natta reaction, Heck reaction and Suzuki coupling reaction.	
TEXT BOOKS/REFERENCES: 1. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London (1996). 2. Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998 3. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002. 4. Inorganic Chemistry, 4th Edition J. E. Huheey, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000 5. Modern Inorganic Chemistry W. L. Jolly, McGraw Hill Co. 6. Inorganic Chemistry, 3rd Edition (ISE) A G Sharpe, Addison Wesley, 1989.	

EXPERIMENTS
1. Estimation of percentage of iron in haematite using barium diphenylamine sulphonate as an internal indicator.
2. Estimation of calcium in lime stone.
3. Estimation of nickel using EDTA and standard zinc sulphate.
4. Preparation of sodium trioxalatoferrate (III) and estimation of iron.
5. Estimation of zinc using EDTA.
TEXT BOOKS/REFERENCES: 1. Vogel's Text Book of Practical Organic Chemistry, 5 th Edition, A.J. Hannford, A.R. Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication. 2. Chemistry Practical Inorganic Qualitative Analysis For Under Graduate Students, M.J. Mamtora, S.C. Karad, J.S. Makasana, Lap Lambert Academic Publishing. 3. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication.

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22CY4703					
TITLE OF THE COURSE	NANOSCIENCE AND MATERIAL CHEMISTRY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

COURSE OBJECTIVES:

- To make students understand about co-ordination compounds their synthesis, reactions and applications
- To impart knowledge about organometallic compounds.

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Will understand the mechanism of reaction of transition metal complexes.	L1
CO2	Should be able to correlate the structure of Transition Metal complexes with their magnetic properties.	L2
CO3	Will be able to gain knowledge organo-metallic compounds and its significance as a catalyst.	L3

COURSE CONTENT:

MODULE 1	15 Hrs
INTRODUCTION OF NANOMATERIALS Background to Nanoscience: Definition of Nano, Scientific revolution-Atomic Structure and atomic size, emergence and challenges of nanoscience and nanotechnology, carbon age-new form of carbon (CNT to Graphene), influence of Nano over micro/macro, size effects and crystals, large surface to volume ration, surface effects on the properties. Types of nanostructure and properties of nanomaterials: One dimensional, Two dimensional and Three-dimensional nanostructured materials, Quantum Dots shell structures, metal oxides, semiconductors, composites, mechanical-physical-chemical properties.	
MODULE 2	15 Hrs
SYNTHESIS OF NANOMATERIALS Colloids :- Introduction to Colloids and Colloids in Solutions, Effect of Charges on Colloids, Stearic Repulsion, Synthesis of Colloids, Nucleation and Growth of Nanoparticles. Different methods of production: Top down and bottom-up approach with examples. Physical Methods; Inert gas condensation, Arc discharge, RF-plasma, Plasma arc technique, Ball Milling, Molecular beam epitaxy, Chemical Vapour deposition (CVD), ALD method and other variants, electrodeposition. Chemical Methods: Sol-gel, hydrothermal, solvothermal, combustion method, microwave method, coprecipitation method, Photochemical synthesis, Electrochemical synthesis. Biological Methods:- Synthesis Using Microorganisms, Synthesis Using Plant Extracts Use of Proteins	

MODULE 3	15 Hrs
Characterization: Basic principle and application of X-ray diffraction, SEM, FESEM, TEM, EDS analysis, AFM, XPS, UV-Visible Spectrophotometers with respect to CNT, graphite, graphene, metal dichalcogenides, Quantum dots, core-shell nanoparticles.	
MODULE 4	15 Hrs
APPLICATION OF NANOMATERIALS Environmental Nano-Remediation Technology Nanofiltration for treatment of wastes – Removal of Organics, Inorganics and Pathogens – Nanotechnology for water purification –Treatment of industrial waste water using Nanomaterials – Environmental benefits of Nanomaterials. Class of Materials Used in Medicine Introduction, Properties of Materials, Type of Materials in Medicine – Metals, Polymers, Hydrogels, Ceramics, Glasses and Glass Ceramics, Composites, Thin films, Grafts and Coatings.	
TEXT BOOKS/REFERENCES: 1. Nanochemistry: A Chemical Approach to Nanomaterials – Royal Society of Chemistry, Cambridge UK 2005. 2. Chemistry of Nanomaterials: Synthesis, properties and applications by CNR Rao et.al., Royal Society of Chemistry, Cambridge UK 2006. 3. Nanocharacterization Techniques, Alessandra L. Da Roz, M. Ferreira, F. L. Leite, O. N. Oliveira, 2017, Elsevier, Cambridge, USA, ISBN: 978-0-323-49788-7 4. Fundamental Properties of Nanostructured Materials, Ed. D. Fiorani (World Scientific, Singapore, 1994. 5. Hand Book of Nanotechnology, by Bharat Bhushan, 2007, Springer Science + Business Media, Inc, NY, USA. 6. Biomaterials Science, An Introduction to Materials in Medicine, Edited by Buddy D.Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, Academic Press, A 7. Wiesner, M.R., and Bottero, J.Y. (Ed.) — Environmental Nanotechnology: Applications and Impacts of Nanomaterials McGraw-Hill, New York, 2007.	

EXPERIMENTS	
1.	Synthesis of metal oxide nanoparticles by solution sol-gel methods.
2.	Synthesis of metal oxide nanoparticles by solution combustion methods
3.	Synthesis of multi-ferrite nano-particles by chemical co-precipitation method.
4.	Synthesis of silver nanoparticles, and its spectral analysis.
5.	Preparation of cadmium sulphide nanoclusters and its spectral studies
TEXT BOOKS/REFERANCES:	
1.	Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.
2.	Nanofabrication Principles, Capabilities and Limits, Zheng Cui, Springer, New York, 2008.
3.	Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, R.S.C. Publication.

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22BS4701					
TITLE OF THE COURSE	RESEARCH METHODOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	45	3
Perquisite Courses (if any)						
#	Sem/Year	Course Code	Title of the Course			
-	-	-	-			

COURSE OBJECTIVES:
To provide an overview of essential research steps to be followed when conducting research / project work.
To understand chief ingredients to be incorporated in conduct as well as writing of scientific reports/dissertation/thesis
To know the implication professional research ethics and common misconduct details of researcher and research work

COURSE OUTCOME		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Show and explain the concepts of meaning of research, scope of research including different types of research, scientific research process and research methodology steps	L1
CO2	Perform review of literature using electronic media, selecting research problem formulate research problem statement, writing hypothesis, explain criteria of forming objectives, materials and methods, results and discussion	L2
CO3	Identify and explain experimental research designs for both qualitative and quantitative research	L2
CO4	Explain different sampling methods and sampling design, basic statistical methods for treatment of data and observations	L2
CO5	Demonstrate ingredients and components of a research report, dissertation and thesis and explain integral components of research article and research proposal	L2
CO6	Explain professional research ethics and elaborate on misconduct in research	L2

COURSE CONTENT:	
MODULE 1:	12 hrs
INTRODUCTION TO RESEARCH: Meaning, Objectives and Characteristics of research – Scientific Method Types of research - Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical - Research process - Criteria of good research PROBLEM STATEMENT: Defining the research problem - Selecting the problem - Necessity of defining the problem - Techniques involved in defining the problem; LITERATURE SURVEY: Importance of literature review in defining a problem - Survey of literature - Primary and secondary sources - web as a source - searching the web - Identifying gap areas from literature review. HYPOTHESIS: Definition of hypothesis, Basic concepts, variables-Dependent and independent variables, Development of working hypothesis; Ingredients of Research Objectives, deriving objectives of research.	
MODULE 2:	12 hrs
Sampling, Material and Methods: Sample- Sampling - Types of sampling; Material - Experiments, Data – Basics of Analysis; Writing materials and method chapter of a research report Results and Discussion: Representation of results; Tables, graphs; Discussion, Purpose and Function of Discussion Research Designs: Research design; Need of research design - Basic Principles; Features of good design – Important concepts relating to research design; Max-min-con principle, Common Research Designs: Cross-sectional, Case-control, Longitudinal and Cohort research designs, advantages and disadvantages of each of research designs Summary and Conclusion: Writing of Summary, conclusions of research findings, Acknowledgement section of a research report and an article.	
MODULE 3:	10Hrs
Research Ethics: Values, Ethics and Morals, Research Professionalism, Tenets of Ethics; Conducting and reporting of science/engineering; Relationship in research groups; Hazards to good scientific practice; Scientific misconduct: Fabrication, Falsification and Plagiarism. Report and Article Writing: Structure and components of scientific reports; Abstract-Key words; Types of reports; Significance of reporting; Different steps in the preparation of reports; Layout, structure and Language of typical reports; References; Citation styles- APA and MLA styles of citation, intext and end text citations. Oral Presentation: Importance of effective communication. Planning; Preparation; Practice; Making presentation; Use of visual aids.	
MODULE 4:	11Hrs
Scientific Article Writing: Title preparation – Importance of title; need for specific titles; List of authors and addresses – order of names; defining the order with example; types of abstracts; economy of words; How to write introduction- Rules; exceptions; citations and abbreviations Materials and methods: Purpose; materials; methods; tables and figures; form and grammar; Result and Discussion writing: content of results; handling numbers; clarity; avoiding redundancy; Discussion writing: Components of discussion; factual relationships; strengths and limitations; significance of paper; Stating Acknowledgements: Ingredients of the acknowledgements; courtesy; Citation of the References: Rules; electronics aid; in-textcitation; styles of referencing Research Proposal Fundamentals: What is a grant proposal? Why proposals fail?; Developing and writing of grant proposals; overview of steps to develop grant proposals; Proposal Development Process:Standard Proposal Parts; writing Budget section. Intellectual Property Rights: IPRs- Invention and Creativity- Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs); A brief summary of: Patents, Copyrights, Trademarks.	

REFERENCES:

1. Bruce Tuckman, Brian E Harper, Conducting Educational Research, 6th Edition, 2012 by Rowman & Littlefield Publishers, Inc. ISBN 978-1-4422-0965-7 (electronic)
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
4. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
5. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
6. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
7. Day, R.A., 1992. How to Write and Publish a Scientific Paper, Cambridge University Press.
8. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
9. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.

SEMESTER	VII					
YEAR	IV					
COURSE CODE	22CY2404					
TITLE OF THE COURSE	COORDINATION COMPOUNDS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	4	-	60	6

COURSE OBJECTIVES:

- To make students understand about co-ordination compounds their synthesis, reactions and applications
- To impart knowledge about organometallic compounds.

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Will understand the mechanism of reaction of transition metal complexes.	L1
CO2	Should be able to correlate the structure of Transition Metal complexes with their magnetic properties.	L2
CO3	Will be able to gain knowledge organo-metallic compounds and its significance as a catalyst.	L3

COURSE CONTENT:

MODULE 1	15 Hrs

CO-ORDINATION COMPOUNDS

Coordination compounds, terminologies, ligands and their classification (mono, bi, tri, tetra, penta and hexa dentate ligands) and ambidentate ligands, coordination number, nomenclature of coordination compounds. Theories of structure and bonding (Explanation for the formation of complexes by Werner's Theory taking cobalt amine complexes). EAN rule, Valence bond theory-postulates, low spin and high spin complexes with examples (cobalt and nickel-based complexes), limitations of VBT. Crystal field theory (octahedral, tetrahedral and squareplanar complexes). Magnetic properties of $[\text{CoF}_6]^{3-}$, $[\text{Fe}(\text{CN})_6]^{4-}$ Spectral properties of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$, $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$ Isomerism-Structural: ionization, linkage, hydrate and coordination isomerism with examples. Stereoisomerism : geometrical and optical isomerism in cobalt amine complexes.

MODULE 2	15 Hrs

REACTION MECHANISM IN TRANSITION METAL COMPLEXES

Energy profile of a reaction inert and labile complexes, kinetics of octahedral substitution and mechanistic aspects. Acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism and evidence in its favour. Substitution reactions of square planar complexes - Trans effect and applications of trans effect, substitution reactions of tetrahedral complexes, isomerization and racemisation reactions of coordination compounds. Electron transfer reaction- inner sphere and outer sphere reactions, complementary and noncomplementary reactions.

MODULE 3	15 Hrs
MAGNETIC PROPERTIES OF TRANSITION METAL COMPLEXES Types of magnetic behaviour, orbital contributions, spin orbital coupling, spin cross over system, methods of determining magnetic susceptibility, diamagnetic corrections, ferro and antiferro magnetic coupling, super paramagnetism. Spin-only formula. Electron Spectra of Transition Metal Complexes Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series. Orgel-energy level diagram for d1 and d9 states, discussion of the electronic spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ complex ion.	
MODULE 4	15 Hrs
ORGANOMETALLIC COMPOUNDS Ligands, classification (hapticity). Synthesis and structure of $\text{K}[\text{PtCl}_3(\eta^2\text{-C}_2\text{H}_4)]$ Metal carbonyls – $\text{Cr}(\text{CO})_6$, $\text{Mn}_2(\text{CO})_{10}$; eighteen electron rule and its deviations with examples. Applications of coordination/organometallic compounds: cis-platin in cancer therapy, Na_2Ca , EDTA in the treatment of heavy metals (Pb, Hg) poisoning, Wilkinson's Catalyst in alkene, hydrogenation, decarbonylation reaction, Rh-catalyst reaction, Ziegler natta reaction, Heck reaction and Suzuki coupling reaction.	
TEXT BOOKS/REFERANCES: 1. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London (1996). 2. Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998 3. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002. 4. Inorganic Chemistry, 4th Edition J. E. Huhe, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000 5. Modern Inorganic Chemistry W. L. Jolly, McGraw Hill Co. 6. Inorganic Chemistry, 3rd Edition (ISE) A G Sharpe, Addison Wesley, 1989.	

EXPERIMENT
1. Estimation of percentage of iron in haematite using barium diphenylamine sulphonate as an internal indicator.
2. Estimation of calcium in lime stone.
3. Estimation of nickel using EDTA and standard zinc sulphate.
4. Preparation of sodium trioxalatoferrate (III) and estimation of iron.
5. Estimation of zinc using EDTA.
TEXT BOOKS/REFERANCES: 1. Vogel's Text Book of Practical Organic Chemistry, 5 th Edition, A.J. Hannford, A.R. Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication. 2. Chemistry Practical Inorganic Qualitaive Analysis For Under Graduate Students, M.J. Mamtora, S.C. Karad, J.S. Makasana, Lap Lambert Academic Publishing. 3. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication.

SEMESTER			V			
YEAR			III			
COURSE CODE			22CY3503			
TITLE OF THE COURSE			PHYSICAL CHEMISTRY FOR BIOLOGICAL SCIENCES			
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4		4		60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
Students should gain a deep understanding of the basic concepts of thermodynamics, including the laws of thermodynamics, internal energy, heat, work, entropy, and the different thermodynamic functions.	
Through a variety of exercises and real-world examples, students should develop strong problem-solving skills related to thermodynamics in chemistry, enabling them to tackle complex thermodynamic problems.	
Students should be able to apply kinetic theories and concepts to analyse and predict the behaviour of chemical reactions, including reaction mechanisms, reaction order, and the effects of temperature, concentration, and catalysts on reaction rates.	
Students should be able to identify and understand the relevance of chemical kinetics in various real-world applications, such as industrial processes, environmental chemistry, and pharmaceutical research.	
Develop a comprehensive understanding of the structure, properties, and behavior of solid materials.	
Develop a thorough understanding of the principles of nuclear chemistry and its applications in various scientific and industrial contexts.	

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students should be able to articulate and explain the laws of thermodynamics, including the first, second, and third laws, and understand their significance in the context of energy and chemical systems.	L1
CO2	Students should be proficient in performing calculations involving thermodynamic quantities, such as heat transfer, work done, changes in internal energy, entropy changes, and Gibbs free energy changes.	L2

CO3	Students should be able to apply kinetic theories and concepts to analyze and predict the behavior of chemical reactions, including reaction mechanisms, reaction order, and the effects of temperature, concentration, and catalysts on reaction rates.	L3
CO4	Students should be able to identify and understand the relevance of chemical kinetics in various real-world applications, such as industrial processes, environmental chemistry, and pharmaceutical research.	L2
CO5	Students should be proficient in analyzing crystal structures of various solid materials, including simple and complex crystal lattices, and understand the relationship between crystal structures and material properties.	L1
CO6	Students should be proficient in understanding and analyzing nuclear reactions, including radioactive decay, nuclear stability, nuclear fission, and nuclear fusion, as well as the concepts of half-life, decay constant, and radioactivity.	L2

COURSE CONTENT:

MODULE 1

15Hrs

Thermodynamics

Exact and inexact differentials. Review of terms, I law of Thermodynamics. Work done (derivation with problems) in isothermal and adiabatic expansion and compression of an ideal gas (IUPAC sign conventions to be used). Heat capacity of a gas at constant pressure and constant volume: relation between P, V and T in an adiabatic process to be derived. Derivation of Kirchoff's equation. Numerical problems. Spontaneous and non-spontaneous processes.

Second law of thermodynamics: Limitations of I law of thermodynamics with illustrations. Need for II law of thermodynamics, different ways of stating II law with respect to heat and spontaneity. Other forms of II law of thermodynamics. Concept of entropy and its physical significance-illustrations with order, disorder, physical and chemical processes and probability.

Heat engine-Carnot's cycle and derivation of the expression for its efficiency. Problems based on efficiency equation. II law in terms of efficiency (η). Change in entropy in reversible and irreversible processes (derivations required). Calculation of entropy changes in reversible isothermal and reversible adiabatic processes. Phase transitions in terms of Entropy (Fusion, vaporization, sublimation and polymorphic changes) in terms of entropy. Limitations of the entropy concept of spontaneity. Problem on Phase transitions. III law of thermodynamics-statement only. Elementary concept of residual entropy.

MODULE 2

15Hrs

Chemical Kinetics

Review of terms –Rate, Order and Molecularity, Derivation of expression for the rate constant of a second order reaction with $a = b$ and $a \neq b$. Expression for half-life of a second order reaction. Mean life for first order reaction to be mentioned. Problems on rate constant, half-life period, mean life period and order of reaction.

Determination of order of reaction: differential method, method of integration, method of half-life period and isolation method.

Theories of reaction rates: Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Problems. Simple collisions theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects. Steady state approximation and Lindemann's hypothesis. Experimental determination of kinetics of: (i) inversion of cane sugar by polarimetric method, (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.

MODULE 3

15Hrs

Electrochemistry

Conductance related terms, Methods of determination of molar conductance. Conductometric titrations (only acid-base type). Transport numbers: definition – determination by moving boundary method. Ionic mobility. Problems on transport numbers. Kohlrausch's law and its applications, Problems based on these. Qualitative account of Debye-Huckel theory, Debye-Huckel- Onsagar equation for aqueous solutions of 1:1 electrolytes. Verification of DHO equation. Galvanic cell: conventions of representing galvanic cells, derivation of Nernst equation for single electrode potential (free energy concept). Determination of emf of a cell by compensation method. Liquid junction potentials, elimination of liquid junction potential. Types of electrodes: Metal and gas electrodes (chlorine), metal/metal insoluble salt electrodes, redox electrodes. Reference electrodes- standard hydrogen electrode, calomel electrode, quinhydrone electrode and glass electrode. Determination of pH using these electrodes. Numerical problems.

MODULE 4

15Hrs

Solid state

Crystalline state, Laws of crystallography. Symmetry elements in crystals, crystal systems. Weiss and Miller indices. X-ray diffraction of crystals-derivation of Bragg's equation, Problems Liquid crystals-Types with examples. Applications Superconducting Solids-High temperature superconductors. Applications.

Nuclear and Radiochemistry

Nucleus: Structure and stability, binding energy calculations. Instability of the nuclei, radioactive decay law, half life: numerical problems. Radioactive equilibrium, radioactive series. Artificial radioactivity: Nuclear reactions induced by γ -radiation, α , n , p , and d particles. Nuclear fission and fusion. Nuclear reactors, Breeder reactors, Isotopes- separation of isotopes, use of radio isotopes in tracer technique, agriculture, medicine, food preservation and Carbon dating-Numerical problems.

TEXT BOOKS/REFERENCES:

1. Physical Chemistry, 7th Edition P. W. Atkins and Julio de Paula, Oxford Univ. Press, 2002.
2. The Elements of Physical Chemistry, 3rd Edition Peter Atkins, Oxford Univ. Press, 2000.
3. Physical Chemistry – A molecular Approach Donal A. Mcquarrie and John D. Simon, Viva Low-priced Student Edition, 2001.
4. Introduction to Physical Chemistry, 3rd Edition Mark Ladd, Cambridge Low-Priced Edition, 1999.
5. Text Book of Physical Chemistry S. Glasstone, MacMillan India Ltd., 1998.
6. Principles of Physical Chemistry, 4th Edition B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987

7. Text Book of Physical Chemistry P. L. Soni., S. Chand & Co., 1993.
8. Physical Chemistry Alberty R. A. and Silbey R. J. John Wiley & Sons, 1992.
9. Physical Chemistry G. M. Barrow, McGraw Hill, 1986.
10. Physical Chemistry, 3rd Edition Gibert W. Castellan, Narora Publishing House, 1985.

List of Laboratory/Practical Experiments to be conducted:

1. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and
a. determination of energy of activation.
2. To determine the enthalpy change when a solute dissolved in a solvent.
3. The study of kinetics of potassium persulphate and potassium iodide.
4. Conductometric titration of hydrochloric acid with sodium hydroxide.
5. Determination of equivalent conductivity of 0.1 N sodium chloride and verification of
6. DHO equation.
7. Radiation Detection and Measurement using radiation detectors (e.g., Geiger-Müller counters)

TEXT BOOKS/ REFERENCES

1. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford, A.R. Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication.
3. Advanced Practical Chemistry, K. Chelladurai, K. Subbian, Lap Lambert Academic Publishing.
4. Experiments in Physical Chemistry 8th edition, Carl W. Garland, Joseph W. Nibler, and David P. Shoemaker, McGraw-Hill Education.

SEMESTER			VI			
YEAR			III			
COURSE CODE			22CY3603			
TITLE OF THE COURSE			ORGANIC CHEMISTRY FOR BIOLOGICAL SCIENCES			
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4		4		60	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
•	Understand the structure, reactivity, and synthesis of aldehydes and ketones, and their significance in organic chemistry.
•	Explore the properties, reactions, and applications of carboxylic acids and their derivatives.
•	Master the principles of stereochemistry and their role in organic reactions.
•	Master the fundamental principles of organic reaction mechanisms.
•	Understand the principles of spectroscopic techniques used in chemical analysis.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students should be proficient in explaining the mechanisms of reactions involving aldehydes and ketones, including nucleophilic addition, oxidation, reduction, and condensation reactions. They should understand the importance of these compounds in both synthetic organic chemistry.	L1
CO2	Students should be able to explain the structure and reactivity of carboxylic acids, as well as their derivatives (esters, amides, acid chlorides, etc.), including hydrolysis, esterification, and acylation reactions.	L2
CO3	Students should be able to explain the mechanisms of various organic reactions, understand electron flow in chemical reactions (e.g., nucleophilic and electrophilic reactions), and predict the products of typical organic transformations. They should be familiar with key reaction intermediates and reaction pathways.	L3
CO4	Students should be proficient in explaining stereochemistry, including chiral molecules, enantiomers, diastereomers, and the basics of optical activity. They should be able to apply these concepts to predict stereochemical outcomes in organic reactions and to analyze the three-dimensional arrangement of molecules.	L2
CO5	Students should understand the underlying principles of various spectroscopic techniques, such as UV spectroscopy, nuclear magnetic resonance (NMR), and infrared spectroscopy (IR). They should be able to describe how these techniques provide information about molecular structure and behavior.	L3

COURSE CONTENT:	
MODULE 1	15Hrs
Aliphatic Hydrocarbons and Alcohol Alkanes: Sources, Nomenclature of branched chain alkanes, preparation of symmetrical and unsymmetrical alkanes- Corey- House reaction and Wurtz reaction - their merits and demerits. Conformational analysis of n-butane - Sawhorse and Newman projection formulae to be used-Energy profile diagram. Alkenes: Preparation of alkenes by Wittig reaction-stereoselectivity. Addition of HX to unsymmetrical alkene - Markownikov's rule and Antimarkownikov's rule with mechanism. Reactions: Hydroboration-oxidation, reduction, oxymercuration - demercuration, epoxidation. Alkynes: Methods of preparation - Dehydrohalogenation of vicinal and geminal dihalides; and higher alkynes from terminal alkynes. Reactions - metal ammonia reduction-significance. Oxidation with KMnO ₄ , acidic nature of terminal alkynes. Alcohols: Introduction and classification. Methods of preparation - (i) From carbonyl compounds - reduction of aldehydes and ketones (by Meerwein-Ponndorf-Verley reaction); (ii) from acids and esters (by reduction with LiAlH ₄); (iii) From alkenes (by hydroborationoxidation with alkaline peroxide); (iv) hydration of alkenes. Reactions of alcohols: Acidic nature, esterification, oxidation of alcohols with KMnO ₄ . Comparison of the reactivity of 1°, 2° and 3° alcohols- Lucas test, oxidation with K ₂ Cr ₂ O ₇	
MODULE 2	15Hrs
Phenols, Aldehydes and Ketones Phenols: Classification. Acidic nature - Comparison of acidic strength of phenol with alcohols and monocarboxylic acids. Effect of electron withdrawing –NO ₂ group and electron donating –CH ₃ group on acidity of phenols at <i>o</i> -, <i>m</i> -, <i>p</i> - positions. Pechmann reaction, Mechanisms of Reimer-Tiemann and Kolbe-Schmidt reactions. Industrial applications of phenols: Conversion of phenol to (i) aspirin, (ii) methyl salicylate, (iii) salol, (iv) salicyl salicylic acid. Aldehydes and Ketones: Nomenclature. Preparation of aldehydes: from acid chlorides (Rosenmund reaction), Gattermann-Koch aldehyde synthesis. Preparation of Ketones: From nitriles, from carboxylic acids with alkyl lithium, from acid chlorides with metal alkyls. Mechanisms of: Aldol condensation, Perkin condensation, Knoevenagel condensation, Benzoin condensation and Acetal formation. General mechanism of condensation with ammonia and its derivatives (NH ₂ -R; R = –NH ₂ , –OH, –NH–CO–NH ₂). Reduction: Reduction by LiAlH ₄ and NaBH ₄ . Mannich reaction. Mechanisms of Clemmensen and Wolff-Kishner reductions.	
MODULE 3	15Hrs
Carboxylic acids and Stereochemistry <i>Carboxylic acids</i> : Nomenclature. Preparation: Acid hydrolysis of nitriles with mechanism. Acidic strength (pK _a values) - Effect of substituents on the strength of aliphatic and aromatic carboxylic acids. (comparison of acidic strength of formic and acetic acids; acetic acid and monochloro, dichloro, trichloro acetic acids ; benzoic and p-nitrobenzoic acid; benzoic acid and p-aminobenzoic acid) Reactions: Formation of esters, acid chlorides, amides and anhydrides. Hell-Vollhardt-Zelinski reaction, Mechanism of ester hydrolysis - acid and base catalysed (acyl O-cleavage: BAC2, AAC2; alkyl O-cleavage: AAL1 mechanisms).	

Stereochemistry: Elements of symmetry in chiral and achiral molecules, chirality, stereogenic centre. Fischer projection formulae. **Enantiomers:** Optical activity; use of $\pm$ -, d/l and D/L notations. Properties of enantiomers, chiral and achiral molecules with two stereogenic centers. Meso compounds. Cahn-Ingold-Prelog sequence rules: R, S system of nomenclature. **Diastereomers:** Threo and Erythro isomers. Racemisation and resolution. Relative and absolute configuration. **Optical isomerism** due to restricted rotation about single bonds- diphenyl systems. **Geometric isomerism:** Determination of configuration of geometric isomers. Cis & trans, E, Z system of nomenclature. Geometric isomerism in oximes.

MODULE 4

15Hrs

Spectroscopy

Fundamentals of Spectroscopy, Electromagnetic radiation.

Ultra-Violet and Visible Spectroscopy: The Absorption Laws, Measurement of Absorption Intensity, Theory of Electronic Spectroscopy, Types of Electronic Transitions, The Chromophore Concept, Auxochrome, Absorption and Intensity shifts, Applications of ultra-violet Spectroscopy.

Infra-Red Spectroscopy: Principle of infra-red spectroscopy, Theory—Molecular Vibrations, Factors Influencing Vibrational Frequencies, Scanning of Infra-red Spectrum (Instrumentation), Sampling Techniques, Finger Print Region, Spectral Features of Some classes of organic Applications of infra-red spectroscopy.

Nuclear Magnetic Resonance (NMR) Spectroscopy: Introduction, Theory, Positions of Signals (Chemical Shift), Internal Standards, Shielding and Deshielding Effects, Factors Influencing Chemical Shift, Solvents Used, Peak area and Proton Counting, Splitting of the Signals, Spin-spin Coupling, Coupling Constant (J), Some Important NMR Spectra, C^{13} -NMR Spectroscopy, Applications of NMR Spectroscopy, Important Features in Nuclear Magnetic Resonance Spectroscopy, Simple Problems on Nuclear Magnetic.

List of Laboratory/Practical Experiments to be conducted:

1. Organic qualitative analysis of mono functional organic compounds through functional group analysis. (At least 5 organic functional groups)
2. Recrystallisation and determination of melting point of solids (mixed melting point determination and its importance may be mentioned).
3. Simple distillation and determination of boiling point of liquids.
4. Purification of solids by sublimation.

TEXT BOOKS/REFERENCE BOOKS

1. Vogels Textbook Of Practical Organic Chemistry 5Th Edition, FURNISS and BRIAN S and HANNAFORD and ANTONY J, PEARSON INDIA.
2. Microscale Organic Laboratory: With Multistep and Multiscale Syntheses" by Dana W. Mayo, Ronald M. Pike, and David C. Forbes, J. Wiley & Sons.
3. Experimental Organic Chemistry: A Miniscale and Microscale Approach" by John C. Gilbert and Stephen F. Martin, Cengage Learning Publisher.
4. A Small Scale Approach to Organic Laboratory Techniques" 3rd edition, Donald L. Pavia, George S. Kriz, and Gary M. Lampman, Cengage Learning Publisher.

DAYANANDA SAGAR UNIVERSITY
Innovation Campus, Kudlu Gate, Hosur Road, Bengaluru - 560 068

SCHOOL OF BASIC & APPLIED SCIENCES



SCHEME & SYLLABUS

BACHELOR OF SCIENCE HONOURS (B.Sc. HONS) – 2023

B.Sc. HONS IN BIOCHEMISTRY
B.Sc. HONS IN BIOTECHNOLOGY
B.Sc. HONS IN GENETICS
B.Sc. HONS IN MICROBIOLOGY

(With effect from 2023 onwards)

SCHEME 2023 ONWARDS**I SEM - B.Sc. HONS (Common)**

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23BS1101	Biological Chemistry	CR	3	-	4	-	4	60	40
2	139	23BS1102	Cell Biology	CR	3	-	4	-	4	60	40
3	139	23BS1103	Environmental Science and Public Health	CR	3	-	4	-	4	60	40
4	139	23BS1104	Communicative English	CR	2	-	-	-	2	60	40
5	139	23BS1105	Computer Applications	CR	2	-	-	-	2	60	40
6	139	23BS1106	Biosafety and Good Laboratory Practices	CR	2	-	-	-	2	60	40
7	139	23BS1107	Python for Biologists	CR	2	-	-	-	2	60	40
Total					18	-	8	-	20	-	-

II**SEM - B.Sc. HONS (Common)**

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23BS1201	Biomolecules	CR	3	-	4	-	4	60	40
2	139	23BS1202	Principles of Genetics	CR	3	-	4	-	4	60	40
3	139	23BS1203	Biostatistics	CR	3	-	-	-	3	60	40
4	139	23BS1204	Bioinformatics	CR	3	-	-	-	3	60	40
5	139	23BS1205	Technical English	CR	2	-	-	-	2	60	40
6	139	23BS1206	Kannada	CR	2	-	-	-	2	60	40
7	139	23BS1207	SPSS	CR	2	-	-	-	2	60	40
Total					18	-	8	-	20	-	-

III**SEM - B.Sc. HONS (Common)**

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23BS2301	Biophysics and Instrumentation	CR	3	-	4	-	4	60	40
2	139	23BS2302	Molecular Biology	CR	3	-	4	-	4	60	40
3	139	23BS2303	Fundamentals of Microbiology	CR	3	-	4	-	4	60	40
4	139	23BS2304	Research Methodology	CR	3	-	-	-	3	60	40
5	139	23BS2305	Bioethics and IPR	CR	2	-	-	-	2	60	40
6	139	23BS2306	Constitution of India	CR	2	-	-	-	2	60	40
7	139	23BS2307	R- Program for Biologists	CR	2	-	-	-	2	60	40
Total					18	-	12	-	21	-	-

B.Sc. - HONS –BIOCHEMISTRY

IV

SEM

SL	PROGRA M CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23BY2401	Major 1- Enzyme technology	CR	3	-	4	-	4	60	40
2	139	23BY2402	Major 2- Carbohydrate & Protein Metabolism	CR	3	-	4	-	4	60	40
3	139	23BY2403	Major 3- Human Anatomy	CR	3	-	-	-	3	60	40
4	139	23BY2404	Minor 1- Metabolism And Bioenergetics	CR	3	-	-	-	3	60	40
5	139	23BY2405	Minor 2- Biochemistry in Health And Diseases	CR	3	-	-	-	3	60	40
6	139	23BS2401	AI and ML for Biologists	CR	2	-	-	-	2	60	40
7	139	23BS2402	MOOC/ SWAYAM/ NPTL	CR	2	-	-	-	2	-	-
Total					19	-	8	-	21		

V

SEM

SL	PROGRA M CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23BY3501	Major 1- Human Physiology	CR	3	-	4	-	4	60	40
2	139	23BY3502	Major 2- Immunology	CR	3	-	4	-	4	60	40
3	139	23BY3503	Major 2- Signal Transduction	CR	3	-	-	-	3	60	40
4	139	23BY3504	Minor 1- Anatomy and Physiology	CR	3	-	-	-	3	60	40
5	139	23BY3505	Minor 2- Nutrition	CR	3	-	-	-	3	60	40
6	139	23BS3501	Forensic Biology	CR	3	-	-	-	3	60	40
7	139	23BS3502	Term Paper presentation	CR	2	-	-	-	2	100	-
Total					20	-	8	-	22	-	-

VI

SEM

SL	PROGRA M CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23BY3601	Minor Project	CR	6	-	4	-	6	60	40
2	139	23BY3602	Major 1- Lipid & Nucleotide Metabolism	CR	3	-	4	-	4	60	40
3	139	23BY3603	Major 2- r-DNA Technology	CR	3	-	-	-	4	60	40
4	139	23BY3604	Minor 1- Enzymology	CR	3	-	-	-	3	60	40
5	139	23BY3605	Minor 2- Basics of Endocrinology	CR	3	-	-	-	3	60	40
6	139	23BS3601	Scientific Writing	CR	2	-	-	-	2	60	40
7	139	23BS3602	MOOC/ SWAYAM/ NPTL	CR	2	-	-	-	2	-	-
					22	-	8	-	24	-	-

VII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23BY4701	Major 1- Medical Biochemistry	CR	3	-	4	-	4	60	40
2	139	23BY4702	Major 2- Plant Biochemistry	CR	3	-	4	-	4	60	40
3	139	23BY4703	Major 3-Pharmacology	CR	3	-	-	-	3	60	40
4	139	23BY4704	Major 4- Nutrition and Dietetics	CR	3	-	-	-	3	60	40
5	139	23BY4705	Major 5- Membrane Biology	CR	3	-	-	-	3	60	40
6	139	23BS4701	Toxicology	CR	3	-	-	-	3	60	40
7	139	23BS4702	Term Paper presentation	CR	2	-	-	-	2	100	-
Total					20	-	8	-	22	-	-

III

SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23BS4801	Research Project	CR	-	-	10	-	10	60	40
2	139	23BS4802	MOOC / SWAYAM / NPTL	CR	2	-	-	-	2	-	-
Total					2	-	10	-	12	-	-

**B.Sc. HONS –BIOTECHNOLOGY
IV SEM**

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23BT2401	Major 1- Recombinant DNA Technology	CR	3	-	4	-	4	60	40
2	139	23BT2402	Major 2- Immunology	CR	3	-	4	-	4	60	40
3	139	23BT2403	Major 3- Food Technology	CR	3	-	-	-	3	60	40
4	139	23BT2404	Minor 1- Nano-Biotechnology	CR	3	-	-	-	3	60	40
5	139	23BT2405	Minor 2- Plant/ Animal Tissue Culture	CR	3	-	-	-	3	60	40
6	139	23BS2401	AI and ML for Biologists	CR	2	-	-	-	2	60	40
7	139	23BS2402	MOOC/ SWAYAM/ NPTEL	CR	2	-	-	-	2	-	-
Total					19	-	8	-	21	-	-

V SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23BT3501	Major 1- Industrial Biotechnology	CR	3	-	4	-	4	60	40
2	139	23BT3502	Major 2- Plant physiology and Pathology	CR	3	-	4	-	4	60	40
3	139	23BT3503	Major 2- Enzymology and Metabolism	CR	3	-	-	-	3	60	40
4	139	23BT3504	Minor 1- Molecular Cloning	CR	3	-	-	-	3	60	40
5	139	23BT3505	Minor 2- Clinical Research	CR	3	-	-	-	3	60	40
6	139	23BS3501	Forensic Biology	CR	3	-	-	-	3	60	40
7	139	23BS3502	Term Paper presentation	CR	2	-	-	-	2	100	-
Total					20	-	8	-	22	-	-

VI SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23BT3601	Minor Project	CR	6	-	4	-	6	60	40
2	139	23BT3602	Major 1- Plant Biotechnology	CR	3	-	4	-	4	60	40
3	139	23BT3603	Major 2- Animal Biotechnology	CR	3	-	-	-	4	60	40
4	139	23BT3604	Minor 1- Industrial Biotechnology	CR	3	-	-	-	3	60	40
5	139	23BT3605	Minor 2- Phytochemistry	CR	3	-	-	-	3	60	40
6	139	23BS3601	Scientific Writing	CR	2	-	-	-	2	60	40
7	139	23BS3602	MOOC/ SWAYAM/ NPTEL	CR	2	-	-	-	2	-	-
Total					22	-	8	-	24	-	-

VII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23BT4701	Major 1- Medical Biotechnology	CR	3	-	4	-	4	60	40
2	139	23BT4702	Major 2- Agricultural Biotechnology	CR	3	-	4	-	4	60	40
3	139	23BT4703	Major 3- Environmental Biotechnology	CR	3	-	-	-	3	60	40
4	139	23BT4704	Major 4- Stem-Cell and regenerative medicine	CR	3	-	-	-	3	60	40
5	139	23BT4705	Major 5- Nano-Sciences	CR	3	-	-	-	3	60	40
6	139	23BS4701	Toxicology	CR	3	-	-	-	3	60	40
7	139	23BS4702	Term Paper presentation	CR	2	-	-	-	2	100	-
Total					20	-	8	-	22	-	-

VIII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23BS4801	Research Project	CR	-	-	10	-	10	60	40
2	139	23BS4802	MOOC / SWAYAM / NPTEL	CR	2	-	-	-	2	100	-
Total					2	-	-	-	12	-	-

B.Sc. HONS –GENETICS**IV SEM**

SL	PROGRA M CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23GN2401	Major 1- Animal and Plant Genetics	CR	3	-	4	-	4	60	40
2	139	23GN2402	Major 2- Quantitative and Population Genetics	CR	3	-	4	-	4	60	40
3	139	23GN2403	Major 3- Transmission genetics	CR	3	-	-	-	3	60	40
4	139	23GN2404	Minor 1- Genomics and Proteomics	CR	3	-	-	-	3	60	40
5	139	23GN2405	Minor 2- Microbial Genetics	CR	3	-	-	-	3	60	40
6	139	23BS2401	AI and ML for Biologists	CR	2	-	-	-	2	60	40
7	139	23BS2402	MOOC/ SWAYAM/ NPTEL	CR	2	-	-	-	2	-	-
Total					19		8		21	-	-

V SEM

SL	PROGRA M CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23GN3501	Major 1- Developmental and Evolutionary Genetics	CR	3	-	4	-	4	60	40
2	139	23GN3502	Major 2- Cytogenetics and Immunogenetics	CR	3	-	4	-	4	60	40
3	139	23GN3503	Major 3- Stem cell and Regenerative Biology	CR	3	-	-	-	3	60	40
4	139	23GN3504	Minor 1- Medical and reproductive genetics	CR	3	-	-	-	3	60	40
5	139	23GN3505	Minor 2- Techniques in genome editing	CR	3	-	-	-	3	60	40
6	139	23BS3501	Forensic Biology	CR	3	-	-	-	3	60	40
7	139	23BS3502	Term Paper presentation	CR	2	-	-	-	2	100	-
Total					20	-	12	-	22	-	-

VI SEM

SL	PROGRA M CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23GN3601	Minor Project	CR	6	-	4	-	6	60	40
2	139	23GN3602	Major 1- Molecular Genetics	CR	3	-	4	-	4	60	40
3	139	23GN3603	Major 2- Gene Regulatory Networks and Genome Editing	CR	3	-	-	-	4	60	40
4	139	23GN3604	Minor 1- Oncogenetics	CR	3	-	-	-	3	60	40
5	139	23GN3605	Minor 2- Regulation of Gene expression	CR	3	-	-	-	3	60	40
6	139	23BS3601	Scientific Writing	CR	2	-	-	-	2	60	40
7	139	23BS3602	MOOC/ SWAYAM/ NPTEL	CR	2	-	-	-	2	-	-
Total					22	-	8	-	24	-	-

VII

SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23GN4701	Major 1- Behavioral and Neuro-genetics	CR	3	-	4	-	4	60	40
2	139	23GN4702	Major 2- Human and Clinical Genetics	CR	3	-	4	-	4	60	40
3	139	23GN4703	Major 3- Genetic Counseling	CR	3	-	-	-	3	60	40
4	139	23GN4704	Major 4- Genome Instability and Cancer	CR	3	-	-	-	3	60	40
5	139	23GN4705	Major 5- Epigenetics	CR	3	-	-	-	3	60	40
6	139	23BS4701	Toxicology	CR	3	-	-	-	3	60	40
7	139	23BS4702	Term Paper presentation	CR	2	-	-	-	2	100	-
Total					20	-	8	-	22	-	-

VIII

SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23BS4801	Research Project	CR	-	-	10	-	10	60	40
2	139	23BS4802	MOOC / SWAYAM / NPTL	CR	2	-	-	-	2	100	-
Total					2	-	-	-	12	-	-

B.Sc. HONS –MICROBIOLOGY**IV SEM**

S. No	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	ENS EXAM
1	139	23MY2401	Major-1 Bacteriology and Virology	CR	3	-	4	-	4	60	40
2	139	23MY2402	Major2-Mycology and Phycology	CR	3	-	4	-	4	60	40
3	139	23MY2403	Major3- Parasitology and Epidemiology	CR	3	-	-	-	3	60	40
4	139	23MY2404	Minor1-Extremophiles	CR	3	-	-	-	3	60	40
5	139	23MY2405	Minor2-Microbial diversity and Kinetics	CR	3	-	-	-	3	60	40
6	139	23BS2401	AI and ML for Biologists	CR	2	-	-	-	2	60	40
7	139	23BS2402	MOOC/ SWAYAM/NPTEL	CR	2	-	-	-	2	-	-
Total					19		8		21	-	-

V SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23MY3501	Major 1- Microbial Physiology and Metabolism	CR	3	-	4	-	4	60	40
2	139	23MY3502	Major 2- Microbial Fermentation Technology	CR	3	-	4	-	4	60	40
3	139	23MY3503	Major 2- Immunology and Immuno-techniques	CR	3	-	-	-	3	60	40
4	139	23MY3504	Minor 1- Soil microbiology	CR	3	-	-	-	3	60	40
5	139	23MY3505	Minor 2- Aquatic and Marine microbiology	CR	3	-	-	-	3	60	40
6	139	23BS3501	Forensic Biology	CR	3	-	-	-	3	60	40
7	139	23BS3502	Term Paper presentation	CR	2	-	-	-	2	100	-
Total					20	-	8	-	22	-	-

VI SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23MY3601	Minor Project	CR	4	-	4	-	5	60	40
2	139	23MY3602	Major 1- Microbial Enzymology	CR	3	-	4	-	4	60	40
3	139	23MY3603	Major 2- Food and Dairy Microbiology	CR	3	-	-	-	4	60	40
4	139	23MY3604	Minor 1- Pharmaceutical Microbiology	CR	3	-	-	-	3	60	40
5	139	23MY3605	Minor 2- Exo microbiology	CR	3	-	-	-	3	60	40
6	139	23BS3601	Scientific Writing	CR	2	-	-	-	2	60	40
7	139	23BS3602	MOOC/ SWAYAM/ NPTEL	CR	2	-	-	-	2	-	-
Total					22	-	8	-	24	-	-

VII

SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23MY4701	Major 1- Medical Microbiology	CR	3	-	4	-	4	60	40
2	139	23MY4702	Major 2- Plant-pathogen interaction	CR	3	-	4	-	4	60	40
3	139	23MY4703	Major 3- Environmental Microbial technology	CR	3	-	-	-	3	60	40
4	139	23MY4704	Major 4- Clinical and Diagnostic Microbiology	CR	3	-	-	-	3	60	40
5	139	23MY4705	Major 5- Human Microbiome And Biofilms	CR	3	-	-	-	3	60	40
6	139	23BS4701	Toxicology	CR	3	-	-	-	3	60	40
7	139	23BS4702	Term Paper presentation	CR	2	-	-	-	2	100	-
Total					20	-	8	-	22	-	-

VIII

SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23BS4801	Research Project	CR	-	-	10	-	10	60	40
2	139	23BS4802	MOOC / SWAYAM / NPTL	CR	2	-	-	-	2	100	-
Total					2	-	10	-	12	-	-

SEMESTER	I					
YEAR	I					
COURSE CODE	23BS1101					
TITLE OF THE COURSE	BIOLOGICAL CHEMISTRY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects	Total Hours	Credits
	4	-	2	-	60	5

COURSE OBJECTIVES:

- To create in depth understanding about types of bonding, significance of water and pH in biological systems.
- To understand the significance of thermodynamics and chemical kinetics in bioprocess.
- To impart knowledge about organic reaction and their mechanisms in relevance to biomolecules.

COURSE OUTCOMES:

CONo.	OUTCOMES	Bloom's Taxonomy Level
CO1	Will be able to differentiate the types of chemical bonds and be able to use MSDS as necessary.	L1
CO2	Should be able to correlate the laws of thermodynamics in relevance to biological systems	L2
CO3	Should be able to differentiate the mechanism and types of organic reactions in biomolecules.	L3

COURSE CONTENT:

MODULE 1	12Hrs
GENERAL CHEMISTRY Types of chemical bonds in biological molecules (Ionic Bonds, Covalent Bonds, Hydrogen Bonds, van der Waals interactions), Water- Molecular structure of Water, cohesion property- role in plants take up water at their roots and animals regulate body temperature, importance of water in biological systems (Supports protein, DNA, Cellular Structure), pH, pK _a , pK _b , pOH, preparation of buffers, Henderson-Hasselbalch equation, Buffer action in blood. Coordination bonds in biomolecules - bonding of iron in haemoglobin, Oxygen-Haemoglobin Dissociation Curve & cobalt in vitamin B12, role of trace metals in human body (iron, zinc, copper, chromium, cobalt, Selenium). Chemical safety, Toxicology information-material safety data sheets (MSDS).	
MODULE 2	12Hrs
PHYSICAL CHEMISTRY - I Systems and surroundings, Work and heat, Exothermic and endothermic processes, Internal energy and enthalpy, The First Law of thermodynamics (example-oxidation of tristearin), Bomb calorimeter, Biological fuels. The Second Law: The direction of spontaneous change, Entropy and the Second Law (entropy change of the surroundings due to metabolism), The definition of entropy, The Gibbs energy, The definition of the Gibbs energy, Spontaneity and the Gibbs energy (Estimating a change in Gibbs energy for a metabolic process), Life and the Second Law (The action of adenosine triphosphate), Absolute entropies and the Third Law of thermodynamics.	

MODULE 3	12Hrs
PHYSICAL CHEMISTRY - II Chemical Kinetics: Rate of reaction (Case study: Mechanisms of protein folding and unfolding), order & molecularity of reactions, effect of temperature on reaction rates, Arrhenius equation, activated complex theory, catalysis. Types of reaction in Toxicology (Hydrolysis, Conjugation, Recombination and Adduct formation). Electrochemistry: Electrode potential, standard & reference electrode, calculation of biological standard potential & biological equilibrium constant, Nernst equation.	
MODULE 4	12Hrs
ORGANIC CHEMISTRY - I Reactive intermediates: Reactive intermediates (Biological Reactive Intermediates formed from Botanical Dietary Supplements- Example: Safrole, Aristolochic acid), Ionic, radical & concerted reactions, transition state theory, kinetically & thermodynamically controlled reactions. Stereochemistry: Geometric & Optical Isomerism, Symmetry elements, R/S notation, chirality & optical activity, Stereochemistry (Examples: glucose & amino acids)	
MODULE 5	12Hrs
ORGANIC CHEMISTRY - II Reaction mechanism: S _N 1 (Biological conversion of geranyl diphosphate to geraniol), S _N 2 (Biosynthetic transformation of norepinephrine to adrenaline) E1 (Biosynthesis of limonene from linalyl diphosphate) & E2 reactions, aromatic electrophilic and aromatic nucleophilic reactions, mechanistic study of reactions important for biology, metabolic reactions, trans esterification reaction aldol condensation – collagen and elastin, Biosynthesis of glucose from pyruvate, of acids, oxidation and reduction (Biological oxidation of alcohol). Heterocyclic compounds: aromaticity, Chemistry & biological relevance of pyrrole, thiazole, indole, pteridine, chemistry of porphyrins.	
TEXTBOOKS/REFERENCES: - Physical chemistry for the life sciences. Atkins, Peter, et al. Oxford University Press, 2023. - Biochemistry 4th Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010). - Lehninger-Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012). - A textbook of organic chemistry, Arun Bahl, B.S Bahl, S Chand, 2019, 22nd edition.	

BIOLOGICAL CHEMISTRY - PRACTICALS
EXPERIMENTS
1. Estimation of hardness of water using EDTA.
2. Determination of pK _a of weak acid by pH metric method
3. Determination of rate constant of hydrolysis of methyl acetate.
4. Isolation of lycopene from tomatoes.
5. Preparation of Benzyl lactone.
6. Determination of calorific value by bomb calorimeter.
7. Preparation of buffers and determination of their pH values using pH meter.
TEXTBOOKS/REFERENCES: - Vogel's textbook of practical organic chemistry. Furniss, Brian S., ed. Pearson Education India, 2011. "Vogel's textbook of quantitative chemical analysis." Vogel, Arthur Israel, and George Harold Jeffery, 2012.

SEMESTER	I					
YEAR	I					
COURSE CODE	23BS1102					
TITLE OF THE COURSE	CELL BIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	4	-	60	4

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
• To familiarize the students with the basic components of prokaryotic and eukaryotic cells with special focus on the physiological processes of the cell organelles and cell. • To introduce the students to the cell membrane and cell wall. • To introduce the cell cycle and regulations and cell death pathways.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Would be able to identify different organelles of the cell	L1
CO2	Can demonstrate/identify the different parts of cell cycle and their function	L2
CO3	Would be able to identify the regulatory steps of the cell cycle	L3
CO4	Can demonstrate the essential importance of cell death pathways	L2

COURSE CONTENT:	
MODULE 1	9 Hrs
ULTRA STRUCTURE OF CELL Historical perspectives and discovery of cell, The cell theory, Prokaryotic (Bacteria) and Eukaryotic cells (Animal and Plant) - Characteristics and differences. Cell Wall: Ultrastructure, chemical composition and function.	
MODULE 2	9 Hrs
BIOLOGICAL MEMBRANES Structure and properties, Models of cell membrane, membrane constituents- phospholipids, glycolipid, cholesterol, membrane proteins, membrane carbohydrates. Transport of nutrients- transport of ions and macromolecules, diffusion, osmosis. Types of transport mechanisms: active and passive transport, symport, antiport, co-transport, endocytosis and exocytosis.	
MODULE 3	9 Hrs

CELL ORGANELLES -I Structure and general functions: Chloroplast (Envelope, Stroma, Thylakoids), Endoplasmicreticulum (Smooth and Rough); Golgi complex (Cisternae, Tubules, Vesicles), Mitochondria, Ribosomes, Lysosomes (Primary and Secondary), Microsomes. Cytoskeleton (Microtubules, Microfilaments and Intermediate Filaments), Cilia and Flagella.	
MODULE 4	9 Hrs
CELL ORGANELLES-II Structure and general functions of Nucleus (Nuclear envelope, Nucleoplasm and Nucleolus). Chromosomes-Structure and functions (Centromere, Secondary constrictions, Telomere). Types of Chromatin (Euchromatin and Heterochromatin); Dosage Compensation. Organization of Chromatin: Nucleosomes and Solenoid Model, Giant Chromosomes (Polytene and Lamp brush).	
MODULE 5	9 Hrs
CELL CYCLE AND ITS CONTROL: Introduction to cell cycle stages, Mitosis: Mitotic phases and Cytokinesis, Significance of Mitosis. Meiosis: First meiotic division, Second meiotic division, Significance of meiosis. Cell cycle control (Cyclins and Cyclin dependent kinases). Cell death: Apoptosis & Necrosis.	

TEXT BOOKS/REFERENCES:
1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology S Chand Publishers, 2006.
2. Gerald Karp. Cell and Molecular Biology. 6 th Edition (2009) Wiley Publications.
3. Bruce Alberts et al. Molecular Biology of the cell - (2002) GarlandPublications.
4. Ambrose and Esty D. M. Cell Biology - (1997) ELBS Publications.
5. C.B Powar Cell Biology-, Himalaya Publications.

CELL BIOLOGY- PRACTICALS
1. Study and maintenance of simple and compound microscope
2. Use of Micrometer and calibration, measurement of onion epidermal cells and yeast
3. Study of stages in mitosis from onion root tips
4. Study of stages in meiosis in grasshopper testes/onion or Rhoeo flower buds
5. Isolation and staining of Mitochondria
6. Chloroplast isolation and their microscopic examination
7. Study of model organisms -Tobacco Mosaic Virus, Lambda Phage, <i>Neurospora crassa</i> , <i>Caenorhabditis elegans</i> , <i>Arabidopsis thaliana</i> , <i>Drosophila melanogaster</i>

TEXT BOOKS/ REFERENCES
1. Dr. Renu Gupta , Dr. Seema Makhija , Dr. Ravi Toteja. Cell Biology : Practical Manual. Prestige Publishers, 2018.
2. Amit Gupta and Bipin Kumar Sati . Practical laboratory manual- Cell biology. LAP Lambert Academic Publishing, 2019.
3. Alberts et al., Molecular Biology of the Cell, 4th ed., Garland Publishing, Inc., 2002.

SEMESTER	I					
YEAR	I					
COURSE CODE	23BS1103					
TITLE OF THE COURSE	ENVIRONMENTAL SCIENCE AND PUBLIC HEALTH					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	4	-	60	4

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To give an overview of the e basic concepts and principles of environment; - To have knowledge of the current issues' pollution endangering life on earth. - To educate about the environmental resources, energy, pollution effects and control. - Lean about environmental health, disasters, and elementary public health	

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will explain concepts governing pollution (air, water, physical, chemical, solid waste pollution	L1
CO2	Recognize and conversant with sources and nature of pollution types, control and environmental standards; management	L2
CO3	Explain energy resource types and their environmental implications;	L2
CO\$	Will explain common communicable and non-communicable diseases, their origin, effects and control	L2

COURSE CONTENT:	
MODULE 1	10 Hrs
Basic Concepts of Environment – Scope and importance of environmental studies. Definition of environment- comprehensive understanding of environment. Basic concepts: Xenobiotic, natural & anthropogenic; why are we concerned? Types of xenobiotics: Chemical, Physical, Biological pollutants; Hazard & Risk Eco-kinetic & Bio-kinetic Properties of a xenobiotic Dose-Response Relationships-chronic and acute effects; Time, Tonnage, Toxicity (3Ts) Environmental Standards: AAQS, TLV's. Appraisal, Assessment & Abatement (Recognition, Evaluation & Control) of pollutants- Structure of Atmosphere; Atmospheric inversions Environmental System	
MODULE 2	10 Hrs

Environmental Pollution Air Pollution: Criteria pollutants – Ozone, Particulate Matter, Carbon Monoxide, Nitrogen Oxides, Sulfur Dioxide, Lead; SMOG & Air-pollution episodes Aerosols: Primary & Secondary pollutants, Acid Rain Cycle. Water Treatment: Hydrosphere; Lentic and Lotic Water Systems; Fresh Water as a resource; Rain Water Harvesting, Water quality parameters, standards, Treatment of potable water; Waste water- Characteristics, Municipal Sewage Water and Treatment Waste Management: Types of Wastes: Municipal Solid Waste, Hazardous Waste, Nuclear Waste, Electronic Waste, Biomedical Waste; Solid Waste Management: Landfills, composting Physical Hazards: Temperature (heat stress), Cold, Noise Pollution, effects and control	
MODULE 3	10 Hrs
Elementary Public Health: Introduction to Communicable and Non-Communicable Diseases. Introduction to terminologies related to health and disease. Communicable diseases: (Etiological factors signs and symptoms, control and prevention): Acute diarrheal diseases, Cholera, Typhoid fever (Enteric fever), HIV/AIDS, Malaria. Epidemiology and control of vaccine preventable diseases: Tuberculosis, Diphtheria, Whooping Cough, Measles, Tetanus, Poliomyelitis, Hepatitis -B Non-infectious diseases: (Etiological factors signs and symptoms, control and prevention): Cardiovascular Diseases: Coronary artery disease, Hypertension, Diabetes, Obesity, Accidents.	
MODULE 4	10 Hrs
Disasters and Environmental Health Definition, origin and classification. Natural (Earthquakes, landslides, floods, Cyclones). Man-made disasters (biological, chemical, nuclear, radiological, explosions) – definition, causes and management and/or mitigation strategies; Bhopal & Chernobyl Disasters. Environment & Health - Occupational Health Hazards, Occupational Diseases. Epidemics, Pandemics, Endemics (Fluoride, Arsenic). Principles and Significance of Sanitation	
MODULE 5	5Hrs
Energy Types of energy: Conventional sources of energy, fossil fuel, Coal, Nuclear based, solar, wind, sea - Tidal Wave energy, Geo-Thermal Non-conventional sources of energy, Biofuels - biomass, biogas Natural Gas; Hydrogen as an alternative future source of energy.	

TEXT BOOKS/REFERANCES:

1. R.C. Gaur, Basic Environmental Engineering, New age international (p) limited, publishers, 2008.
2. J. Glynn Henry and Gary. W. Heinke, Environmental Science and Engineering, Pretice Hall of India, 2004.
3. P. Venugopala Rao, A Text Book of Environmental Engineering, PHI Learning Pvt. Ltd., 2012.
4. "Introduction to Environmental Toxicology: Molecular substructures to Ecological Landscapes" by Wayne Landis and Ruth Sofield.
5. Environmental Health Sciences: A focus on sustainability by Howard Frumkin.

ENVIRONMENTAL SCIENCE AND PUBLIC HEALTH- PRACTICALS

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|--|
| 1. Determination of pH of water. |
| 2. Determination of Total Solids |
| 3. Determination of Dissolved Oxygen |
| 4. Determination of Chemical Oxygen Demand |
| 5. Determination of percentage of available chlorine in bleaching powder |
| 6. Detection of Coliforms for determination of purity of potable water. |
| 7. Environmental Noise intensity measurements using Sound Levelmeter |

TEXT BOOKS/ REFERENCES

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| 1. "Introduction to Environmental Toxicology: Molecular substructures to Ecological Landscapes" by Wayne Landis and Ruth Sofield |
| 2. Environmental Health Sciences: A focus on sustainability by Howard Frumkin. |
| 3. Laboratory Manual for Environmental Science and Engineering by J. Glynn Henry and Gary W. Heinke |
| 4. Essentials of Environmental Health by Robert H. Friss |
| 5. Environmental Health: from Epidemiology to Public Health by Roberto Bertollini, <i>et.al.</i> , |

SEMESTER	I					
YEAR	I					
COURSE CODE	23BS1104					
TITLE OF THE COURSE	COMMUNICATIVE ENGLISH					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To encourage the students to speak English confidently and enable them to communicate for day- to-day needs.
- To build up their confidence in the usage of English and to enhance their written communicative competence also helping them for competitive exams

COURSE OUTCOMES:

CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students are confident in oral and written communication.	L1
CO2	Have enhanced competence for competitive exams	L2

COURSE CONTENT:

MODULE 1	6Hrs
COMMUNICATION SKILLS Definition, importance of communication, communication process – source, message, encoding, channel, decoding, receiver, feedback, context, levels of communication, Flow of Communication, Verbal and Non- Verbal Communication, Barriers to Communication - physiological, physical, cultural, language, gender, interpersonal, psychological, emotional. Perspective in communication/ Communication styles: introduction, visual perception, language, other factors affecting our perspective.	
MODULE 2	6Hrs
Elements of communication – introduction, face to face communication – tone of voice, body language (non- verbal communication), verbal communication, physical communication; Basic listening skills: introduction, self-awareness, active listening, becoming an active listener, listening in difficult situations; Interview skills: purpose of an interview, do's and don't's of an interview. Giving presentations: dealing with fears, planning your presentation, structuring your presentation, delivering your presentation, techniques of delivery; Group discussion: introduction, communication skills in group discussion, do's and don't's of group discussion.	

MODULE 3	6 Hrs
Phonetics: The Organs of Speech, The Description and Classification of Speech Sounds, The Description and Classification of Vowels, The Description and Classification of Consonants, Phonetic symbols and the IPA, Phonemic and Phonetic Transcription Phonology, Phoneme sequences and Consonant Cluster, The Syllable, Word Accent, Accent and Rhythm in Connected Speech, Intonation, Varieties of English Pronunciation	
MODULE 4	6Hrs
EFFECTIVE WRITING SKILLS Effective written communication: introduction, when and when not to use written communication – complexity of the topic, amount of discussion required, shades of meaning, formal communication Writing effectively: subject lines, put the main point first, and know your audience, organisation of the message, Paragraph Writing, Letter Writing, Report Writing, Book Review, Scientific writing, Making a message – Transitivity/ intransitivity – complementation – talking about closely linked action – using two verbs together (eg: She started laughing), Transforming messages – Making statements, questions, orders and suggestions –denying – rejecting – disagreeing – possibility – ability, permission, obligation.	
MODULE 5	6 Hrs
GRAMMAR Word Classes: Open Word Classes: - Nouns, Verbs, Adjectives, Adverbs, Pronouns; Closed Word Classes: - Pre-determiners, Determiners, Numerals, Enumrators, Prepositions, Conjunctions, Auxiliary Verbs, Interjection; Morphology: Bound and Free Morphemes; Affixes, Stems and Roots; Morphological Analysis; Phrases: Noun Phrase, Verb Phrase, Genetive Phrase, Adjective Phrase, Adverb Phrase, Prepositional Phrase, Phrases and its types, Clauses and its types, Sentences and its types, Common errors, phonetics; Clauses: Clause Elements, Clause Types, Kinds, Concord; Sentences: Simple Sentences, Compound Sentences, Complex Sentences; Sub Ordination: Sub-Clauses, Finite and Non-Finite Sub-Clauses; Co-ordination: Linked and Unlinked Coordination, Synthesis; Ambiguity: Types of Ambiguity, Structural and Lexical Ambiguity; Common Errors: Nouns and Pronouns, Articles, Verbs, Concord, Adjectives, Adverbs, Prepositions, Vocabulary, Expressing time, Referring to present, past and future time - use of adjuncts - frequency and duration, Talking about manner and place, Information about place, manner - position of adjuncts - types of adverbs (time, frequency, duration etc), Reporting what people say/think, Reporting verbs - reporting someone's actual words - reporting in one's own words, The structure of information, Focusing on the thing affected (passive voice) -selecting focus (left structure) taking the focus off the subject (impersonal 'it' etc.) –Introducing something new (with 'there') - focusing on information using adjuncts.	

TEXT BOOKS/REFERENCES:

1. Crystal, David., Rediscover Grammar with David Crystal. Longman,1985.
2. Bakshi, R. N. A Course in English Grammar. Orient Longman
3. Close, R. A. Reference Grammar for Students of English. Orient Longman
4. Krishnaswamy, N. Modern English – A Book of Grammar, Usage & composition. Macmillan India Ltd.
5. Aroor, Usha (Ed.) WordMaster Learner's Dictionary of Modern English. Orient Longman17.
6. Hewings, M., Advanced English Grammar. Cambridge University Press,1999.
7. Basic communication skills for technology, Andreja J. Ruther Ford, 2nd Edition,Pearson Education, 2011.
8. Communication Skills, Sanjay Kumar, Pushpalata, 1st Edition, Oxford Press, 2011.
9. Brilliant – Communication Skills, Gill Hasson, 1st Edition, Pearson Life, 2011.
10. Soft Skill and Professional Communication, Francis Peters SJ, 1st Edition, Mc Graw Hill Education, 2011.

SEMESTER	I					
YEAR	I					
COURSE CODE	23BS1105					
TITLE OF THE COURSE	COMPUTER APPLICATIONS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	Basic knowledge of computer hardware software and electronic device X-XII standard level

COURSE OBJECTIVES:
- To introduce to the students a basic understanding of the working of a computer system. - To familiarize the students with the basic notations and data representation methods used. - To familiarize the students with the various software and hardware aspects of computers. - To make the students understand the need and working of the interconnection and communication between computers. 5. To make the students familiar with the basic internet technology and concepts.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will know a basic understanding of the working model of a computer system.	L1
CO2	Students will be familiarized with basic notations and data representation methods used.	L2
CO3	Ability to know the various software and hardware aspects of computers and their application	L3
CO4	Identify the need and working of the interconnection and communication between computers.	L4

C05	Evaluate the basic internet technology and its protocols communication aspects.	L4

COURSE CONTENT:	
MODULE 1	6Hrs
Unit- 1 : Introduction to Computers, History, Generation of Computers, Data Processing, Memory Hierarchy. Input/ Output devices, BIOS, VDU, Data Representation – Binary, Decimal, Octal, Hexadecimal and their conversions, 1's and 2's compliment. Block Diagram of a Basic Computer and its working. Unit 2: Application Software and System Software, Open-Source Software and Proprietary Software Computer Languages and its types (Machine Language, Assembly Language, High Level Language) Translators, Compiler, Interpreter, Operating System and its functions, Types (Single-User, Multi-User, Multi-Tasking, Time-Sharing, Distributed, Real-Time)	
MODULE 2	6Hrs
Unit 3: Data Communication – Need for Network Communication, Modes of communication- Simplex, Duplex, Half-Duplex; Introduction to Networks, LAN, MAN, WAN, Protocols – Ethernet, IP, TCP, UDP, HTTP Networking Elements – Switch, Router, Server, Firewall. Unit 4: Introduction of Internet and WWW, Basic working of a Web Browser, Introduction to popular web browsers. Concepts of URL, Domain Name, Web Server, Smartphone Apps, Email, Instant Messaging, ISP Communication and Collaboration: Using e-governance, search engines, Webhosting, netiquettes.	
MODULE 3	6Hrs
Practice Component: MS Word Basics: • Basics of Word Processing, Create, Save, Edit, open files. • Using the Interface (Menu Toolbars), Editing Text (Copy, Delete, Move Etc.). Finding and replacing text. • Insert: Table, images, textbox, word art, symbols. • Auto correct Feature, Grammar check Facility, Formatting and Editing, Font, Size, alignment paragraph, Bullets and numbering. • Table: Insert and Draw, changing cell width and height, insert/delete rows in columns. • Borders and shadings, Mail merge.	
MODULE 4	6Hrs
Practice Component: MS Excel Basic: • Creating and opening worksheets, saving and data entry in cells. • Entry of Numbers, Text and Formulae, Moving Data in the Worksheet. • Selecting Data Range, Using the Interface (Toolbars, Menus). • Editing basics, working with Workbooks Saving, Cell Reference, Formatting, Editing. • Working with Data, charts, graphs.	

MODULE 5	6 Hrs
Practice Component: MS Power Point Basics: • Creating, opening and saving a PowerPoint Slide. • Creating presentations using existing templates. • Entering and editing text. Inserting and deleting slides. • Use of fonts and drawing, inserting images, graphics. viewing and printing. • Creation of animated slides, adding images, graphics and sound in slides. Adding Timing, auto slide changes	

REFERENCES:

1. Fundamentals of Computers, V Rajaraman 6th edition PHI Learning Private Limited 2014
2. Computer today, Donald H. Sanders, McGraw Hill Publishing Company.
3. Microcomputers Software and Applications, Dennis P. Curtin and Leslie R. Portel, PHI.
4. Data Processing: An Introduction, Donald P. Spencer and Charles R. Merrill Pub. And Co.
5. Computers and Their Applications, Larry Joel Goldestein, PHI.
6. Computer Fundamentals.P.K.Sinha
7. Internet Basics. E.Douglas Commer PHI.

SEMESTER	I						
YEAR	I						
COURSE CODE	23BS1106						
TITLE OF THE COURSE	BIOSAFETY AND GOOD LABORATORY PRACTICE						
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits	
	2	-	-	-	30	2	

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To introduce the students to the concepts of biosafety regulatory frameworks concerning genetically modified organisms at national and international levels - To impart Knowledge of the principles of GLP and their practical applications

COURSE OUTCOMES:		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Gain knowledge of the various safety procedures to be followed in laboratory.	L2
CO2	Gain the skills and knowledge necessary to understand and work in GLP compliant environment.	L2
CO3	This course should generate interest for avenues for pursuing higher studies and careers in these areas	L2

MODULE 1	6 Hrs
Biosafety: Introduction, Historical Background; risk assessment and lab acquired infections, Introduction to Biological Safety Cabinets& their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms. Recommended Biosafety Levels for Infectious Agents and Infected Animals	
MODULE 2	6 Hrs
. Biosafety Guidelines: Biosafety guidelines and regulations (National and International); Definition of GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Recombinant DNA Guidelines (1990). - Cartagena Protocol.	

MODULE 3	6 Hrs
Biosafety Guidelines: Rules for the manufacture, use/import/export and storage of hazardous microorganisms/ genetically engineered organisms or cells (Ministry of Environment and Forests Notification,1989); Environmental release of GMOs; Risk Assessment; Risk management and communication; Overview of International Agreements	
MODULE 4	6 Hrs
GOOD LABORATORY PRACTICE: Introduction to GLP, WHO guidelines on GLP, History, Scope (Resources Characterization, Rules, Results, Quality assurance);Levels of Laboratories; General Rules/Protocols for Lab Safety measures; Precaution and Safety in handling of chemicals, Laboratory tools, glasswares and instruments;Sample storage and disposal; Log Book maintenance,.	
MODULE 5	6 Hrs
GOOD LABORATORY PRACTICE: Basic SOPs for instrument handling and Maintenance. Keeping data records, its analysis by using statistical and mathematical tools. Result analysis and its interpretation.GLP as given by OECD, FDA etc (International perspective); Internal and External Audits	

TEXTBOOKS/REFERENCES:

1. Handbook Good Laboratory Practices-World health organization(WHO)
2. Life science protocol manual (2018)-DBT star college scheme
3. Guidelines for good laboratory practices-Indian council of medical research, New Delhi, 2008.
4. Handbook: Good Laboratory Practices (GLP): quality practices for regulated non-clinical research and development-2nd ed.

SEMESTER	I					
YEAR	I					
COURSE CODE	23BS1107					
TITLE OF THE	PYTHON FOR BIOLOGISTS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
• Providing fundamentals of Python Programming language • Essentials of variables, standard packages and python data structures • Managing and analysis of biological data

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	The student will explain the basics of python programming and the steps of installation of Python and bio-python	L1
CO2	Perform arithmetic operators importing of string operators	L2
CO3	Explain basic data types, error processing and exception raising	L3
CO4	Demonstrate python statements and loops, simple GenBank parsing, nucleotide sequences, transcription and translation	L4

COURSE CONTENT:	
MODULE 1	6Hrs
An introduction to python: Python description and installation, the print statement, comments, quotes and string operations in python, Naming rules, simple input and variables, output - exercises	
MODULE 2	6Hrs
Python Modules and Packages: Arithmetic operators, indexing and slice operators, importing of string modules, string operators - exercises	
MODULE 3	6 Hrs

Basic data types: Lists, Tuples, Dictionary, Error processing, Exception Raising and Handling. - exercises	
MODULE 4	6Hrs
Python statements and Loops: if, if-else, While, for loops, break, continue, pass, Python Functions; Files I/O - exercises	
MODULE 5	6 Hrs
Biopython: Installation Biopython, Simple GenBank parsing, Nucleotide sequences and (reverse) complements, Transcription, Translation – exercises	

TEXT BOOKS/ REFERENCES:

1. Dr Martin Jones, Python for Biologists: A complete programming course for beginners.
2. Tim J. Stevens, Wayne Boucher, Python Programming for Biology.
3. Mitchell L Model, Bioinformatics Programming Using Python. 2009.
4. Ken Youens-Clark, Mastering Python for Bioinformatics. 2021.
5. Internet Basics. E.Douglas Commer PHI.

SEMESTER	II					
YEAR	I					
COURSE CODE	23BS1201					
TITLE OF THE COURSE	BIOMOLECULES					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	60	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	--

COURSE OBJECTIVES:
- To create in depth understanding about fundamentals of biomolecules, their structure and significance. - To know about the structural and functional classification of biomolecules.

COURSE OUTCOMES:		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Will be able to demonstrate the composition and structure of various bio-molecules in the living systems	L1
CO2	Should be able to correlate the structure and functions of bio-molecules, like carbohydrates, lipids, proteins, and nucleic acids in biological systems	L2
CO3	Should be able to demonstrate the mechanism of interaction and functions various bio-molecules in living systems.	L3
CO4	Should be able to demonstrate the normal and abnormal structure of various bio-molecules in the context of various medical conditions	L3

COURSE CONTENT	
MODULE 1	12 Hrs
BIOCHEMICAL CALCULATIONS: Solutions, Stock Solutions- preparation and dilution of stock solutions. Avogadro Number Molarity, Molality, mole fraction and Normality. Density and Relative Density. Ionic Strength - pKa, pKb and pI. Equilibrium Constants, Dissociation constant, Henderson-Hasselbalch equation and buffer preparations. Electrochemical series, Nernst equation, standard electrode potential. pH, pOH. Law of Rational indices and Miller indices with numerical. Calculation of molecular weight of proteins and nucleic acids.	
MODULE 2	12 Hrs

CARBOHYDRATES: Simple Carbohydrates: Structure and classification of carbohydrates. Configuration and conformational aspects of monosaccharides and sugar derivatives. Brief structural elucidation by permethylation (MALDI), Glycosidic linkages in disaccharides and glycosides (GC-MS). Complex Carbohydrates: Homopolysaccharides and heteropolysaccharides - starch, glycogen, cellulose chitin, glycosaminoglycans and proteoglycans; Glycoproteins and Glycolipids.	
MODULE 3	12 Hrs
AMINO ACID AND PROTEINS Amino acids and its classification and properties. Primary structure – structure, classification and acid-base properties of amino acids, Peptide bond, peptides, Primary structure –scheme of determination –amino acid composition analysis, N and C terminal analysis, cleavage of Disulfide bond, chemical and enzymatic fragmentation and sequencing through Edman's reagent. Secondary structure: α -, PP-, 310 and π -helix, β pleated sheet, β bend, Peptide bond geometry and Ramchandran plot, motifs and domains.	
MODULE 4	12 Hrs
PROTEIN CONFORMATION AND FOLDING Tertiary structure: Interactions stabilizing tertiary structure; denaturation of proteins, secondary and tertiary structure of fibrous proteins: α -keratin, silk fibroin and collagen. Quaternary structure: Hemoglobin Structure, molecular basis of Sickle-cell anemia; Cross linking agents to determine subunit composition. Protein folding: Protein renaturation, significance of Anfinsen's experiment, Landscape model of folding, accessory proteins- protein molecular chaperones Basics of enzymes and bio-catalysis	
MODULE 5	12 Hrs
LIPIDS AND NUCLEIC ACIDS Lipids: Classification, Nomenclature and biological functions of lipids. Complex lipids - phospholipids, sphingolipids, galactolipids and Eicosanoids and sterols–prostaglandins, thromboxanes and leukotrienes. Nucleic acids: Nucleosides, nucleotides and polynucleotides; Primary and secondary structure, properties and types of DNA; structure and function of RNA's; Specialized sequences: G-quadruplexes, palindromic and mirror repeats; denaturation and renaturation curves of nucleic acids;	

TEXT BOOKS/REFERENCES:

1. Biochemistry. Donald Voet & Judith G. Voet, 4th Ed, John Wiley & Sons, Inc. 2010.
2. Lehninger, Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications, 2012.
3. Physical Biology of the Cell, Rob Phillips, Jane Kondev, Julie Theriot, 2nd Ed., Hernan Garcia, Garland Publishers, 2011.
4. Proteins Structures and Molecular Properties Thomas E. Creighton, 2nd Ed., W H Freeman and Co. 199).
5. Principles of Protein Structure, Function, & evolution, Dickerson & Geis, 2nd Ed., Benjamin-Cummings, 1983.
6. Biochemistry; David Rawn, J, Neil, Patterson Publishers, 1989.
7. Biochemistry, Jeremy M Berg, John L Tymoczko and Lubert Stryer, 6th Ed, W H Freeman and Co., 2006.
8. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

BIOMOLECULES -PRACTICALS
1. Qualitative analysis of Monosaccharides.
2. Qualitative analysis of Disaccharides and Polysaccharides.
3. Qualitative analysis of Aromatic amino acids.
4. Qualitative analysis of Basic amino acids.
5. Quantitative estimation of protein by Lowry's method.

TEXT BOOKS/ REFERENCES
1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7 th ed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER	II					
YEAR	I					
COURSE CODE	23BS1202					
TITLE OF THE COURSE	PRINCIPLES OF GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	4	-	60	4

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To Understanding Genetic Foundations - To Exploring Genetic Diversity and Interactions - To Uncovering Mechanisms of Inheritance and Evolution

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students will demonstrate a thorough understanding of the historical development of genetics, including pre-Mendelian theories, and the key contributions of Gregor Mendel to the field.	L1
CO2	Students will be able to analyze and predict inheritance patterns beyond Mendelian principles, including co-dominance, incomplete dominance, and multiple allelism. They will understand the concept of gene interactions and their roles in trait expression.	L2
CO3	Students will comprehend various mechanisms of sex determination and their impact on genetic diversity. They will also explain how genetic variation, mutation, recombination, and evolutionary processes like natural selection and genetic drift contribute to species adaptations.	L3

COURSE CONTENT:	
MODULE 1	12Hrs
HISTORY OF GENETICS AND MENDELIAN PRINCIPLES	
Pre- formation theories, History and scope of Genetics, Pre- Mendelian genetic concepts epigenesis, pangenesis, germplasm theory. Mendel- Life and his experiments on pea plants. Principle of Dominance (Dominance and Recessiveness), Laws of Inheritance and their applications. Monohybrid Cross, Dihybrid Cross, Back Cross, Test Cross.	
MODULE 2	12Hrs
EXTENSIONS OF MENDELISM AND GENE INTERACTIONS	
Co-dominance and incomplete dominance - definition, examples. Multiple allelism- definition, Eye color in Drosophila, Blood groups and Rh factor in Human; Allelic series; Lethal alleles; Multifactorial inheritance- Skin colour in Humans; Penetrance and Expressivity; Pleiotropy. Epistasis- dominant, recessive. Supplementary and Complementary gene interactions; Non epistatic inter allelic gene interaction, Position effect.	
MODULE 3	12Hrs
SEX DETERMINATION	
Chromosomal theory of Inheritance - Concepts and evidences. Mechanism of sex determination- XX- XY; XX-XO; ZZ-ZW; Bridges genetic balance theory. Environmental and hormonal control of sex determination Gynandromorphs / Intersexes, Super sexes in Drosophila. Sex differentiation and dosage compensation (Drosophila and Man). Sex linked and sex-limited traits in Humans.	
MODULE 4	12Hrs
GENETIC VARIATION AND EVOLUTION	
Mutation: Types and effects on genetic variation, Genetic recombination and crossing-over during meiosis, Linkage and recombination mapping, Population genetics: Hardy-Weinberg equilibrium and factors affecting gene frequencies, Evolutionary processes: Natural selection, genetic drift, and gene flow	
MODULE 5	12Hrs
MODEL ORGANISMS IN GENETICS	
Bacteria - E. coli; Viruses - Tobacco Mosaic Virus; Bacteriophage - Lambda Phage; Fungi- Neurospora species, N crassa, Saccharomyces cerevisiae; Nematode - Caenorhabditis elegans, Plant -Arabidopsis thaliana, Fly - Drosophila melanogaster, Fish - Zebra fish (Danio rerio), Mammal - Mice (Mus musculus) and Rat (Rattus rattus).	

TEXT BOOKS/REFERENCES:

1. "Genetics: A Conceptual Approach" by Benjamin A. Pierce
2. "Genetics: From Genes to Genomes" by Leland Hartwell, et al.
3. "Essentials of Genetics" by William S. Klug, et al.
4. "Introduction to Genetic Analysis" by Anthony J.F. Griffiths, et al.
5. "Genetics: Analysis and Principles" by Robert J. Brooker
6. "Genetics: Genes, Genomes, and Evolution" by Philip Meneely, et al.
7. "Principles of Genetics" by D. Peter Snustad and Michael J. Simmons
8. "Genetics: Analysis of Genes and Genomes" by Daniel L. Hartl and Elizabeth W. Jones
9. "Genetics: A Molecular Approach" by T.A. Brown.
10. "Genetics: From Genes to Genomes" by Dale E. Bergman and Michael M. Howe

PRINCIPLES OF GENETICS-PRACTICALS

1. Temporary squash preparation of : Grasshopper Testes, Onion flower bud
2. Observation of meiotic stages in permanent slides
3. Blood Typing
4. Sex differentiation in *Drosophila*
5. Detection of sex chromatin bodies: Preparation of Barr bodies from bucal smears.
6. Genetic problems on : (a) Probability (b) multiple alleles (c) Gene interactions (d) Sex Linkage
7. Study of: (a) Flower color in *Mirabilis jalapa* (b) Coat color in Mice (c) Comb pattern in fowl.

TEXTBOOKS/REFERENCES:

1. "A Laboratory Manual of Cytology and Histology" by William F. Ganong
2. "Cell and Molecular Biology: Concepts and Experiments" by Gerald Karp
3. "Laboratory Manual of Blood Grouping and Serology" by P.C. Das
4. "Experiments with *Drosophila*" by E.B. Lewis
5. "A Laboratory Guide to Human Physiology" by Stuart Ira Fox
6. "Genetics: A Conceptual Approach" by Benjamin A. Pierce
7. "Genetics: From Genes to Genomes" by Leland Hartwell, et al.

SEMESTER	II					
YEAR	I					
COURSE CODE	23BS1203					
TITLE OF THE COURSE	BIOSTATISTICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To familiarize the students with basic concepts/principles of statistics in biology - To understand the applications of statistics in biological research

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Will be able to solve simple statistical problems related to biology	L2
CO2	Will be able to design and execute the biological experiments in compliance with statistics	L3
CO3	Students will be able to analyze biological data with statistical models	L4
CO4	Students will be able to apply different statistical tools to analyze multi-parameter research data	L4

COURSE CONTENT:	
MODULE 1	5 Hrs
Measures of Central Tendencies Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median.	
MODULE 2	6 Hrs

Dispersion And Correlation	
Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation with multiple examples. Problem solving	
MODULE 3	11 Hrs
Standard error Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance. Sampling methods and their significance.	
MODULE 4	11 Hrs
Probability Distributions	
Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions- Binomial, Poisson and Normal distributions. Problem solving	
MODULE 5	12 Hrs
Testing of hypothesis:	
Basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of "p" value. Statistical package- Features of statistical software, SPSS for various applications in Biostatistical program.	

TEXT BOOKS/REFERENCES:

1. Daniel Biostatistics (3rd edition) Panima Publishing Corporation, 1999.
2. Khan Fundamentals of Biostatistics, Panima Publishing Corporation, 1999
3. Swardlaw, A.C. Practical Statistics for Experime.ntal Biologists, Joh, 1985.
4. Bazin, M.J. Mathematics in microbiology Academic press. 1983.
5. Green, R.H. Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y., 1979.
6. Campbell, R.C. Statistics for Biologists, Cambridge Univ. Press, Cambridge. 1974.
7. Bliss, C.I.K. Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY. 1967.

SEMESTER	II					
YEAR	I					
COURSECODE	23BS1204					
TITLEOFTHECOURSE	BIONFORMATICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses(if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
•	To get introduced to the basic concepts of Bioinformatics and its significance in biological data analysis.
•	To get an overview about biological macromolecular structures and structure prediction methods.

COURSE OUTCOMES:		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Will be able to demonstrate mastery of the core concepts of bioinformatics	L1
CO2	The student will be able to apply basic principles of biology, computer science and mathematics to address complex biological problem	L2
CO3	Should be able to plan basic experiments in microbial genetics concerned with clarifying phenotypes and their relationship with the genotype	L3

COURSE CONTENT:	
MODULE 1	06 Hrs
BIOLOGICAL DATA TYPES AND SOURCE Introduction to population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb).	
MODULE 2	07 Hrs
SIMILARITY SEARCHING Global and Local sequence alignment, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs	

MODULE 3	06Hrs
INTERPRETTING THE SEQUENCE Reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank libraries, annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files.	
MODULE 4	06Hrs
SCALING THE HUMAN GENOME UCSC genome browser, RegulomeDB database, ENCODE-ChIA-PET database, transcription factors binding sites. SNP, EST, STS. Regular Expression (REGEX), Hierarchies and Graphical models (including Markov chain and Bayes algorithm). Genetic variability and connections to clinical data.	
MODULE 5	05Hrs
SYSTEMS BIOLOGY The description of biological networks and protein and metabolic gene network modelling. Emphasis in both topological aspects of networks and their dynamical behaviour.	

TEXTBOOKS/REFERANCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R. F. Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W. Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Bioinformatics. Baxavanis, Wiley and Sons, 2020.
7. Biological Data Analysis. A practical Approach, Fry, J. C. IRL Press, Oxford. 1993.
8. The UCSC Genome Browser database: 2015 update. Rosenbloom KR et al, Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81.

SEMESTER	II					
YEAR	I					
COURSE CODE	23BS1205					
TITLE OF THE COURSE	TECHNICAL ENGLISH					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES
- The students will draw inferences relying on the context. - The students will analyze and synthesize information presented in different sources.

COURSE OUTCOMES		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students should be able to identify words or phrase related to the topic	L1
CO2	Students should be able to distinguish between more important ideas from less important ones.	L2
CO3	Students should be able to identify the figures of speech used	L3
CO4	Students should be able to write effectively concluding paragraphs that include a summary of the main points, repetition of the thesis- argument sentence, and/or their own comments	L2

COURSE CONTENT:	
MODULE 1	6 Hrs
Reading Skills Comprehension passage, classification and process analysis, Data interpretation, skimming and scanning, Types of reading, Techniques to improve reading.	
MODULE 2	6 Hrs
Writing skills Referencing skills, Brochure, Advertisements, graphic representation, Data interpretation, letter of appreciation, scientific writing, types of writing, travelogue writing	
MODULE 3	6 Hrs
Listening skills Listening Vs Hearing, Non verbal and Verbal signs of active listening, Barriers of listening skills, principles of listening skills, Types of listening, Techniques to improve listening skills	

MODULE 4	6 Hrs
Speaking skills	
Phonetics: basic concepts in phonetics, elocution, interviews, types of speaking, discussion. Narrating a story	Debate, Group
MODULE 5	6 hrs
Grammar	
Linkers, Types of sentence, Gerunds, Question tags, WH questions, Tenses, Common errors, antonyms and synonyms, affix.	

TEXT BOOKS/REFERENCES:

1. Crystal, David., Rediscover Grammar with David Crystal. Longman, 1985.
2. Bakshi, R. N. A Course in English Grammar. Orient Longman
3. Close, R. A. Reference Grammar for Students of English. Orient Longman
4. Krishnaswamy, N. Modern English – A Book of Grammar, Usage & Composition. Macmillan India Ltd.
5. Aroor, Usha (Ed.) WordMaster Learner's Dictionary of Modern English. Orient Longman.

SEMESTER	II					
YEAR	I					
COURSE CODE	23BS1206					
TITLE OF THE COURSE	KANNADA KALI					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	1	-	-	-	15	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To enable students read and write in Kannada - To make students to communicate in Kannada helping them to interact with local people for their daily needs

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students should be able to read, write and communicate in Kannada	L1

COURSE CONTENT:
1. ALPHABETS – AKSHARAMAALE - ಅಕ್ಷರಮಾಲೆ 2. SIGNS OF VOWELS AND CONJUNCT CONSONANTS – KAAGMODULEHA MATTHU OTTHAKSHARAGALU ಕಾಗುಣಿತ ಮತ್ತು ಒತ್ತಕ್ಷರಗಳು 3. DAILY USING WORDS PART – 1 DINANITHYADA PADAGALU BHAAGA – 1 ದಿನನಿತ್ಯದ ಪದಗಳು ಭಾಗ – 1 4. WEEKDAY AND MONTH NAMES – VAARADA MATTHU THINGALA HESARUGALU ವಾರದ ಮತ್ತು ತಿಂಗಳ ಹೆಸರುಗಳು 5. TASTE – RUCHI – ರುಚಿ 6. COLOURS – BANNAGALU – ಬಣ್ಣಗಳು 7. NUMBERS – SANKYEGALU - ಸಂಖ್ಯೆಗಳು 8. DAILY USING WORDS PART – 2 DINANITHYADA PADAGALU BHAAGA – 2 ದಿನನಿತ್ಯದ ಪದಗಳು ಭಾಗ – 2 9. QUESTION PATTERNS – PRASHNEYA VIDHAANAGALU ಪ್ರಶ್ನೆಯ ವಿಧಾನಗಳು 10. MEASUREMENTS – ALATHEGALU - ಅಳತೆಗಳು 11. EDUCATION WORDS – SHAIKSHANIK PADAGALU ಶೈಕ್ಷಣಿಕ ಪದಗಳು 12. LIQUID ITEMS – NEERINAAMSHADA PADAGALU ನೀರಿನಾಂಶದ ಪದಗಳು 13. FRUITS – HANNUGALU – ಹಣ್ಣುಗಳು 14. VEGETABLES – THARAKAARIGALU – ತರಕಾರಿಗಳು

15. FOOD ITEMS – AHAARA PADAARTHAGALU
ಆಹಾರ ಪದಾರ್ಥಗಳು
16. DAILY USING WORDS PART -3 –
DINANITHYADA PADAGALU BHAAGA -3
ದಿನನಿತ್ಯದ ಪದಗಳು ಭಾಗ -3
17. METALS – LOHAGALU – ಲೋಹಗಳು
18. RELATIVES – SAMBANDHIKARU – ಸಂಬಂಧಿಕರು
19. SEASONS AND CLOTHES –
KAALAGALU MATTHU BATTEGALU
ಕಾಲಗಳು ಮತ್ತು ಬಟ್ಟೆಗಳು
20. HOUSE AND FURNITURE –
MANE MATTHU PEETOPAKARANAGALU
ಮನೆ ಮತ್ತು ಪೀಠೋಪಕರಣಗಳು
21. OPPOSITE WORDS – VIRUDDHA PADAGALU
ವಿರುದ್ಧ ಪದಗಳು
22. VERBS - KRIYAA PADAGALU – ಕ್ರಿಯಾ ಪದಗಳು
23. ANIMALS – PRAANIGALU – ಪ್ರಾಣಿಗಳು
24. INSECTS – KRIMIKEETAGALU – ಕ್ರಿಮಿಕೀಟಗಳು
25. BIRDS – PAKSHIGALU – ಪಕ್ಷಿಗಳು
26. FEELINGS – BHAAVANEGALU – ಭಾವನೆಗಳು
27. TENSES – KAALASOOCHAKAGALU – ಕಾಲಸೂಚಕಗಳು
28. COMMUNICATION WORDS – SAMBHAASHANEYA PADAGALU
ಸಂಭಾಷಣೆಯ ಪದಗಳು

SEMESTER	II					
YEAR	I					
COURSE CODE	23BS1206					
TITLE OF THE COURSE	KANNADA MANASU					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	1	-	-	-	15	2

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To enable students read and write in Kannada - To make students to communicate in Kannada helping them to interact with local people for their daily needs

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Students should be able to read, write and communicate in Kannada	L1

COURSE CONTENT:
ಕನ್ನಡ ಪಠ್ಯಕ್ರಮ - ಕನ್ನಡ ಭಾಷಾ ವಿಜ್ಞಾನದ ಸ್ವರೂಪಗಳು - ಭಾಷಾ ಕಲಿಕೆಯ ವಿವಿಧ ನೆಲೆಗಳು - ವ್ಯವಹಾರಿಕ ಭಾಷೆಯಲ್ಲಿ ಕನ್ನಡ - ಕಂಪ್ಯೂಟರ್ ಕಲಿಕೆಯಲ್ಲಿ (ಗಣಕಯಂತ್ರ) ಕನ್ನಡ ಬಳಕೆ - ಪತ್ರ ಲೇಖನ - ವೈಯಕ್ತಿಕ ಪತ್ರಗಳು - ವ್ಯವಹಾರಿಕ ಪತ್ರಗಳು - ಪ್ರಬಂಧ ರಚನೆ - ಸಾಮಾಜಿಕ ಶ್ಲೋಕ - ಶೈಕ್ಷಣಿಕ ಶ್ಲೋಕ - ಗಾದೆಗಳ ಬಳಕೆ - ಉಪನಿಷದದ ಶೈಲಿ - ಅನುಭವದ ಶೈಲಿ - ವಾಕ್ಯ ಸಂಯೋಜನೆ - ಸರಳ ವಾಕ್ಯ - ಮಿಶ್ರವಾಕ್ಯ - ಸಂಯೋಜಿತ ವಾಕ್ಯ - ವ್ಯಾಕರಣ ಭಾಗ - ಅನುಕರಣವಾಚಕ ಪದಗಳು - ವಿರುದ್ಧ ಪದಗಳು, ನುಡಿಗಟ್ಟುಗಳು - ವಿದ್ವಂಸ ಪದಗಳು - ಅರ್ಥ, ಸಮಾನಾರ್ಥ, ನಾನಾರ್ಥ ಪದಗಳು - ನಿಷೇಧಾರ್ಥಕ ಪದಗಳು - ಸಂಖ್ಯಾವಾಚಕ, ಸಾಮಾನ್ಯವಾಚಕಗಳು - ವಿಭಕ್ತಿ ಪ್ರತ್ಯಯಗಳು - ಕ್ರಿಯಾಪದಗಳು, ಧಾತುರೂಪ - ಪದ ವಿಂಗಡಣೆ - ದ್ವಿರುಕ್ತಿ, ಜೋಡುನುಡಿ, ಇತ್ಯಾದಿ - ಸೃಜನಾತ್ಮಕ ಬರವಣಿಗೆ - ವಿಷಯದ ಆಯ್ಕೆ - ಅನಿಸಿಕೆಯ ಭಾಗ - ವಿಶ್ಲೇಷಣೆ - ಉಪಸಂಹಾರ - ವಿಷಯದ ಚರ್ಚೆ, ಪ್ರಬಂಧ ಮಂಡನೆ - ಸಮೂಹ ಚರ್ಚೆ, ಪಠ್ಯ - ಪದ್ಯ - ನಾಟಕ ಭಾಗ - ವಿಷಯ ಸಂಗ್ರಹಣೆ, ವರದಿ, ಲೇಖನ ಕಲೆ - ಸಂಪರ್ಕ ಮಾಧ್ಯಮಗಳು - ಅದರ ಬಳಕೆ - ಸ್ವತಂತ್ರ ಕಥೆ, ವರ್ಣನೆ, ಪ್ರವಾಸಕಥನ ಮತ್ತು ಅನುಭವಗಳ ನಿರೂಪಣೆ *****

SEMESTER	II					
YEAR	I					
COURSECODE	23BS1207					
TITLEOFTHECOURSE	SPSS (Statistical Package for Social Sciences)					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

Pre-requisite Courses(if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSEOBJECTIVES:
Providing fundamentals of Statistics
Essentials of SPSS in data analysis
Managing and analysis of biological data using SPSS

COURSE OUTCOMES:		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	The student will apply the basics of python programming and the steps of installation of Python and bio-python	L2
CO2	Perform descriptive analysis of data.	L2
CO3	Perform statistical tests and multivariate analysis	L3

COURSECONTENT:	
MODULE 1	06 Hrs
An introduction to SPSS: Introduction to SPSS, general aspects, workflow, critical issues, SPSS: general description, functions, menus, commands, SPSS file management, defining variables, - Manual input of data, automated input of data and file import – class exercise	
MODULE 2	06 Hrs
Introduction to Statistics Classification, tabulation, Measures of central tendency, Measures of Dispersion, Probability and Probability Distribution, Methods of Sampling	

MODULE 3	06 Hrs
Data manipulation and Descriptive analysis of data Data Transformation, Syntax files and scripts,- Output management Class exercise Frequencies- Descriptive, Explore, - Crosstabs, - Charts	
MODULE 4	06 Hrs
Statistical tests For Means (Large and Small test), T-test, One-way ANOVA, Non parametric tests, Normality tests, test for proportion, Class exercise Correlation and regression - Linear correlation and regression, multiple regressions (linear), Class exercise.	
MODULE 5	06 Hrs
Multivariate analysis Factor analysis, Cluster analysis, Class exercise	

TEXTBOOKS/REFERENCES:

1. Field A., Discovering Statistics Using SPSS, Fourth Edition, SAGE, 2013

**SYLLABUS FOR B.Sc. HONS
SEMESTER - III**

SEM – B.Sc. HONS (Common)

SEMESTER	III					
YEAR	II					
COURSE CODE	23BS2301					
TITLE OF THE COURSE	BIOPHYSICS AND INSTRUMENTATION					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	4	-	60	4

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To familiarize the students with basic concepts and principles of biophysical and biochemical techniques used in biological & medical research and also in industry. - To give holistic view for understanding the screening, isolation, separation and characterization of various biological molecules	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Student will be able to handle the biological samples and perform experiments independently using different techniques.	L2
CO2	Student will be equipped with the skills to design and execute minor research projects involving different techniques and methodologies.	L3
CO3	Student will be able to interpret the read outs collected from various experiments and troubleshoot the minor problems associated with various techniques.	L4

COURSE CONTENT:		
MODULE 1:		8 Hrs
Centrifugation: Basic principles, RCF, Svedberg constant and Sedimentation coefficient. Preparative centrifugation: Differential & density gradient centrifugation and their applications. Analytical centrifugation: Determination of molecular weight of biomolecules.		
MODULE 2:		7 Hrs
Beer-Lambert's law, applications and its limitations. Extinction coefficient determination and uses, Principle, schematics and applications of Colorimeter and UV-Vis spectrophotometer.		
MODULE 3:		15 Hrs
Chromatography: Principle of Chromatography. Distribution/partition coefficient, Planar chromatography: TLC and circular chromatography. Types and applications of chromatography: Types of matrices used in different chromatographic techniques, Separation of biomolecules using gel permeation, ion exchange, affinity chromatography and their applications. Brief idea about High Performance Liquid Chromatography (HPLC) and Gas Chromatography (GC) and their applications.		

MODULE 4:	15 Hrs
Electrophoresis: Migration of ions in the electric field. Factors affecting electrophoretic mobility. Principle, schematics and application of Agarose gel electrophoresis, SDS-PAGE, High voltage electrophoresis and their Applications. Isoelectric focusing (IEF), 2D-Electrophoresis and Capillary electrophoresis and applications .	
MODULE 5:	15 Hrs
Basic Principles of Structural elucidation: CD, IR, NMR, MALDI & LC-MS, X-ray diffraction in structural analysis of macromolecules. Isotopic tracer techniques: Radioactive & stable isotopes, Pattern and rate of radioactive decay. Measurement of radioactivity: Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique), Autoradiography their advantages and limitations.	

TEXT BOOKS/REFERENCES
1) 1. Principles and Techniques of Practical Biochemistry – Keith Wilson and John Walker. Cambridge low price edition. 2) Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications 3) Analytical Techniques in Biochemistry and Molecular biology – Katoch. Springer. 4) Fundamentals of Analytical Chemistry - Skoog, Holler and West. Saunders 5) Handbook of Analytical Techniques – Gunzler and Williams. Wiley & Sons 6) 6. A Textbook of Practical Biochemistry- Joshi and Saraswat. Jain Publishers.

BIOPHYSICS AND INSTRUMENTATION - PRACTICALS
1) pH metric titrations (HCl-NaOH / Acetic acid-NaOH). 2) Determination of pI of amino acid (glycine). 3) Determination of extinction coefficient using colorimetry. 4) Determination of lambda maximum of biomolecules using UV spectroscopy. 5) Estimation of pKa of amino acid (glycine). 6) Separation of amino acid by Thin Layer Chromatography (TLC).

REFERENCES
1) Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt (2011). 12th edition, Essential Immunology, ELBS, Blackwell Scientific Publishers, London 2) William E Paul (2012). Fundamentals in Immunology. 7th edition, Raven Press. 3) 3. Kuby J, Judy Owen, Jenni Punt, Sharon Stranford (2013). Immunology. 7th Edition. W.H. Freeman and Company.

SEMESTER	III					
YEAR	II					
COURSE CODE	23BS2302					
TITLE OF THE COURSE	MOLECULAR BIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	4	-	60	4

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- Understand the general principles of central dogma, DNA and RNA types structure and their role in cells. - Explain the mechanisms of DNA replication, RNA synthesis and repair, various levels of gene expression, regulation and protein function.	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	To demonstrate the fundamental understanding of central dogma of molecular biology	L1
CO2	To compile the steps involved in DNA replication and display experimental evidence that indicates that it is semi conservative in nature	L2
CO3	To demonstrate the fundamentals of steps involved in transcription and translation	L3

COURSE CONTENT:		
MODULE 1:	The Molecular Basis Of Life	12 Hrs
Central dogma, DNA and RNA as genetic material – experimental proof. Evidences for DNA as the genetic material- Griffith's transformation experiment, Hershey and Chase experiment, evidence for RNA as the genetic material of viruses (TMV, Retroviruses). Nucleic acids: DNA structure and types (A, B and Z model), Denaturation and renaturation kinetics of DNA, Types of RNA – mRNA, tRNA and rRNA, mi RNA.		
MODULE 2:	Dna Replication And Its Components	12 Hrs
Replication of DNA (Conservative, Dispersive and Semi Conservative DNA replication, Meselson and Stahl experiment), theta and rolling circle model of replication. Prokaryotic and Eukaryotic – Enzymes and proteins involved in replication. DNA repair.		
MODULE 3:	Dna Transcription And Its Components	12 Hrs
RNA polymerases, Mechanism of transcription – initiation, elongation and termination in prokaryotes and eukaryotes. Post-transcriptional modifications of Eukaryotic mRNA (Poly A		

tailing, 5' capping and splicing mechanisms)		
MODULE 4:	Translation And Regulation Of Gene Expression	12 Hrs
Genetic code, wobble hypothesis, Mechanism of translation in prokaryotes and eukaryotes, Post translational modification of Proteins.		
MODULE 5:	Regulation Of Gene Expression	12 Hrs
Regulation of Gene expression in Prokaryotes – Operon concepts, induction, repression, attenuation, examples of Lac and Trp operons. Regulation of Gene expression in Eukaryotes – galactose metabolism in yeast.		

TEXT BOOKS/REFERENCES	
1) Cell & Molecular Biology by Gerald Karp, 3rd Edition, John Wiley & Sons (2009) 2) Molecular Biology of the Gene by James Watson et al, Pearson Education (2013) 3) Molecular Biology of the Cell, Bruce Alberts et al, Garland Science Publication (2007) 4) Principles of Biochemistry by Nelson and Cox, WH Freeman Publications (2008) 5) Textbook of Cell and Molecular Biology by Ajoy Paul, Books and Allied Ltd (2011). 6) Molecular Biology and Genetic Engineering by P K Gupta, Deep and Deep Publications (2008). 7) Cell Biology, Genetics, Molecular Biology, evolution and Ecology by PS Verma and VK Agarwal, S. Chand Publications (2006).	

MOLECULAR BIOLOGY - PRACTICALS
1) Extraction of DNA from plant/bacteria and animal sources (2 Units) 2) Separation of DNA on agarose gel electrophoresis, Visualization of DNA (2 units) 3) Quantification of DNA by spectrophotometry

REFERENCES
1) Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz. Scientific American books. USA. 1983. 2) Biotechnology A Laboratory Course by Becker JM, Caldwell GA, Zachgo EA. Second edition. Elsevier. 1996. 3) Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer 2011 4) Lab Manual in Biochemistry, Immunology and Biotechnology by Arti Nigam and Archana Ayyagari. TATA McGraw Hill publishers, 2008.

SEMESTER	III					
YEAR	II					
COURSE CODE	23BS2303					
TITLE OF THE COURSE	FUNDAMENTALS OF MICROBIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	4	-	60	4

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To equip the students about the importance of microorganisms in our global society. - To create in-depth knowledge of the structural and functional characteristics of prokaryotic and eukaryotic cells and their classification. - To make students to learn basic microbiological techniques employed for isolation, culturing and identification of prokaryotic and eukaryotic microorganisms	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be acquainted with fundamental aspects of basic microbiology & isolation techniques.	L1
CO2	Enable the students to understand the diversity of microbial, structure, function and their environment.	L2
CO3	Students will be able to understand the importance of microorganisms.	L3

COURSE CONTENT:		
MODULE 1:	History And Scope Of Microbiology	12 Hrs
Development of microbiology as a discipline, spontaneous generation and biogenesis. Scope, disciplines and Applications of microbiology. Contributions of Antony von Leeuwenhoek, Joseph Lister, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Sumbunath Dey, Ananda Chakroborty, Paul Ehrlich, Selman A. Waksman, and Sir Ronald Ross in the field of Microbiology. Difference between prokaryotic and eukaryotic microorganisms.		
MODULE 2:	Microbial Systematics	12 Hrs
Classification systems: Criteria for classification of microorganisms, classification systems artificial and phylogenetic, Haeckel's three-kingdom classification, Whittaker's five-kingdom classification, three-domain concept of Carl Woese. Taxonomy: Identification and nomenclature, binomial nomenclature, international code of nomenclature of prokaryotes, taxonomic ranks and hierarchical organization. Concepts and Applications of Bergey's manual of systematic and determinative bacteriology.		

MODULE 3:	Microscopy	12 Hrs
Principles of microscopy - resolving power, numerical aperture, working distance and magnification. Types of optical and electron microscopy – Basic principle, sample preparation, applications and limitations of Simple, Compound, Dark field, Fluorescence, Phase contrast, Confocal, Atomic force microscope and Electron Microscope - TEM and SEM.		
MODULE 4:	Sterilisation And Disinfection	9 Hrs
Sterilization and Disinfection: Definition, Principles, construction, and applications for physical and chemical methods of sterilization. Physical: Pasteurization, Fractional sterilization -Tyndallization and Moist heat and Dry heat sterilization. Filtration – Seitz filter, membrane filter and laminar air flows. Radiation: Ionizing radiation and non-ionizing. Chemical methods: Alcohol, aldehydes, phenols, halogen, metallic salts, Quaternary ammonium compounds and sterilizing gases as antimicrobial agents.		
MODULE 5:	Culture Media And Staining	9 Hrs
Culture media and its types: Components, Types - Simple, Selective, Transport, Enriched, Differential media. Pure culture techniques: Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic). Staining techniques: Nature of dyes, Physical and chemical theories of staining, Principles and applications of a) Simple, negative staining b) Differential Staining- Gram's and Acid-fast staining c) Structural staining –cell wall, endospore, flagella, capsular staining, fungal staining.		

TEXT BOOKS/REFERENCES
1) Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2007. Introductory Mycology; Fourth edition, Wiley India Private Limited 2) Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York. 3) Benson, H. J. 1994. Microbiological Application. WCB McGraw-Hill of India Private Limited. 4) Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J. 5) Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999. 6) Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005 7) Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1986. 8) Pommerville, J.C. 2007. Alcamo's Fundamentals of Microbiology. Eighth Edition. Jones and Bartlett Publishers, USA. 9) Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005. 10) Salle, A. J. 1984. Fundamental Principles of Bacteriology. Tata McGraw-Hill Publishing Company Limited, New Delhi. 11) Salle, A.J. Principles of Microbiology, 2nd edition., 1997, Mc Graw Hill.1997. 12) Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005.

FUNDAMENTALS OF MICROBIOLOGY - PRACTICALS
1. Study of instruments (2 Units) 1. Autoclave 2. Hot air oven 3. Incubator

4. pH meter
5. High speed centrifuge
6. Colorimeter
7. UV-Vis Spectrophotometer
8. Laminar air flow
2. Media Preparation:
 - a) Basal media (Nutrient agar and broth, PDA media and MRBA)
 - b) Selective media (EMB agar and McConkey agar),
 - c) Enriched media (Blood agar).
3. Isolation of bacteria and fungi by serial dilution technique from soil, water and air
4. Methods of pure culture techniques
 - a) Pour plate technique
 - b) Spread plate technique
 - c) Streak plate technique
5. Transfer of media and inoculum
 - a) Slant culture technique
 - b) Broth culture technique
 - c) Stab culture technique
6. Microscopic observation of temporary slides: a) Simple staining and b) Gram's staining
Microscopic observation of permanent slides
 - a. Algae: Chlamydomonas and Spirulina
 - b. Fungi: Rhizopus, Aspergillus, Penicillium, Yeast.
 - c. Protozoa: Amoeba, Paramecium and Euglena.

REFERENCES

- 1) Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
- 2) Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
- 3) Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
- 4) Pelczar, M. J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.
- 5) Prescott, L.M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, NY.

SCHEME & SYLLABUS - SCHOOL OF BASIC & APPLIED SCIENCES, DSU

SEMESTER	III					
YEAR	II					
COURSE CODE	23BS2304					
TITLE OF THE COURSE	RESEARCH METHODOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	-	45	-	3

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To provide an overview of essential research steps to be followed when conducting research / project work. - To understand chief ingredients to be incorporated in conduct as well as writing of scientific reports/dissertation/thesis - To know the implication professional research ethics and common misconduct details of researcher and research work	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
C01	Show and explain the concepts of meaning of research, scope of research including different types of research, scientific research process and research methodology steps	L1
C02	Perform review of literature using electronic media, selecting research problem formulate research problem statement, writing hypothesis, explain criteria of forming objectives, materials and methods, results and discussion	L1
C03	Identify and explain experimental research designs for both qualitative and quantitative research	L2
C04	Explain different sampling methods and sampling design, basic statistical methods for treatment of data and observations	L2
C05	Demonstrate ingredients and components of a research report, dissertation and thesis and explain integral components of research article and research proposal	L1
C06	Explain professional research ethics and elaborate on misconduct in research	L1

COURSE CONTENT:		
MODULE 1:		9 Hrs
INTRODUCTION TO RESEARCH: Meaning, Objectives and Characteristics of research – Scientific Method Types of research - Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical - Research process - Criteria of good research		

PROBLEM STATEMENT: Defining the research problem - Selecting the problem - Necessity of defining the problem - Techniques involved in defining the problem;		
MODULE 2:		9 Hrs
LITERATURE SURVEY: Importance of literature review in defining a problem - Survey of literature - Primary and secondary sources - web as a source - searching the web - Identifying gap areas from literature review HYPOTHESIS: Definition of hypothesis, Basic concepts, variables-Dependent and independent variables, Development of working hypothesis; Ingredients of Research Objectives, deriving objectives of research		
MODULE 3:		9 Hrs
Sampling, Material and Methods: Sample- Sampling - Types of sampling; Material - Experiments, Data – Basics of Analysis; Writing materials and method chapter of a research report Research Designs: Research design; Need of research design - Basic Principles; Features of good design – Important concepts relating to research design; Max-min-con principle,		
MODULE 4:		9 Hrs
Common research Designs: Cross-sectional, Case-control, Longitudinal and Cohort research designs, advantages and disadvantages of each of research designs Report and Article Writing: Structure and components of scientific reports; Abstract-Key words; Types of reports; Significance of reporting; Different steps in the preparation of reports; Layout, structure and Language of typical reports; References; Citation styles- APA and MLA styles of citation, intext and end text citations		
MODULE 5:		9 Hrs
Oral Presentation: Importance of effective communication. Planning; Preparation; Practice; Making presentation; Use of visual aids. Research Ethics: Values, Ethics and Morals, Research Professionalism, Tenets of Ethics; Conducting and reporting of science/engineering; Relationship in research groups; Hazards to good scientific practice; Scientific misconduct: Fabrication, Falsification and Plagiarism.		

TEXT BOOKS/REFERENCES:	
1) Bruce Tuckman, Brian E Harper, Conducting Educational Research, 6 th Edition, 2012 by Rowman & Littlefield Publishers, Inc. ISBN 978-1-4422-0965-7 (electronic) 2) Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p. 3) Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers. 4) Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi 5) Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes. 6) Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p. 7) Day, R.A., 1992. How to Write and Publish a Scientific Paper, Cambridge University Press. 8) Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications 9) Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.	

SCHEME & SYLLABUS - SCHOOL OF BASIC & APPLIED SCIENCES, DSU

SEMESTER	III					
YEAR	II					
COURSE CODE	23BS2305					
TITLE OF THE COURSE	Bioethics and IPR					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To recognize, compare, and contrast the general "ways of thinking" of science (biology) and of philosophy (ethics). - To recognize, compare, and contrast the general "ways of thinking" of science (biology) and of philosophy (ethics). - To give elementary essential concepts of Bioethics, IPR and patent laws.	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Student should develop basic understanding of the concepts of Bioethics, IPR and Patent Laws	L2
CO2	This course should generate interest for avenues for pursuing higher studies and careers in these areas	L2
CO3	General knowledge should create awareness necessary for higher studies in biotechnological fields	L2

COURSE CONTENT:		
MODULE 1:	Introduction To Bioethics	6 Hrs
Bioethics- The environmental, legal and socioeconomic impacts of biotechnology; Ethical concerns of biotechnology in research and innovation-The GM crop debate – safety, ethics, perception and acceptance of GM crops; Bioethics of Genetically modified organism; Bioethics of CRISPR technique- for editing human embryos.		
MODULE 2:	Bioethics Of Gene Therapy	6 Hrs
Bioethics of Gene therapy; Bioethics of Stem cell research; Reproductive medicine and ethics; Use of Animals in Research and Testing, and Alternatives for Animals in Research, Animal Cloning, Human Cloning, and their Ethical Aspects; Public education of the process of biotechnology involved in generating new forms of life for informed decision-making.		
MODULE 3:	Intellectual Property Rights And Regulations	6 Hrs
Introduction to Intellectual Property and History. Patents, Trademarks, Copyright, Trade secrets, Industrial Design and Rights, Traditional Knowledge, Geographical Indications - importance of IPR – patentable and non-patentable – patenting life – legal protection of biotechnological inventions –		

World Intellectual Property Rights Organization (WIPO), Pros and Cons of IP protection.		
MODULE 4:	PATENT APPLICATIONS	6 Hrs
Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement-meaning, scope, litigation, case studies, Rights and Duties of patent owner.		
MODULE 5:	Agreements And Treaties	6 Hrs
Agreements and Treaties: GATT, TRIPS Agreements; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.		

TEXT BOOKS/REFERENCES:	
1) Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.	
2) Ganguli Prabuddha Gearing up for Patents. The Indian Scenario”, Universities Press (1998)	
3) Introduction to Plant Biotechnology, H S Chawla	
4) M K Sateesh. Bioethics and Biosafety. Kindle Edition	
5) Shomini Parashar, Deepa Goel IPR, Biosafety and Bioethics Pearson India, 2013	
6) F. H. Erbisch and K. M. Maredia. Intellectual property rights in agricultural Biotechnology, University Press, 2004.	

SEMESTER	III					
YEAR	II					
COURSE CODE	22BS2306					
TITLE OF THE COURSE	CONSTITUTION OF INDIA					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
• Define a constitution • Describe the salient features of the Indian Constitution • Explain different ways of acquiring Indian Citizenship • List the Fundamental Rights and Fundamental Duties of Indian citizens • Describe the Directive Principles of State Policy and their significance	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will appreciate the fundamental law of the land	L1
CO2	Students will be aware of what kind of government the country will have.	L1
CO3	Aid in understanding what lays down the rules to govern the country	L2
CO4	It also tells about the rights and also the duties of its citizens	L1

COURSE CONTENT:		
MODULE 1:		6 Hrs
Framing of the Indian Constitution: Role of the Constituent Assembly. Philosophy of the Constitution: Objectives, resolution, preamble, fundamental Rights and Duties. Human rights and Environmental protection.		
MODULE 2:		6 Hrs
Special Rights created in the Constitution of Dalits, Backward Classes, Women and Children, and religious and linguistic minorities. Directive Principles of State policy: The need to balance fundamental rights with directive principles.		
MODULE 3:		6 Hrs
Union Executive: President, Prime Minister and Council of Ministers; powers and functions, coalition Government, problems in their working. Union Legislature: Lok Sabha and Rajya Sabha, powers and functions. Recent trends in their functioning		
MODULE 4:		6 Hrs
State Government: Governor, Chief Minister and Council of ministers, Legislature. Centre – State		

relations: Political, financial, administrative: Recent Trends.

MODULE 5:

6 Hrs

Judiciary: Supreme Court, Judicial Review, Writs, Public interest litigations. Enforcing rights through writs. Emergency provisions (Article 356)

TEXT BOOKS/REFERENCES:

1. Computer Fundamentals, 4th edition (2004) P.K. Sinha, BPB publication, India
2. Computer Networks. 4th edition (2008). Tanenbaum. Pearson Education, India
3. Biostatistics: P.N.Arora ,P.K.Malha.
4. Introduction to Database Management Systems, 1st edition, (2004), Atul Kahate, Pearson education, India.

SEMESTER	III					
YEAR	II					
COURSE CODE	23BS2307					
TITLE OF THE COURSE	R – PROGRAMMING FOR BIOLOGISTS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- Set to acquire grasp of the R-Programming language - Establishing fundamentals of R- data structures, variables and control structures - Learning organization of biological data efficiently; Overview of functions, R-graphical capacities, data visualizations	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Demonstrate a comprehensive understanding of R's fundamental concepts	L1
CO2	Explain variables, data types, and basic operations..	L2
CO3	Explain preprocess biological data using R, including data importing, cleaning, and transformation.	L1
CO4	Utilize R's various data structures to organize and manage biological data efficiently.	L2

COURSE CONTENT:		
MODULE 1:	Fundamentals of R	6 Hrs
Installation of R & R Studio, Features of R, Variables, Constants, Operators, Datatypes and R Objects, Important Built-in functions		
MODULE 2:	Control Statements	6 Hrs
if , if...else statement, if else() function, switch() function, repeat loop, while loop, for loop, break statement, next statement.		
MODULE 3:	R Packages and Data visualization in R	6 Hrs
: Package basics, Initialization, Data management and manipulation using dplyr: subsetting, transforming, sorting, calculating summary statistics		
MODULE 4:	Data visualization in R	6 Hrs
ggplot: a grammar of graphics, box-and-whisker plots, histograms, saving the graphs		
MODULE 4:	Bioconductor for genomic data science	6 Hrs
Installing Bioconductor, IRanges - Basic Usage, Genomic Ranges - Basic GRanges Usage, Biostring, BSgenome.		

TEXT BOOKS/REFERENCES:

- 1) Andrew P. Beckerman, Owen L. Petchey, Getting Started with R: An Introduction for Biologists.
- 2) Robert Gentleman, R Programming for Bioinformatics.
- 3) Wickham H, Golemund G. R for data science: import, tidy, transform, visualize, and model data. " O'Reilly Media, Inc."; 2016 Dec 12.
- 4) Lander JP. R for everyone: Advanced analytics and graphics. Pearson Education; 2014

**SYLLABUS FOR B.Sc. HONS
SEMESTER - IV**

COMMON COURSE

SEMESTER	IV					
YEAR	II					
COURSE CODE	23BS2401					
TITLE OF THE COURSE	AI AND ML FOR BIOLOGISTS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	2	-	-	-	30	2

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To introduce the students the fundamental concepts of AI and ML. - To equip with practical skills in applying basic ML techniques to biological data analysis - To introduce the students to potential of AI and ML in various biological fields.	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to apply fundamental machine learning algorithms to analyze biological datasets and make predictions effectively.	L2
CO2	Students will understand the principles and significance of molecular docking in drug discovery and protein-ligand interactions, enhancing their comprehension of computational methods in biology research.	L2
CO3	Students will evaluate ethical implications and potential challenges associated with AI and ML in biology, proposing thoughtful solutions and demonstrating ethical decision-making skills.	L4

COURSE CONTENT:		
MODULE 1:	INTRODUCTION TO AI AND ML	6 Hrs
Understanding the basics of Artificial Intelligence (AI) and Machine Learning (ML), Importance of AI and ML in biological research, Overview of key concepts: algorithms, models, training, and prediction, Practical applications of AI and ML in biology		
MODULE 2:	FUNDAMENTALS OF DATA ANALYSIS	6 Hrs
Introduction to data types in biology: DNA sequences, protein structures, gene expression data, etc. Data preprocessing techniques: cleaning, normalization, and feature selection, Exploratory Data Analysis (EDA) methods for biological datasets, Hands-on exercises using simple biological datasets.		
MODULE 3:	MACHINE LEARNING ALGORITHMS FOR BIOLOGISTS	6 Hrs
Introduction to supervised, unsupervised, and semi-supervised learning, Overview of commonly used ML algorithms: Decision Trees, Random Forests, Support Vector Machines (SVM), k-Nearest Neighbors (k-		

NN), etc. Understanding model evaluation metrics: accuracy, precision, recall, F1-score		
MODULE 4:	APPLICATIONS OF AI AND ML IN BIOINFORMATICS	6 Hrs
Introduction to bioinformatics and its role in biological research. Molecular docking: principles and applications in drug discovery and protein-ligand interactions Quantitative Structure-Activity Relationship (QSAR): predicting biological activity of compounds.		
MODULE 5:	DEEP NEURAL NETWORKS	6 Hrs
Introduction to deep learning and neural networks, Application of deep learning in biology: image analysis, genomics, and healthcare		

TEXT BOOKS/REFERENCES:	
1)"Bioinformatics Data Skills: Reproducible and Robust Research with Open Source Tools" by Vince Buffalo 2)"Machine Learning for Biology: Methods for Data Analysis, Prediction, and Control" by William Stafford Noble 3)"Biological Data Mining" by Jake Y. Chen and Stefano Lonardi 4)"Bioinformatics Algorithms: An Active Learning Approach" by Phillip Compeau and Pavel Pevzner 5)"Chemoinformatics and Computational Chemical Biology" by Junmei Wang.	

**B.Sc. – BIOCHEMISTRY (Major) SYLLABUS
SEMESTER – IV**

SEMESTER	VI					
YEAR	III					
COURSE CODE	23BY2401					
TITLE OF THE COURSE	ENZYME TECHNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	4	-	60	4

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	23BS1201	Biomolecules

COURSE OBJECTIVES:	
- To create an understanding about enzymes, coenzymes and their properties - To gain knowledge of enzyme assays, enzyme kinetics and drawing enzyme assisted reaction plots. - To learn about protein isolation and purification methods	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students would understand active site structure and enzyme catalysis	L1
CO2	Students would have a brief idea about regulation of enzyme activity along with enzyme inhibition.	L2
CO3	Students should learn understand the applications of various enzymes	L2

COURSE CONTENT:		
MODULE 1:	INTRODUCTION TO ENZYMES	12 Hrs
Classification and nomenclature, specificity, active site groups, theories of enzyme action. Enzyme assay: Principle and types, enzyme units. Monomeric, oligomeric and multifunctional enzymes, multi enzyme complexes. Enzyme purification and criteria of purity.		
MODULE 2:	ENZYME CATALYSIS	12 Hrs
Lock and key, Induced fit and Transition state Hypotheses. Mechanism of enzyme catalysis- Acid-base catalysis, covalent catalysis, Metal ion catalysis, Proximity and orientation effects etc. Mechanism of Serine proteases-Chymotrypsin, Lysozyme, Carboxypeptidase A and Ribonuclease., Proenzymes (Zymogens).		
MODULE 3:	ENZYME KINETICS	12 Hrs
Factors affecting the enzyme activity- Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, L.B Plot, Turnover number, Kcat. Kinetics of Enzyme Inhibition.		

MODULE 4:	ENZYME INHIBITION	12 Hrs
Types of reversible inhibitors; competitive, non-competitive, uncompetitive, and mixed inhibitors. Partial, substrate, allosteric and Irreversible inhibition. Allosteric enzymes and metabolic regulation. Study of ATCase as typical allosteric enzyme. Enzyme inhibitors as drugs.		
MODULE 5:	INDUSTRIAL AND CLINICAL USES OF ENZYMES	12 Hrs
Industrial Enzymes- Thermophilic enzymes, amylases, lipases, proteolytic enzymes in meat and leather industry, enzymes used in various fermentation processes, cellulose degrading enzymes, Metal degrading enzymes. Clinical enzymes- Enzymes as thrombolytic agents, Anti-inflammatory agents, strptokinasae, asparaginase, Isoenzymes like CK and LDH, Transaminases (AST, ALT), Amylases, Cholinesterases, Phosphatases. Immobilization of enzymes, Biosensors. Enzyme Engineering and site directed mutagenesis, Designer enzymes		

TEXT BOOKS/REFERENCES
1) Enzymes - Biochemistry, Biotechnology, Clinical Chemistry, Palmer and Bonner, Elsevier Press (2007). 2) Biochemistry, Voet and Voet, 4th Ed, Wiley (2010). 3) Fundamentals of Enzymology, Price and Stevens, Oxford University Press (2009). 4) Fundamentals of Enzyme Kinetics, Bowden, Portland Press (2004). 5) Biophysical Chemistry Part II, Charles R. Cantor, Paul R. Schimmel, W.H. Freeman & Companys (2080). 6) Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland, Wiley-VCH Publishers (2000). 7) Biochemical Calculations, 2nd Ed. Irwin H. Segel, John Wiley and Sons (2076).

ENZYME TECHNOLOGY- PRACTICALS
1) Introduction to enzymology Lab and product curve determination. 2) Isolation of enzyme amylase from biological source and activity determination through time curve. 3) Determination of kinetic constants through LB plot. 4) Effect of pH on enzyme activity. 5) Effect of temperature on enzyme activity.

REFERENCES
1) Practical enzymology – Hans Bisswanger, Wiley-VCH, 2019, 3 rd Ed 2) Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house 2001, 1st Ed. 3) Principles and Techniques of Practical Biochemistry – Wilson, Wilson and Walker, Cambridge University Press 2000, revised Ed 63. 4) Introduction to practical Biochemistry, Plummer, Tata McGraw-Hill Education 2001, 2nd Ed. 5) 5. Basics of Enzyme Immobilization – Alka Dwevedi, Springer International Publishing, 2016, 1st Ed.

SCHEME & SYLLABUS - SCHOOL OF BASIC & APPLIED SCIENCES, DSU

SEMESTER	IV					
YEAR	II					
COURSE CODE	23BY2402					
TITLE OF THE COURSE	CARBOHYDRATE AND PROTEIN METABOLISM					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	3	-	60	4

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	I	23BS1201	Biomolecules

COURSE OBJECTIVES:	
- To understand the metabolic pathways of bio-molecules of the system - To create an understanding of structural and functional defects associated with metabolic pathways	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students should identify the various rate determining steps in metabolism.	L1
CO2	Students should be able to interconnect and compare the carbohydrate and protein metabolic pathway	L2
CO3	Students should be able to understand various diseases associated with metabolic pathways	L3

COURSE CONTENT:		
MODULE 1:	Carbohydrate metabolism - I	12 Hrs
Introduction to metabolism (anabolic, catabolic, amphibolic, and intermediary metabolism). Glycolytic pathway; energetics and regulation, aerobic and anaerobic fates of pyruvate, Cori cycle, entry of sugars other than glucose into metabolism, Gluconeogenesis, reciprocal regulation, Pyruvate dehydrogenase complex.		
MODULE 2:	Carbohydrate metabolism - II	12 Hrs
TCA cycle: amphibolic nature and regulation, anapleurotic reaction, substrate cycle, pentose phosphate pathway, Degradation, synthesis, and regulation of glycogen. Regulation of blood glucose level by organs and hormones, Diabetes mellitus, carbohydrate metabolic disorders (glycogen storage disorders).		
MODULE 3:	Amino acids and Peptides - I	12 Hrs
General metabolic reaction of amino acids– transamination, deamination, oxidative and nonoxidative deamination, glucose – alanine cycle. Urea cycle– regulation and metabolic disorders. Biosynthesis of creatine and creatine phosphate, polyamines, glutathione, physiologically active amines (serotonin and α – histamine) and catecholamines (dopamine, epinephrine and norepinephrine).		

MODULE 4:	Amino acids and Peptides-II	12 Hrs
Role of RER and Golgi complex in the synthesis of glycoproteins and GPI anchored proteins. Biogenic amines – polyamines. Bioactive peptides – Bradykinin, angiotensin, oxytocin and vasopressin. Regulation of amino acid and purine/pyrimidine levels by Glutamine Synthetase.		
MODULE 5:	Metabolism of standard amino acids	12 Hrs
Biosynthesis and degradation of twenty standard amino acids – A, G, T, S, C, E, N, D, Q, R, H, P, V, I, M, L, K, W, F & Y.		

TEXT BOOKS/REFERENCES
1) Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3rd Ed. John Wiley and Sons (2009). 2) Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012). 3) Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and Lubert Stryer, W H Freeman and Co. (2006). 4) Textbook of Biochemistry with Clinical Correlations – Thomas M. Devlin, John Wiley & Sons; 7th edition (22 January 2010) 5) Biochemistry of Foods, Eskin, Elsevier (2012). 6) Biochemistry and Molecular Biology; 5th Ed. D. Papachristodoulou, A. Snape, W.H.Elliott, and D. C. Elliott, Oxford University Press (2014). 7) Harpers Illustrated Biochemistry; 30th Ed. V.W. Rodwell , D. Bender , K.M. Botham , P.J. Kennelly, P. A. Weil (2015).

CARBOHYDRATE AND PROTEIN METABOLISM - PRACTICALS
1. Estimation of reducing sugar by DNS method / Miller's method. 2. Estimation of sugar by Folin - Wu method 3. Determination of ratio of albumin and globulin in serum. 4. Estimation of urea by DAM method 5. 5. Estimation of protein by Lowry's method.

REFERENCES
1) Essentials of Practical Biochemistry, Prem Prakash Gupta, Neelu Gupta, 10.5005/jp/books/12972, 2017. 2) A textbook of practical Biochemistry, Joshi and Saraswat, Jain Publishers, New Delhi 2002

SCHEME & SYLLABUS - SCHOOL OF BASIC & APPLIED SCIENCES, DSU

SEMESTER	IV					
YEAR	II					
COURSE CODE	23BY2403					
TITLE OF THE COURSE	HUMAN ANATOMY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	23BS1101	Essentials of Biochemistry

COURSE OBJECTIVES:	
- Students will be able to understand different types of cells and tissues of organs in human system - Comprehensively able to understand the cellular organization, barriers, targets and functions of different cells and tissues and their pathology	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
C01	Students will be able to demonstrate the different cellular and tissue organization of different organ system	L1
C02	Will be able to explain the functions of different cell types their abnormalities in different organ systems	L2
C03	Students will be able understand and interpret the anatomical abnormalities from the diagnostic data.	L3

COURSE CONTENT:		
MODULE 1:	Introduction	10 Hrs
Scope of anatomy and physiology; levels of structural organization and body systems; Term used in Gross Anatomy; Classification and Types of tissues: Structure, location and functions of epithelial, muscular, nervous and connective tissues; General principles of cell communication		
MODULE 2:	Integumentary system	10 Hrs
Structure organization, functions and nutrition of skin; Bones: Definition, Classification and functions of bone; Parts, types of epiphyses, Ossification, Blood supply of long bone; Cartilage – Definition, types, structure, distribution and nutrition. Joints: Classification, synovial joints, Blood supply & nerve supply.		
MODULE 3:	Muscular and Central Vein system	10 Hrs
Muscular system: Functional classification, Prime movers, Fixators, Antagonists, Synergists Central Vein System: Classification and structure of blood vessels; Lymphatic system: structure and functions of lymph vessels, lymphoid tissue; Superficial Fascia: Distribution of fat and functions.		
MODULE 4:	Nervous system and Histology of Organs	10 Hrs

Nervous system: Classification of nervous system, Cell in the nervous system, Structure of a neuron, Structure of a typical spinal nerve. Anatomy of human brain and functions.

Histology of organs: Tongue, Stomach, Liver and Kidney, and Brain

MODULE 5:	Anatomical Diseases

	5 Hrs

	Introduction to systemic diseases- Heart diseases, Hemostasis and Thrombosis, Stroke, Diabetes mellitus, Multiple sclerosis; Organ damage and cell death: Organ damage, mechanism of Apoptosis, autophagy and necrosis

TEXT BOOKS/REFERENCES

	1. BD Chaurasia's Human , 8th Edition, 2019. 2. Anatomy & Physiology For Dummies, Erin O'dya, 2002 3. Paramedical Hand Book on Anatomy, Physiology and Biochemistry, P Arun Jyoti, Arya Bhushan, Venugopal, , 2nd Edition, 2016. 4. Human Anatomy and Physiology, Rahul Phate, 2008, 5. Medical Immunology made memorable, 2nd Ed., John H. L. Playfair and P.M. Lydyard, Churchill Livingstone Publications, 2000. 6. Anatomy Histology and Cell Biology by Klein, 4th Edition, 2010.

**B.Sc. – BIOCHEMISTRY (Minor) SYLLABUS
SEMESTER – IV**

SEMESTER	IV					
YEAR	II					
COURSE CODE	23BY2404					
TITLE OF THE COURSE	METABOLISM AND BIOENERGETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To introduce the students to the fundamentals of Metabolism and Bio-energetics. - To create an understanding of structural and functional defects associated with metabolic pathways.	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
C01	Students should identify the various rate determining steps in metabolism.	L1
C02	Students should be able to interconnect and compare the carbohydrate and lipid metabolic pathway	L2
C03	Students should be able to comprehend the basic concepts of Bioenergetics	L3

COURSE CONTENT:		
MODULE 1:	Carbohydrate Metabolism	9 Hrs
Introduction to metabolism. Glycolytic pathway; aerobic and anaerobic fates of pyruvate, Pyruvate dehydrogenase complex, TCA cycle. Cori cycle. Regulation of blood glucose level by organs and hormones. Diabetes mellitus- classification, biochemical and clinical changes associated with DM, diagnosis (HbA1c) and Management.		
MODULE 2:	Lipid Metabolism	9 Hrs
Basic scheme of fat absorption, synthesis and Mobililization; Degradation of triacylglycerol and phospholipids - lipases and phospholipases. Fatty acid oxidation by β -oxidation. Fatty acid biosynthesis - FAS- multi functional enzyme. Cholesterol structure and its biosynthesis from acetyl CoA, Utilization of cholesterol for biosynthesis of hormones and bile salts.		
MODULE 3:	Amino acid Metabolism	9 Hrs
General metabolic reaction of amino acids– transamination, deamination, oxidative and nonoxidative deamination, glucose – alanine cycle. Urea cycle– regulation and metabolic disorders.		

Outline of Biosynthesis and catabolism of amino acids.

MODULE 4:	Nucleotide Metabolism	9 Hrs

Structure of nucleoside and nucleotide; Synthesis of purine and pyrimidine nucleotides – the de novo and the salvage pathway. Degradation of purine and pyrimidines.

MODULE 5:	Bioenergetics	9 Hrs

Mitochondrial electron transfer system- Sequence and structure of electron carriers. Proton motive force and the Mitchell hypothesis. F_0F_1 -ATPase- structure and mechanism, Coupling of electron transfer to ATP synthesis. Mechanism of oxidative phosphorylation. Uncouplers, inhibitors and ionophores.

TEXT BOOKS/REFERENCES:

- | |
|---|
| <ol style="list-style-type: none">1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed.2. Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed.3. Biochemistry – Voet and Voet. Wiley & Sons 2011, 4th Ed4. Textbook of Biochemistry with clinical correlations - Devlin, John Wiley & Sons, 7th Ed, 2010.5. Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and Lubert Stryer, W H Freeman and Co. (2006).6. Harpers Illustrated Biochemistry; 30th Ed. V.W. Rodwell , D. Bender , K.M. Botham , P. J. Kennelly, P. A. Weil (2015). |
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SEMESTER	IV					
YEAR	II					
COURSE CODE	23BY2404					
TITLE OF THE COURSE	BIOCHEMISTRY IN HEALTH AND DISEASE					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To introduce the students to the fun - To create an understanding of structural and functional defects associated with metabolic pathways.	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students should identify the various rate determining steps in metabolism.	L1
CO2	Students should be able to interconnect and compare the carbohydrate and lipid metabolic pathway	L2
CO3	Students should be able to comprehend the basic concepts of Bioenergetics	L3

COURSE CONTENT:		
MODULE 1:	Introduction to health, Disease and classification of Diseases	9 Hrs
Health and hygiene, General health care, Factors affecting health, Indices and evaluation of health, International Classification of Diseases (ICD), Disease patterns in developed and developing world; Classification of diseases - Endemic, Epidemic, Pandemic; Professional health hazards. Disease conditions: Acute disease, Chronic disease, Incurable disease, Terminal disease, Illness, disorders, Syndrome, Pre-disease.		
MODULE 2:	Diseases due to unhealthy, Sedentary Life style and Obesity	9 Hrs
Definition of a Healthy lifestyle; factors affecting lifestyle in the present society and their impact on health: Consumption of junk food, smoking, drinking, stress and lack of exercise; Sedentary lifestyle: Influence on the psychology of youth; Steps taken to adopt a stress-free and healthy lifestyle; Obesity: Biochemistry of obesity, consequences and Management of obesity.		
MODULE 3:	Diabetes	9 Hrs
Regulation of blood glucose level by organs and hormones; hypoglycemia and hyperglycemia; Diabetes mellitus – causes, classification, biochemical and clinical changes associated with DM. Diagnosis: traditional methods, hexokinase method, glycated hemoglobin test (A1-C test), Glucose tolerance test curves; management of DM by medication, exercise and meal planning.		

MODULE 4:	Biochemistry of Cardiovascular diseases	9 Hrs
Atherosclerosis, causes, symptoms, diagnosis and treatment; role of atherosclerosis leading to myocardial infarction; role of hypercholesterolemia in CVDs; Management of cardiovascular disease: medication, diet and lifestyle management.		
MODULE 5:	Metabolic disorders	9 Hrs
Study of Sickle cell anemia: structure of hemoglobin, genetic causes, molecular basis for formation of sickled hemoglobin and management of sickle cell anemia; Alkaptonuria and Phenylketonuria: genetic and biochemical basis, management; Cancer: cell biological, biochemical and genetic basis, cancer micro-environment and management of cancer.		

TEXT BOOKS/REFERENCES:	
1) Harrison, J. E., Weber, S., Jakob, R., and Chute, G. C. (2021) 2) Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed. 3) Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed. 4) Biochemistry – Voet and Voet. Wiley & Sons 2011, 4th Ed 5) Textbook of Biochemistry with clinical correlations - Devlin, John Wiley & Sons, 7th Ed, 2010. 6) Biochemistry of Foods - N A Michael Eskin, Fereidoon Shahidi. 3rd edition, Elsevier, 2012. 7) Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and Lubert Stryer, W H Freeman and Co. (2006). 8) Harpers Illustrated Biochemistry; 30th Ed. V.W. Rodwell , D. Bender , K.M. Botham , P. J. Kennelly, P. A. Weil (2015). 9) Functional Biochemistry in Health and Disease: Eric A. Newsholme and Tony R. Leech (2010), Wiley Blackwell Publishers	

**B.Sc. – BIOTCHNOLOGY (Major) SYLLABUS
SEMESTER – IV**

SEMESTER	IV					
YEAR	II					
COURSE CODE	23BT2401					
TITLE OF THE COURSE	RECOMBINANT DNA TECHNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	4	-	60	4

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	II	22BS1202	Basics Genetics
	III	22BS2302	Molecular Biology

COURSE OBJECTIVES:	
- To understand the concepts of genetic engineering including the tools, techniques, protocols and applications. - To have knowledge on how to design recombinant molecules using different vectors specific for a particular species and understand the concept of protein expression. - To be able to learn the applications of rDNA technology and apply the knowledge to their future research.	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Student will gain fundamental knowledge about the tools and strategies used in genetic engineering.	L2
CO2	Students will be able to design, screen, isolate, amplify DNA and also learn the concept of protein expression and apply the knowledge in problem solving and in practice	L3
CO3	The students will understand the applications of rDNA technology from academic and industrial perspective.	L4

COURSE CONTENT:		
MODULE 1:	Introduction and Basic Concepts	12 Hrs
Introduction: Overview of major steps involved in genetic engineering. Molecular Tools: Restriction endonucleases: types and characteristic features; modification of cut ends. DNA ligases, Alkaline phosphatase, Polynucleotide kinase, DNase I, DNA polymerase and Klenow fragment, Terminal nucleotidyl transferase, RNA dependent DNA Polymerase. Basic principles of gene editing – CRISPR/CAS9.		
MODULE 2:	Vectors and Gene transfer	12 Hrs
Properties of an ideal vector. Cloning vectors: Prokaryotic vectors (pBR322; pUC18; Lambda phage, Cosmids). Eukaryotic vectors: YAC vector, Shuttle vector, Plant Vectors – (Ti Plasmid-Binary and Co integrated vectors); Animal Vectors: SV 40, retroviral vectors. Expression vectors in Prokaryotes and Eukaryotes – Basic features and role of promoters, terminator and RBS. Methods of Gene transfer: Transformation, Transfection, Microinjection, Electroporation, Microprojectile, Liposome Fusion		

MODULE 3:	Selection of Recombinants	12 Hrs
Isolation of the desired gene: cDNA library, Genomic library. Selection and screening of recombinants: Identification and selection of transformed cells: Direct methods - Insertional inactivation, Visual screening method, Plaque formation, Complementation of mutation/nutrition Indirect methods - Colony hybridization, Immunochemical detection. Use of selectable and scorable genes: Selectable genes: Plants-npt; Animals-TK. Scorable genes: Plants-Gus; Animals-GFP/RFP.		
MODULE 4:	rDNA TECHNIQUES and Applications	12 Hrs
Techniques: Gel Electrophoresis, Hybridization – Southern, Northern, Western, Sanger’s di-deoxy DNA Sequencing, PCR and its types (Real Time PCR and Multiplex PCR), Basics of New Generation Sequencing.		
MODULE 5:	Applications of Recombinant DNA Technology	12 Hrs
Applications: Production of Insulin, Recombinant Vaccines, hGH, Transgenic animals: Mouse (Knock-out; Methodology, applications); A brief account of Transgenic Sheep, Poultry, Fish, Cow, with value added attributes. Transgenic Plants: Resistance to diseases, Pathogens and insects (Bt gene transfer); Nif gene and its role.		

TEXT BOOKS/REFERENCES	
1. Principles of Gene Manipulation - S. B. Primrose, R. M. Twyman and R.W.Old. 6th Edition, S.B.University Press, 2001. 2. Molecular Cloning: A Laboratory Manual - J. Sambrook and D.W. Russel, Vols 1-3, CSHL, 2001. 3. Genomes - Brown TA, 3rd ed. Garland Science, 2006 4. Molecular Biotechnology - Glick and Pasternak, 2nd Ed, ASM press, Washington DC, 1998 5. Elements of Biotechnology - Gupta PK, 2nd Ed, Rastogi publication, Merrut, 2003. 6. Principles of Gene Manipulation - Primrose, Twyman and Old, 6th Ed, Blackwell Science Ltd, 2002. 7. Gene Cloning and DNA analysis - Brown TA. 6th edition, Wiley-Blackwell Publication, 2013. 8. Molecular Biology and Genetic Engg - Singh BD, Kalyani Publishers, 2005. 9. Satyanarayana U, Biotechnology, Books and Allied Ltd, 2008 10. Recombinant DNA: Genes and Genomes - Watson, Caudy, Myers Wilkowsky. 3rd Ed, WH Freeman, 2007.	

GENETIC ENGINEERING - PRACTICALS
1) PCR amplification and analysis by agarose gel electrophoresis. 2) Preparation of plasmid DNA from <i>E. coli</i>. 3) Restriction digestion and Ligation 4) Preparation of competent cells and transformation. 5) Restriction mapping problems.

REFERENCES
1) Principles of Gene Manipulation - S. B. Primrose, R. M. Twyman and R.W.Old. 6thEdition, S.B.University Press, 2001. 2) Molecular Cloning: A Laboratory Manual - J. Sambrook and D.W. Russel, Vols 1-3,CSHL, 2001. 3) Genomes - Brown TA, 3rd ed. Garland Science, 2006

SEMESTER	IV					
YEAR	II					
COURSE CODE	23BT2401					
TITLE OF THE COURSE	IMMUNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	4	-	60	4

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	22BS1101	Essentials of biochemistry

COURSE OBJECTIVES:	
- Students will be able to understand the role of different cells and organs of immune system. - Students will be able to understand the significance of immune system and immunotherapy in treating diseases	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Student would be acquainted with the basic understanding of immune system as a whole and	L2
CO2	Student would gain fundamental knowledge about the consequences of immune system failure	L3
CO3	Student would be able to demonstrate the significance of immunology diagnosis and therapeutics of the diseases and interpret the diagnostic data in correlation with the patho-physiology	L4

COURSE CONTENT:		
MODULE 1:	Introduction and Basic concepts in immunology	12 Hrs
Introduction: Basic concepts in immunology, role of immune system, principles of innate and adaptive immunity. Innate immunity: Different lines and layers of defence, secretions: skin, lysozyme, pH, mucous. Pattern recognition in innate immune system, the complement system: activation through classical, alternate and lectin pathway, Induced innate immune responses to infections. Functions of natural killers, monocytes, macrophages, eosinophils, neutrophils and basophils.		
MODULE 2:	Antigen-Antibody interactions	12 Hrs
Antigen recognition by B-cells: Clonal selection, effector and memory cells, Antibody types, structure, functions, isotypes, allotype, idiotype, Interaction between the antibody and specific antigen, epitope, paratope, affinity, avidity, radio-equilibrium dialysis study, Diversity of Immunoglobulins. Antigen recognition by T cells: TH, TC and TReg cells, T-specific markers, TCR, MHC, Types, functions, gene structure, receptor structure, antigen processing and presentation, exogenous and endogenous antigen.		

MODULE 3:	Lymphocyte development and inflammation	12 Hrs
Development and survival of lymphocytes: Lymphocytes in bone marrow and thymus, positive and negative selection of lymphocytes, survival and maturation of lymphocytes, self/non self-recognition. Transplantation and Network theory: Transplant rejection, immunosuppressants. Immuno-surveillance, idiotypes and immune network theory.		
MODULE 4:	Pathoimmunology	12 Hrs
Pathoimmunology: Effector mechanisms in allergic reactions and IgE, hypersensitivity diseases; Autoimmune diseases- Rheumatoid arthritis, multiple sclerosis.		
MODULE 5:	Immunotechniques	12 Hrs
Immuno-techniques: Generation of monoclonal antibodies, Immuno-diffusion techniques, RIA, ELISA. Immuno-electrophoresis, Immuno-staining techniques, Immuno-florescence and flow cytometry		

TEXT BOOKS/REFERENCES
1) Cellular and Molecular Immunology - Abbas and Lichtman. 7th Edn., Saunders Publishers, 2011. 2) Immunology - Golsby, Kindt, Osborne and Kuby. 5th Edn, Freeman Publishers, 2003. 3) Roitt's Essential Immunology, Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, 12th Edn., Wiley-Blackwell, 2011. 4) Medical Immunology made memorable, 2nd Ed., John H. L. Play fair and P.M. Lydyard, Churchill Livingstone Publications, 2000. 5) Textbook of Immunology – Sai Leela K, Mohanty S K, Veerendra Reddy P. Jaypee Publishers, 2007. 6) Cell and Molecular Biology: Concepts and Experiments - Karp. 7th Ed., Wiley & Sons 2013. 7) Molecular Cell Biology - Harvey Lodish, David Baltimore and Arnold Berk, 3rd Ed., Scientific American Publishers, 1995.

IMMUNOLOGY-PRACTICALS
1) Serum Separation from whole blood and isolation of immunoglobulins from serum. 2) Study of different cells in whole blood using Giemsa/Leishman stain. 3) Blood grouping 4) ELISA/Dot ELISA 5) Radial Immunodiffusion/Ouchterlony Double Diffusion 6) Rocket Immuno Electrophoresis 7) WIDAL/RPR Test

REFERENCES
1. Essential Immunology - Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt. 12th edition, ELBS, Blackwell Scientific Publishers, London, 2011. 2. Fundamentals in Immunology - William E Paul. 7th edition, Raven Press, 2012. 3. Immunology - Kuby J, Judy Owen, Jenni Punt, Sharon Stranford. 7th Edition. W.H. Freeman and Company, 2013.

SEMESTER	IV					
YEAR	II					
COURSE CODE	23BT2403					
TITLE OF THE COURSE	FOOD TECHNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To comprehend basic concepts of food sciences and properties of foods, and the factors (chemical and enzymatic) affecting these properties. - To equip the students with fundamentals of food processing and preservation. - To provide understanding on emerging concepts in food technology	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Student will be able to explain the basic concepts of food sciences and properties of foods, and the chemical and enzymatic factors affecting these properties.	L1
CO2	Students will be able to comprehend different food standards for various categories of foods.	L2
CO3	Students will be able to understand different analytical techniques employed across various categories of foods	L3
CO4	Students will be able to determine the fundamentals of food processing and preservation	L2

COURSE CONTENT:		
MODULE 1:	Introduction to Food Science and Technology	9 Hrs
Basics of chemistry of food constituents- carbohydrates, proteins, lipids, vitamins, minerals, water (different forms of water present in foods and their effect on quality and preservation of foods), minor constituents affecting texture, colour, taste, odour; Food microbiology, Food biochemistry, Food additives, General food composition and effect of food constituents on food quality.		
MODULE 2:	Food Analysis	9 Hrs
Food adulterations, standards of identity, purity and methodology for analysis of a) Cereals, legumes, oil seeds and their products; b) Fruits, vegetables, tubers, and their products; c) Tea, coffee, cocoa, chocolate, spices, sugar, condiments; d) Milk and milk products; e) Meat, fish and poultry products; f) Miscellaneous foods e.g., fermented products.		
MODULE 3:	Food Processing and Preservation	9 Hrs
Food processing: Introduction to food processing of various foods including dairy, bakery,		

brewing, fruit and vegetable products, plantation products, oilseeds, meat, fish, poultry; pro and prebiotics and nutraceuticals.

Food preservation: Principles of food preservation by dehydration, thermal treatments like pasteurization, sterilization, canning, retorting etc., low temperature i.e., chilling and freezing, chemical preservation/ bio-preservation, traditional methods like salting/ syruping, pickling, fermentation etc., non- thermal processes like MAP, irradiation, high pressure processing etc., and hurdle technology.

MODULE 4:	Enzymes Used in Food Industry	9 Hrs

Enzymes: Enzymes used in food industry, recovery of enzymes from natural sources, cheese making and whey processing, enzymatic processing of fruit juices. Role of enzymes in baking, meat and meat processing; comparative methods of toxicity test in (novel) foods; biosensors; enzymatic approach to tailor made fats; catabolic processes and oxygen-dependent reactions in food; use of lipases and reactions in organic solvents and two phases.

MODULE 5:	Genetically Modified Foods	9 Hrs

Genetically modified foods: Need for GM foods, Potential benefits in agriculture, Crop engineered for input and output traits, nutritional improvement, animal foods, issues of concern, tests for detecting GM foods, safety of GM foods.

TEXT BOOKS/REFERENCES:

- 1) Lee BH. 2014. Fundamentals of Food Biotechnology. John Wiley and sons
- 2) Lloyd RA, Pentzer WT. 2017. Handling transportation and storage of fruits and vegetables, Medtech scientific international PVT LTD (Vol 1 & 2).
- 3) Potter NN, Hotchkiss JH. 1995. Food Science, 5th Ed. Springer US
- 4) Manay NS, Shadaksharaswami M. 2004. Foods: Facts and Principles, 4th Ed. New Age Publishers.
- 5) Srilakshmi B. 2002. Food Science. New Age Publishers.
- 6) Meyer LM. 2004. Food Chemistry. New Age Publishers.
- 7) Deman JM. 1990. Principles of Food Chemistry, 2nd Ed. Van Nostrand Reinhold, NewYork.
- 8) Ramaswamy H and Marcott M. 2005. Food Processing Principles and Applications. CRC Press.

**B.Sc. – BIOTECHNOLOGY (Minor) SYLLABUS
SEMESTER – IV**

SEMESTER	IV					
YEAR	II					
COURSE CODE	23BT2404					
TITLE OF THE COURSE	NANOBIOTECHNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
• To provide basic understanding on nanomaterials • To give knowledge on the basic components of nanotechnology • To aware the student with various important applications of nanobiotechnology. • To understand the properties, preparation and characterization of nanomaterials. • To provide scientific application of nanomaterials and nanotechnology in health and agriculture	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to understand the different types of nanomaterials	L1
CO2	Students will be able to analyse the applications of nanomaterials in biotechnology	L2
CO3	Students will be able to apply nanobiotechnology in health and agriculture	L3

COURSE CONTENT:		
MODULE 1:	Introduction to Nanomaterials	9 Hrs
Introduction to nanomaterials - Various types of nanomaterials - Three-dimensional, two-dimensional, - one-dimensional and zero-dimensional nanomaterials. Carbon nanotubes, Graphene, Carbon dots, metal nanoparticles, metal oxide-based nanomaterials, semiconductor nanomaterials, hybrid nanoparticles.		
MODULE 2:	Synthesis of Nanomaterials	9 Hrs
Preparation and Characterization of nanomaterials: "Top-Down" and "Bottom-Up" approaches of nanomaterials. Combination of Top-Down and Bottom-up techniques: current state-of-the-art.		
MODULE 3:	Role of Nanomaterials in Biotechnology	9 Hrs
Nanomaterials in biotechnology - nanoparticles, nanoclusters, quantum dots, nanotubes and nanowires etc. Miniaturized devices in nanobiotechnology - types and applications, lab on a chip		

concept, Biosensors – nanobiosensors.

MODULE 4:	Nanobiotechnology in Health Care

9 Hrs

Nanobiotechnology in health care - Role of nanobiotechnology in the area of infectious & non-infectious diseases - Nano pharmaceuticals - Diagnosis, sensors and biosensors - Delivery vehicles, biomedical applications of nanomaterials.

MODULE 5:	Nanobiotechnology in Agriculture

9 Hrs

Nanobiotechnology for Agriculture: Nanotechnology based tools to enhance agricultural productivity - Nanobased Agri and Food Products, food preservation and toxicity - Nanopesticides and Nanofertilizers.

TEXT BOOKS/REFERENCES:

- | |
|---|
| <ol style="list-style-type: none">1) G. Cao - Nanostructures and Nanomaterials - Synthesis, Properties and Applications, Imperial College Press, 2004.2) Challa Kumar (Ed) – Biological and Pharmaceutical Nanomaterials, Wiley – VCH Verlag, Weinheim, 2006.3) Ralph S. Greco, Fritz B. Prinz and R. Lane Smith (Eds) - Nanoscale Technology in Biological Systems, CRC Press, 2005. |
|---|

SEMESTER	IV					
YEAR	II					
COURSE CODE	23BT2405					
TITLE OF THE COURSE	PLANT AND ANIMAL TISSUE CULTURE					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To provide basic understanding on plant and animal cell culture. - To give knowledge on plants and animals tissue culture techniques. - To make the students aware with various important applications of plant and animal tissue culture.	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will gain knowledge about the basic requirements of plant and animal cell culture.	L1
CO2	Students will be able to illustrate the various cell culture techniques in plant and animal tissue culture.	L2
CO3	Students will be able to apply the technical skills for plant and animal tissue culture.	L3

COURSE CONTENT:		
MODULE 1:	Introduction to Plant Tissue Culture	9 Hrs
History of plant tissue culture research - basic principles of plant tissue callus culture, meristem culture, organ culture, Totipotency of cells, differentiation and dedifferentiation.		
MODULE 2:	Introduction to Animal Tissue Culture	9 Hrs
Introduction to animal tissue culture - Types of culture media (natural and chemically defined). Importance of serum in the media. Methods of sterilization, Detection of contaminants.		
MODULE 3:	Plant Tissue Culture Techniques	9 Hrs
Methodology - sterilization (physical and chemical methods), culture media, Murashige and Skoog's (MS medium), phytohormones, medium for micro-propagation/clonal propagation of ornamental and horticulturally important plants. Callus subculture maintenance, growth measurements, morphogenesis in callus culture – organogenesis, somatic embryogenesis.		
MODULE 4:	Animal Tissue Culture Techniques	9 Hrs
Stem cells – Adult, Embryonic, Induced pluripotent stem cells. Isolation and characterization of adult stem cells. Primary Cell Culture: Isolation techniques (explant method, mechanical,		

enzymatic). Secondary Cell Culture: Transformed and continuous cell lines (Hela).		
MODULE 5:	Applications of Plant and Animal Tissue Culture	9 Hrs
Applications of Plants in crop improvement, herbicide resistance, insect resistance, virus resistance. Pharmaceutical products produced by mammalian cells (plasminogen activator, erythropoietin, interleukins, interferons), Livestock pharming products. Cell culture-based vaccines.		

TEXT BOOKS/REFERENCES:	
1) Freshney R Ian. 2010. Culture of Animal Cells, 6th Ed, Wiley-Blackwell. 2) John Davis. 2011. Animal Cell Culture Essential Methods, Wiley & Sons. 3) Satyanarayana U. 2008. Biotechnology, Books and Allied Ltd. 4) Glick BR, Pasternak JJ, Patten CL. 2010. Molecular Biotechnology, 4th Ed. American Society for Microbiology.	

**B.Sc. – GENETICS (Major) SYLLABUS
SEMESTER – IV**

SEMESTER	IV					
YEAR	II					
COURSE CODE	23GN2401					
TITLE OF THE COURSE	ANIMAL AND PLANT GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	4	-	4	-	60	4

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To understand the fundamental principles of animal genetics and their application in animal breeding programs. - To evaluate breeding objectives and strategies for different animal production systems, considering both traditional and modern approaches - To analyze advancements in animal and plant genetics, including molecular techniques and reproductive technologies, and their impact on animal and plant breeding.	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to apply Mendelian principles of inheritance to predict patterns of inheritance and perform pedigree analysis in animal breeding contexts.	L1
CO2	Students will demonstrate knowledge of marker-assisted selection (MAS) and genomic selection methods and their application in animal breeding through case study analysis.	L2
CO3	Students will gain an understanding of the genetic variation in plants, breeding methods, and advancements in plant genetics, including molecular techniques and crop improvement strategies.	L3

COURSE CONTENT:		
MODULE 1:	Fundamentals of Animal Genetics	12 Hrs
Introduction to Animal Genetics: Definition, scope, and importance of animal genetics. Historical developments and key contributors. Basic genetic concepts relevant to animal breeding. Mendelian Inheritance in Animals: Mendel's laws of inheritance and their application in animals. Patterns of inheritance: dominance, segregation, and independent assortment. Pedigree analysis and its significance in animal breeding. Marker-Assisted Selection and Genomic Selection: Use of molecular markers for trait mapping and selection. Introduction to genomic selection and its advantages. Case studies of successful genomic selection programs in animal breeding.		
MODULE 2:	Animal Genetics in Breeding And Reproduction	12 Hrs

Breeding Objectives and Strategies: Defining breeding objectives for different animal production systems. Strategies for balanced selection of multiple traits. Considerations for optimizing breeding goals.

Breeding Programs and Genetic Evaluation: Design and implementation of breeding programs. Genetic evaluation methods: BLUP, GEBVs, and genetic trends. Challenges in incorporating molecular and genomic information.

Reproductive Technologies in Animal Breeding: Artificial insemination, embryo transfer, and in vitro fertilization. Cloning, its applications, and ethical considerations. Challenges and opportunities in using reproductive technologies.

MODULE 3:	Introduction to Plant Genetics	12 Hrs

Overview of Plant Genetics: Definition, Scope, and Significance,

Genetic Variation in Plants: Types of Genetic Variation: SNP, CNV, Inversion, Deletion, Insertion, Mechanisms of Mutation: Spontaneous vs. Induced Mutations, Impact of Mutation on Plant Traits: Phenotypic Variation.

Genetic Transfer and Plant Breeding: Plant Breeding Methods: Traditional vs. Modern Approaches, Genetic Improvement of Crop Plants: Hybridization, Selection, and Mutagenesis, Marker-Assisted Selection (MAS) in Plant Breeding Programs

MODULE 4:	Molecular Plant Genetics and Crop Improvement	12 Hrs

Gene Expression and Regulation in Plants: Functional Genomics Approaches: Transcriptomics, Proteomics, Metabolic Pathways and Regulatory Networks in Plants.

Plant Genetics in Crop Improvement: Genomics-Assisted Breeding: Genomic Selection, Marker-Assisted Breeding, Genetic Engineering for Crop Traits: Disease Resistance, Yield Improvement, Challenges and Future Directions in Plant Genetics Research.

MODULE 5:	Advancements in Animal and Plant Genetics	12 Hrs

Advancements in Animal Genetics: Epigenetics and its role in animal breeding, Genome editing techniques in livestock improvement, Genetic engineering in animal agriculture, Ethical issues in animal breeding and genetic manipulation.

Advancements in Plant Genetics: Engineering plant metabolic pathways for enhanced traits. Biofortification and production of value-added compounds. Principles of synthetic biology and its applications in plants. Potential benefits and risks of genetically modified organisms (GMOs).

TEXT BOOKS/REFERENCES

- 1) Falconer, D. S., & Mackay, T. F. (1996). Introduction to quantitative genetics. Pearson Education.
- 2) Lynch, M., & Walsh, B. (1998). Genetics and analysis of quantitative traits. Sinauer Associates.
- 3) Hayes, B. J., & Goddard, M. E. (2001). Prediction of total genetic value using genome-wide dense marker maps. *Genetics*, 157(4), 1819-1829.
- 4) Van Eenennaam, A. L., & Young, A. E. (2014). Prevalence and impacts of genetically engineered feedstuffs on livestock populations. *Journal of Animal Science*, 92(10), 4255-4278.
- 5) Cole, J. B., VanRaden, P. M., O'Connell, J. R., Van Tassell, C. P., Sonstegard, T. S., Schnabel, R. D., ... & Null, D. J. (2009). Distribution and location of genetic effects for dairy traits. *Journal of Dairy Science*, 92(6), 2931-2946.
- 6) Acquaah, G. (2012). Principles of plant genetics and breeding. John Wiley & Sons.
- 7) Schnable, P. S., Ware, D., Fulton, R. S., Stein, J. C., Wei, F., Pasternak, S., ... & Nascimento, L. U. (2009). The B73 maize genome: complexity, diversity, and dynamics. *Science*, 326(5956), 1112-1115.

- 8) Varshney, R. K., Ribaut, J. M., Buckler, E. S., Tuberosa, R., Rafalski, J. A., & Langridge, P. (2012). Can genomics boost productivity of orphan crops? *Nature biotechnology*, 30(12), 1172-1176.
- 9) Edwards, D., Batley, J., & Snowdon, R. J. (2013). Accessing complex crop genomes with next-generation sequencing. *Theoretical and applied genetics*, 126(1), 1-11.
- 10) Zhang, X., & Huang, C. (2013). Advances in molecular marker techniques for plant breeding. *Journal of Integrative Plant Biology*, 55(11), 1064-1070.

ANIMAL AND PLANT GENETICS - PRACTICALS

- 1) **Pedigree Analysis in Animal Breeding:** Construct pedigrees for a selected population of animals and analyze patterns of inheritance for specific traits.
- 2) **All Marker-Assisted Selection (MAS):** Perform MAS using molecular markers to select animals with desirable traits.
- 3) **Genomic Selection:** Use genomic data to predict genetic values and evaluate the effectiveness of genomic selection in animal breeding.
- 4) **Identification of Genetic Variation in Plants:** Analyze DNA samples from different plant varieties using molecular markers (e.g., SNP analysis) to identify genetic variations.
- 5) **Marker-Assisted Selection (MAS) in Plant Breeding:** Apply MAS techniques to select plants with desired traits based on molecular marker information.
- 6) **Gene Expression Analysis in Plants:** Transcriptomic analysis to study gene expression patterns in response to different environmental conditions or treatments.
- 7) **Simulat Genetic Engineering for Crop Improvement:** Introduce foreign genes into plant cells using genetic engineering techniques (e.g., Agrobacterium-mediated transformation) to confer desirable traits such as disease resistance or increased yield.

REFERENCES

1. Lynch, M., & Walsh, B. (1998). *Genetics and analysis of quantitative traits*. Sinauer Associates.
2. Van Eenennaam, A. L., & Young, A. E. (2014). Prevalence and impacts of genetically engineered feedstuffs on livestock populations. *Journal of Animal Science*, 92(10), 4255-4278.
3. Hayes, B. J., & Goddard, M. E. (2001). Prediction of total genetic value using genome-wide dense marker maps. *Genetics*, 157(4), 1819-1829.
4. Schnable, P. S., Ware, D., Fulton, R. S., Stein, J. C., Wei, F., Pasternak, S., ... & Nascimento, L. U. (2009). The B73 maize genome: complexity, diversity, and dynamics. *Science*, 326(5956), 1112-1115.
5. Zhang, X., & Huang, C. (2013). Advances in molecular marker techniques for plant breeding. *Journal of Integrative Plant Biology*, 55(11), 1064-1070.
6. Edwards, D., Batley, J., & Snowdon, R. J. (2013). Accessing complex crop genomes with next-generation sequencing. *Theoretical and applied genetics*, 126(1), 1-11.
7. Varshney, R. K., Ribaut, J. M., Buckler, E. S., Tuberosa, R., Rafalski, J. A., & Langridge, P. (2012). Can genomics boost productivity of orphan crops? *Nature biotechnology*, 30(12), 1172-1176.

SEMESTER	IV					
YEAR	II					
COURSE CODE	22GN2402					
TITLE OF THE COURSE	POPULATION GENETICS AND QUANTITATIVE GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	4	-	4	-	60	4

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
To help students understand the forces that have an impact on levels of genetic variations in natural and/or experimental populations for both qualitative and quantitative traits.	
To familiarize students with the principles and applications of different statistical methods used in biological research.	
To impart knowledge about detecting variations at the genetic level.	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will get in basic knowledge about population genetics and association mapping.	L1
CO2	Enable to obtain in depth knowledge about the principles and applications of various statistical tools used in research.	L2
CO3	Students will learn about the basic principles involved in variations at a genetic level.	L3
CO4	Students will be equipped with functional knowledge about identification of diseased gene/locus for various diseases.	L2

COURSE CONTENT:		
MODULE 1:	Introduction and Historical Background	12 Hrs
Gene pool, allele frequency, genotype frequency, Historical development and significance. Genetic drift: definition, types, and effects, Gene flow: impact on genetic diversity. Mutation: role in generating genetic variation. Natural selection: mechanisms and outcomes. Polygenic traits vs. Mendelian traits. Heritability and its estimation. Phenotypic variation: genetic vs. environmental components. Multiple factor hypothesis, Qualitative and quantitative characters; Components of variation- Phenotypic, Genotypic; Nature of gene action- additive, dominance and epistatic, linkage effect; Principles of analysis of variance and linear model, Expected variance components, Random and fixed effect model, Comparison of means and variances for significance.		
MODULE 2:	Analyses for GxE Interactions	12 Hrs
Designs for plant breeding experiments- principles and applications; Variability parameters, the concept of selection; Association analysis- Genotypic and phenotypic correlation; Path analysis;		

Discriminate function and principal component analysis, Genetic divergence analysis- Metroglyph and D2; Generation mean analysis; Parent progeny regression analysis; Mating designs- classification, $G \times E$ interaction-Adaptability and stability

MODULE 3: Genetic Variation and Stability Analysis

12 Hrs

DNA sequence variation: SNPs, indels, and CNVs, Molecular markers in population genetics (microsatellites, SNPs). Applications of molecular markers in studying genetic diversity. Population subdivision and its causes. F_{ST} and related indices for measuring genetic differentiation. Genetic structure analysis: clustering methods, Principal Component Analysis (PCA). Molecular clocks and their applications. Molecular phylogenetics and constructing phylogenetic trees. QTL mapping, Strategies for QTL mapping- Desired population and statistical methods, QTL mapping in genetic analysis; Marker-assisted selection

MODULE 4: Variability Parameters

12 Hrs

Genotypic and phenotypic correlation analysis and interpretation; Path coefficient analysis and interpretation; Estimation of different types of heterosis, inbreeding depression and interpretation; A, B, and C Scaling test; $L \times T$ analysis and interpretation; QTL analysis; Use of computer packages; Diallel analysis.

MODULE 5: Inheritance of Complex Traits

12 Hrs

Tag markers and Haplotypes, Linkage disequilibrium, Fixation index; Quantitative Genetic analysis; Broad-Sense Heritability and Narrow-Sense Heritability. Testing gene mutations for alleles: complementation test, intragenic complementation Genotypes & phenotypes: Effect of the environment on phenotype development, Penetrance and expressivity, Visible, sterile and lethal mutations, Gene interactions and modifying genes, Pleiotropy.

TEXT BOOKS/REFERENCES

1. Hamilton M.B. (2009). Population Genetics. Wiley-Blackwell, UK.
2. Hedrick P.W.(2011). Genetics of Populations. Jones and Bartlett Publishers, Massachusetts.
3. Jobling, M., Hollox, E., Hurles, M., Kivisild, T. and Tyler-Smith, C. (2013). Human Evolutionary Genetics. Garland Science.
4. Nielsen, R. and Slatkin, M. (2013). An Introduction to Population Genetics: Theory and Applications. Sinauer Associates, Inc.
5. Relethford, J.H. (2012). Human Population Genetics. John Wiley & Sons.
6. Snusted, D.P., Simmons, M. J. (2010). Principles of Genetics. John Wiley & Sons, New York.
7. Knight, J.C. (2009). Human Genetic Diversity –Functional consequences for Health and Disease. Oxford University Press, USA.

POPULATION GENETICS AND QUANTITATIVE GENETICS - PRACTICALS

1. Hardy-Weinberg problems:
 - a. Gene and Genotype frequency
 - b. HW for multiple alleles
 - c. Disease risk prediction
 - d. chi square analysis
 - e. Genetic drift
 - f. Effective population size

- g. Mutation rate
- 2. Problems on inbreeding coefficients
- 3. Problems on polygenic inheritance
- 4. Problems on heritability
- 5. Phylogenetic tree construction
- 6. Probability of disease inheritance using pedigree construction

REFERENCES

- 1) DNA markers Protocols, applications and overviews Anolles G. C. & Gresshoff P. M. Wiley-Liss
- 2) Molecular markers in Plant Genetics and Biotechnology Vienne De. D. Science Publishers
- 3) Genetics of Population Hedrick P.W. Jones & Bartlett
- 4) Principle of Population Genetics Hartl D. L. and Clark A.G. Sinauer Associates
- 5) Biostatistics Danial, W. W Wiley
- 6) Statistical methods in Biology Bailey, N.T.J Cambridge Univ. Press

SCHEME & SYLLABUS - SCHOOL OF BASIC & APPLIED SCIENCES, DSU

SEMESTER	IV					
YEAR	II					
COURSE CODE	23GN2403					
TITLE OF THE COURSE	TRANSMISSION GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To provide students with a solid foundation in microbial genetics, covering DNA structure, replication, transcription, translation, and gene regulation. - To introduce students to the concepts of mutation, mutagenesis, horizontal gene transfer, and microbial evolution. - To equip students with practical skills in recombination, genetic engineering techniques, and genomic analysis.	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to explain the molecular basis of genetic information storage, processing, and regulation in microbial organisms.	L1
CO2	Students will grasp the mechanisms underlying genetic variation, mutation repair, and the role of horizontal gene transfer in shaping microbial diversity.	L2
CO3	Students will be able to perform experiments related to cloning, gene expression analysis, and genomic comparisons, fostering an understanding of applications in biotechnology and research.	L3

COURSE CONTENT:		
MODULE 1:	Fundamentals of Transmission Genetics	9 Hrs
Introduction to Microbial Genetics: Definition, scope, and significance of microbial genetics. Historical overview and key discoveries. The Evolution of Microorganisms and Microbiology. Overview of Microbial Genomes: a) Genetic fine structure and deletion mapping in Virulent Phage ~ Bacteriophage T4, Temperate Phage ~ Bacteriophage lambda, Bacteriophage ΦX174, b) HIV: a eukaryotic virus ~ Structure, life cycle, course of infection. Bacterial cell architecture. Plasmids - types, detection, replication, partitioning, copy-number control. Life cycle, organization of nuclear and organellar genomes of Yeast.		
MODULE 2:	Microbial Genetics and Evolution	9 Hrs
Recombination and Gene Transfer mechanisms: Molecular basis of recombination in bacteria. Recombination types, Gene transfer mechanisms-Transformation: natural transformation,		

competence, DNA uptake, role of natural transformation, artificially induced competence, electroporation. Transduction (generalized and specialized). Conjugation: self-transmissible plasmids, F factor, tra genes, on T, F' and Hfr strains, steps in conjugation, chromosome mobilization. Microbial Evolution and Adaptation: Mechanisms of microbial evolution. Adaptive radiation, speciation, and niche specialization.		
MODULE 3:	Microbial Pathogenesis	9 Hrs
Viral-pathogenesis (Influenza), Protozoan parasites (Plasmodium), mechanism of infection, effects on host cells, host response to infection; resistance to pathogenesis in plants, role of pathogen resistant genes R genes and the mechanism of resistance. Recombinant DNA Technology and Cloning: Restriction enzymes and DNA cleavage. Cloning vectors, gene libraries, and screening methods. Medically important bacteria: Mode of infection and pathogenesis of Staphylococcus, Clostridium, Streptococcus, Enteropathogenic bacteria, Salmonella and Mycobacterium.		
MODULE 4:	Microbiome	9 Hrs
Introduction to Microbiomes: Definition and significance of microbiomes, The Microbe-Human Ecosystem. Gut Microbiome: Composition and function of the gut microbiome Skin and Oral Microbiomes: Skin microbiome: diversity and role in health, Oral microbiome, and its connection to oral health. Therapeutic Applications and Future Directions: Fecal microbiota transplantation (FMT) and its use in medicine, Probiotics, prebiotics, and postbiotics.		
MODULE 5:	Host-pathogen interactions	9 Hrs
Innate Host Resistance, Adaptive Immunity, Infection and Pathogenicity. Microbial Diseases, Detection, and Their Control Human Diseases Caused by Viruses and Prions, Human Diseases Caused by Bacteria, Human Diseases Caused by Fungi and Protists Applications of Microbial Genomics: Pathogenomics: understanding virulence and drug resistance. Metagenomics and ecological insights.		

TEXT BOOKS/REFERENCES	
1) "Microbial Genetics" by Stanley Maloy, John Cronan, and David Freifelder. 2) "Genetics: A Conceptual Approach" by Benjamin A. Pierce. 3) "Principles of Genetics" by Snustad and Simmons. 4) "Recombinant DNA: Genes and Genomes - A Short Course" by James D. Watson. 5) "Microbial Genomics" by David W. Ussery. 6) "Introduction to Genetic Analysis" by Anthony J. F. Griffiths. 7) "Bioinformatics Algorithms: An Active Learning Approach" by Phillip Compeau and Pavel Pevzner. 8) "Microbial Evolution and Coevolution" by Joshua S. Weitz and Richard E. Lenski. 9) "Molecular Evolution: A Phylogenetic Approach" by Roderick D.M. Page and Edward C. Holmes. 10) "The Human Microbiome Handbook" by Kelly S. Bender and Jack A. Gilbert	

**B.Sc. – GENETICS (Minor) SYLLABUS
SEMESTER – IV**

SEMESTER	IV					
YEAR	II					
COURSE CODE	23GN2404					
TITLE OF THE COURSE	GENOMICS AND PROTEOMICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To go through basic and specialized knowledge and understanding the aspects of genomics and proteomics is essential to understanding Genetics and its architecture. - To take the students through foundations in genomics and disease gene mapping.	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Student will be able to understand how genomes are organised and contemplate on the mapping of monogenic and polygenic traits.	L1
CO2	Students should be endowed with strong theoretical knowledge of genomics.	L2
CO3	In conjunction with the practical in bioinformatics, the students should be able to take up biological research as well as find placement in the relevant biotech industry.	L3

COURSE CONTENT:		
MODULE 1:	Prokaryotic and Eukaryotic Genomes	9 Hrs
Prokaryotes: Bacteria and Bacteriophages. Eukaryotic nuclear genomes: Arabidopsis, Drosophila, C. elegans and mouse genome. Eukaryotic organelle genomes - Chloroplast and Mitochondria.		
MODULE 2:	Genome Mapping Techniques	9 Hrs
Genetic mapping: DNA markers – RFLPs, SSLPs, SNPs. Chromosome Walking, Restriction mapping, Fluorescent in situ hybridization.		
MODULE 3:	Accessing the Human Genome	9 Hrs
History, organization and goals of human genome project. DNA segment nomenclature, Human genome diversity, Organization of human genome, Mitochondrial genome, Gross base composition of nuclear genome, Gene density, CpG islands, RNA-encoding genes, Functionally identical genes, Diversity in size and organization of genes.		
MODULE 4:	Comparative Genomics	9 Hrs

Whole genome analysis, Genome sequence, micro assay, molecular phylogeny, C-value, number of genes and complexity of genomes, Conservation and diversity of genomes, Comparative genomics as an aid to gene mapping and study of human disease genes. Comparative genomics of mitochondria and chloroplast genomes.

MODULE 5:	Proteomics and Protein Profiling

	9 Hrs

Prediction of primary, secondary and tertiary structure of proteins- SCOP, DALIDD, CATH classification. Comparing protein structure using PYMOL, Homology modelling. Introduction to proteome and proteomics, protein separation and analysis using 2D Gel Electrophoresis, Liquid chromatography, Mass spectrometry, Interacting proteins by phage display and Yeast two hybrid system.

TEXT BOOKS/REFERENCES:

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| <ol style="list-style-type: none">1) T.A. Brown, Genomes, Bios, 2002.2) Coleman and Tsongalis, Molecular Diagnosis, Humana, 1997.3) Dale and Schartz, From Genes to Genomes, Wiley, 2003.4) Dunham, I., Genome Mapping and sequencing. Horizon Scientific. 2003.5) Hawley and Mori, The Human Genome, Academic, 1999.6) Lewis, Human Genetics, WCB, 1999.7) Liebler, Introduction to Proteomics, Humana, 2002. |
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SCHEME & SYLLABUS - SCHOOL OF BASIC & APPLIED SCIENCES, DSU

SEMESTER	IV					
YEAR	II					
COURSE CODE	23GN2405					
TITLE OF THE COURSE	MICROBIAL GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
To understand the foundational principles of microbial genetics and its significance in various fields, including medicine, biotechnology, and environmental science.	
To describe the structure and replication mechanisms of microbial genomes, including bacterial and viral genomes, and explain the role of mobile genetic elements in genome dynamics.	
To analyze the mechanisms of gene expression regulation in microbes, including transcriptional and post-transcriptional regulation, and assess the impact of environmental factors on gene expression.	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to articulate the importance of microbial genetics in medicine, biotechnology, and environmental science, demonstrating an understanding of its applications in real-world scenarios.	L1
CO2	Students will demonstrate proficiency in explaining the structure and replication mechanisms of microbial genomes, including bacterial and viral genomes, and understanding the significance of mobile genetic elements in microbial evolution.	L2
CO3	Students will develop the ability to critically evaluate mechanisms of gene expression regulation in microbes, including transcriptional and post-transcriptional regulation, and comprehend the influence of environmental cues on gene expression patterns.	L3

COURSE CONTENT:		
MODULE 1:	Fundamentals of Microbial Genetics	9 Hrs
Introduction to Microbial Genetics: Definition, scope, and significance of microbial genetics. Structure and Replication of Microbial Genomes: Overview of bacterial and viral genomes, Mechanisms of DNA replication in bacteria and viruses. Genetic Transfer in Microorganisms: Transformation: Uptake of Naked DNA by Bacteria; Transduction: Gene Transfer Mediated by Bacteriophages; Conjugation: Direct Transfer of Genetic		

Material between Bacterial Cells; Mobile Genetic Elements: Overview of Transposons.		
MODULE 2:	Regulation of Gene Expression in Microbes	9 Hrs
Transcriptional Regulation: Operon Concept and Transcriptional Regulation in Bacteria, Role of Transcription Factors: Activators and Repressors, Post-transcriptional Regulation: RNA Processing, Non-coding RNAs Gene Expression in Viruses and Environmental Regulation: Regulation of Gene Expression in Viruses, Impact of Gene Expression on Host-Pathogen Interactions, Environmental Regulation of Gene Expression: Stress Response Pathways, Quorum Sensing, Stress Response Pathways in Bacteria.		
MODULE 3:	Genetics of Drug Resistance and Microbial Pathogenesis	9 Hrs
Overview of Drug Resistance: Antibiotic, Antiviral, and Antifungal Resistance; Mechanisms of Antimicrobial Resistance: Mutations, Horizontal Gene Transfer; Virulence Factors and Pathogenicity Islands in Microbial Pathogenesis. Genetic Mechanisms of Drug Resistance: Genetics of Antibiotic Resistance Genes: β -lactamases, Efflux Pumps		
MODULE 4:	Microbial Genomics and Bioinformatics	9 Hrs
Genomic Analysis Techniques: Whole-genome sequencing methods and technologies. Comparative genomics and functional annotation. Bioinformatics Tools in Microbial Genetics: Sequence alignment algorithms and databases. Phylogenetics and evolutionary analysis. Applications of Microbial Genomics: Pathogenomics: understanding virulence and drug resistance. Metagenomics and ecological insights.		
MODULE 5:	Applications of Microbial Genetics	9 Hrs
Genetic Engineering Techniques: Recombinant DNA Technology, PCR, DNA Sequencing Genome Editing Tools: CRISPR-Cas9, TALENs, Zinc Finger Nucleases, Applications in Agriculture, Pharmaceutical, and Industrial Biotechnology Microbial Genetics in Medicine: Personalized Medicine Microbial Genetics in Environmental Science: Bioremediation, Microbiome Research		

TEXT BOOKS/REFERENCES:
1. "Microbial Genetics" by Stanley Maloy, John Cronan, and David Freifelder. 2. "Genetics: A Conceptual Approach" by Benjamin A. Pierce. 3. "Principles of Genetics" by Snustad and Simmons. 4. "Recombinant DNA: Genes and Genomes - A Short Course" by James D. Watson. 5. "Microbial Genomics" by David W. Ussery. 6. "Introduction to Genetic Analysis" by Anthony J. F. Griffiths. 7. "Bioinformatics Algorithms: An Active Learning Approach" by Phillip Compeau and Pavel Pevzner. 8. "Microbial Evolution and Coevolution" by Joshua S. Weitz and Richard E. Lenski. 9. "Molecular Evolution: A Phylogenetic Approach" by Roderick D.M. Page and Edward C. Holmes. 10. "Genomes" by T.A. Brown.

**B.Sc. – MICROBIOLOGY (Major) SYLLABUS
SEMESTER – IV**

SEMESTER	IV					
YEAR	II					
COURSE CODE	23MY2401					
TITLE OF THE COURSE	BACTERIOLOGY AND VIROLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	4	-	60	4

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To equip the students about the importance of bacteria and viruses in our global society. - To equip the safety measures in handling different types of microbes and to practice various methods used for isolation, cultivation, and identification of them from different sources and checking growth parameters at various conditions - To help students learn basic microbiological techniques employed for biochemical tests and quantitative analysis for checking the growth of prokaryotic microorganisms.	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be acquainted with fundamental aspects of microbial diversity with respect to bacteria and viruses.	L1
CO2	Enable the students to understand their diversity with structural organization, functions, habitat etc.	L2
CO3	Students will be able to understand the importance of bacteria and viruses with respect to applications in varied fields as well disease-causing pathogens.	L3
CO4	Students will be equipped with fundamental knowledge of identification, growth patterns enabling them to apply in various allied fields.	L2

COURSE CONTENT:		
MODULE 1:	Biology of Bacteria	12 Hrs
Ultrastructure of bacterial cell, Cell morphology: size, shape and arrangement; flagella, pili, capsule, cell wall, cell membrane, cytoplasm. nucleoid, plasmids, transposons. Endospores and exospores. Reproduction in bacteria. Intracytoplasmic inclusions: gas vacuoles, cellulosomes, carboxysomes, magnetosomes, parasporal crystals, metachromatic granules, polyhydroxybutyrate granules, glycogen, oil droplets, and sulphur globules,		
MODULE 2:	Microbial Nutrition and Special Forms	12 Hrs
Nutritional uptake, nutritional factors required for growth and reproduction. Classification of		

microorganisms based on environmental and nutritional requirements. Maintenance and preservation methods of microbial cultures.

Special forms of bacteria: Actinobacteria, Spirochetes, Rickettsia, Chlamydia, Archaeobacteria and extremophiles.

MODULE 3:	Microbial Growth Kinetics	12 Hrs

Cell division, Bacterial growth curve, Generation time; Growth Kinetics; Batch culture, Continuous culture - Chemostat and Turbidostat. Synchronous culture, diauxic growth. Physical factors influencing the growth. Measurement of growth: Measurement of cell numbers- Counting chambers, viable counting techniques, Measurement of cell mass- dry weight and turbidity measurement.

MODULE 4:	Biology of Viruses	12 Hrs

Discovery, distinctive properties, morphology, Ultra-structure and life cycle (lytic, lysogenic), Classification, Cultivation and Purification assay of virus. Type studies (Ultra-structure, replication and importance): animal viruses (Polio) and plant viruses (TMV). Sub-viral agents: Satellite viruses, sat-RNAs, viroid, virusoids and prions. Application of viruses.

MODULE 5:	Biology of Bacteriophages and Viral Oncology	12 Hrs

Bacteriophages - Structural organization and Type studies (Ultra-structure, replication and importance): major RNA (MS2) and DNA (T4, lambda) bacteriophages. Application of bacteriophages.

Viruses and Cancer: Introduction to oncogenic viruses Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes.

TEXT BOOKS/REFERENCES

Microbiology:

1. Brock Biology of Microorganisms 16th Edition (2020) Madigan MT, Martinko JM, Dunlap PV, Clark DP Prentice Hall publisher USA.
2. Foundations in Microbiology, (10th Edition) (2018) Kathleen Park Talaro and Barry Chess, Tata McGraw, India.
3. Microbiology, 10th Edition (2017) Lansing M Prescott, Donald A Klein, John P Harley, McGraw Hill publisher.
4. Microbiology and Parasitology (2016) B. S. Nagoba, Elsevier Health Sciences.
5. Textbook of Microbiology (2016) R. Ananthanarayan, Orient Blackman publications.
6. Textbook of Microbiology, (2013) Dubey RC, Maheswari DK S. Chand & Co.
7. Microbiology, 8th Edition International Student Version Jacquelyn G. Black (Marymount University) (2012), Wiley publication.
8. Understanding Microbes: An Introduction to a Small World Jeremy W. Dale (2012), Wiley-Blackwell.
9. Microbiology, 7th Edition (2009) Michael J Pelczar, Microbiology, Tata McGraw, India.
10. Advances in Applied Microbiology. (2007) Wayne W. Umbreit and D. Pearlman. Academic Press

Virology

1. Evidence-Based Diagnosis: An Introduction to Clinical Epidemiology 2nd Edition, by Thomas B. Newman, Michael A. Kohn (2020). 2 edition, Publisher: Cambridge University Press.
2. Virusphere: From Common Colds to Ebola Epidemics--Why We Need the Viruses That

- Plague Us (2020). 1st edition, Frank Ryan (Author), Publisher: Prometheus.
3. Guide to Clinical and Diagnostic Virology (2019), (ASM Books) 1st Edition, by ReetiKhare, Publisher: ASM Press.
4. Virology (2019), P. Saravanan. 5. Recent Advances in Animal Virology (2019) 1st Edition, Kindle Edition, by Yashpal Singh Malik, Raj Kumar Singh, Mahendra Pal Yadav, 471 pages, Publisher: Springer
5. Virology (2017) RenWarom, Titan Books.
6. Virus: An Illustrated Guide to 101 Incredible Microbes (2016), 1st Edition (ASM Books) Fourth Edition, by Marilyn J. Roossinck, Carl Zimmer, Publisher: Princeton University Press.
7. A Planet of Viruses: (2015) 2nd ed, by Carl Zimmer (2015) University of Chicago Press.
8. Introduction to Modern Virology. (2001). 5th ed. Dimmock et al., Blackwell Sci. Publ.
9. Plant Virology. (2001). 4th ed. By R. Hull. Academic Press.
10. Fundamental Virology, 4th ed. (2001). D.M. Knipe and P.M. Howley.
11. Principles of Virology: (2000). by S.J. Flint et al., ASM Press.
12. Basic Virology, (1999). By Waginer and Hewlett, Black Well Science Publ.
13. Veterinary Virology. 3rd ed. (1999). Murphy et al., Academic Press.
14. Principles of Molecular Virology. (1997). 2nd ed. A. Cann. Academic Press.
15. Medical Virology. (1994). 4th edition. D.O. White and F.J. Fenner. Academic Press. Plant Virology. (2001). 4th ed. By R. Hull. Academic Press.

BACTERIOLOGY AND VIROLOGY – PRACTICAL

1. Anaerobic culturing methods – thioglycolate media culturing.
2. Microscopic examination of bacterial smear
 - a) Gram's staining
 - b) Capsule staining
 - c) Endospore staining
3. Biochemical test:
 - a) IMViC
 - b) TSIA
 - c) Catalase test
 - d) Oxidase test
4. Hydrolyses tests
 - a. Starch hydrolysis
 - b. Gelatin hydrolysis
 - c. Casein hydrolysis
5. Growth measurement of bacteria (turbidity method).
6. Isolation and enumeration of bacteriophages.

REFERENCES

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
3. Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
4. Pelczar, M. J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.
5. Prescott, L.M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, NY.

SCHEME & SYLLABUS - SCHOOL OF BASIC & APPLIED SCIENCES, DSU

SEMESTER	IV					
YEAR	II					
COURSE CODE	23MY2402					
TITLE OF THE COURSE	MYCOLOGY AND PHYCOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	4	-	60	4

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- The course entails a taxonomic classification of fungi and algae and an fundamental knowledge of their cell structure, nutrition and replication - To gain insight into the exploration of the various areas of applied mycology and phycology in the commercial sector, bioremediation of pollution and food and feed industry - To equip the students with practical training for isolating, identification, culturing, and utilizing these microbes for various applications.	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to identify the distribution of fungi and algae in nature	L1
CO2	Enable the students to understand the structural organization, growth requirements, habitat.	L2
CO3	Students will be able to understand the economic importance of fungi and algae	L3
CO4	Students will be able to cultivate, identify and maintain the fungal and algae cultures.	L2

COURSE CONTENT:		
MODULE 1:	Mycology	12 Hrs
Introduction, General characteristics: habitat, distribution and nutritional requirements. Classification of fungi (by Alexopulous). Fungal cell Ultra-structure, thallus organization and aggregation, fungal cell wall structure and synthesis.; Reproduction (vegetative, asexual and sexual).		
MODULE 2:	Nutrition and Type Study	12 Hrs
Nutrition in fungi (saprophyte, parasites, predators, symbionts). Prevention of fungal growth. Type study- Zygomycetes (<i>Rhizopus</i>), Ascomycetes (<i>Aspergillus</i>), Basidiomycetes (<i>Agaricus</i>) and Deuteromycetes (<i>Fusarium</i>).		
MODULE 3:	Phycology	12 Hrs
Introduction, General characteristics of algae including occurrence, thallus organization. Criteria for		

classification of algae (pigment, reserved food, flagella).

Ultrastructure, flagella, eyespot (stigmata), chloroplasts, algal pigments. Reproduction and life cycle: vegetative, asexual and sexual, Haplontic, Diplontic, Haplobiontic and Diplobiontic. Brief account on Lichen.

MODULE 4: Nutrition and Type Study

12 Hrs

Factors affecting algal growth: Photoperoid, Inorganic source, Nitrogen, phosphorous, N/P ratio, Calcium, Silicon, Potassium and sulphur, vitamins and growth factors, trace elements.

Type study: Cyanophyta (*Spirulina*), Chlorophyta (*Spirogyra*), Rhodophyta (*Gracillaria*), Phaeophyta (*Sargassum*).

MODULE 5: Fungal and Algal Applications

12 Hrs

FUNGAL: Primary metabolites of economic importance: industrial alcohol, citric acid, other metabolite. Secondary metabolite of economic importance: in medicine, in agriculture. Antifungal agents. Industrial applications of Yeast.

ALGAL: algae as food, feed and use in industry. Algae as bioindicators: biomarkers and bioindicators, eutrophication, monitoring water quality (inorganic and organic nutrients, acidity and heavy metals). Fossil algae as bioindicators: lake sediment analysis. Nitrogen-fixing BGA

TEXT BOOKS/REFERENCES

- 1) Webster, J., & Weber, R. (2007). *Introduction to fungi*. Cambridge university press.
- 2) Carlile, M. J., Watkinson, S. C., & Gooday, G. W. (2001). *The fungi*. Gulf Professional Publishing.
- 3) Kues, U., & Fischer, R. (Eds.). (2006). *Growth, differentiation and sexuality; The mycota* (Vol. 1). Springer Science & Business Media.
- 4) Dube, H. C. (2013). *An introduction to fungi*. Scientific Publishers.
- 5) Gupta, R. (2001). *Microbial technology*. APH Publishing.
- 6) Bellinger, E. G., & Sigee, D. C. (2015). *Freshwater algae: identification, enumeration and use as bioindicators*. John Wiley & Sons.
- 7) Sahoo, D., & Seckbach, J. (Eds.). (2015). *The algae world* (No. 11564). Dordrecht: Springer Netherlands.
- 8) Pandey, R. K. G. V. D. (2007). *Advances in Applied Phycology*. Daya Books.
- 9) South, G. R., & Whittick, A. (2009). *An introduction to phycology*. John Wiley & Sons.
- 10) Fritsch, F. E. (1945). *The Structure and Reproduction of the Algae Vol 2 Foreword, Phaeophyceae, Rhodophyceae, Myxophyceae*. Cambridge University Press.

MYCOLOGY AND PHYCOLOGY - PRACTICALS

- 1) Isolation and culturing of fungi (yeasts and molds) by dilution, Warcup method, implant and impression.
- 2) Growth measurement of fungi by linear method.
- 3) Staining and identification of fungi using lactophenol cotton blue.
- 4) Isolation and identification of microscopic algae from soil or water.
- 5) Cultivation and enumeration of algae.
- 6) Permanent slides: *Aspergillus*, *Penicillium*, *Fusarium*, *Yeast*, *Rhizopus*, *Agaricus* gills, *Puccinia*
- 7) Permanent slides: *Nostoc*, *Microcystic*, *Scytonema*, *Spirogyra*, *Spirulina*, *Oscillatoria*, *Rivularia*

REFERENCES

- 1) Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
- 2) Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
- 3) Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
- 4) Pelczar, M. J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.
- 5) Prescott, L.M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, NY.

SEMESTER	IV					
YEAR	II					
COURSE CODE	23MY2403					
TITLE OF THE COURSE	PARASITOLOGY AND EPIDEMIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To impart basic fundamental knowledge about protozoan and helminth diseases to students - To make students understand about theory and strategies of the concept behind the protozoan and helminths infection. - To impart the theoretical skills about the Parasitology and Epidemiology to the students	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Student should be able to identify, deduce the Pathogenicity, Diagnosis, Prophylaxis and Treatment of Protozoan diseases.	L1
CO2	Student should be able to identify, deduce the Pathogenicity, Diagnosis, Prophylaxis and Treatment of Helminth diseases.	L3
CO3	Student are trained to know what are the different techniques and methods in diagnostic labs.	L5

COURSE CONTENT:		
MODULE 1:	Parasitology	9 Hrs
Scope and historical landmarks in Parasitology, basic principles and nomenclature. Host parasite inter-relationship (Properties of parasites and host specificity). Kinds of parasites: Hyperparasitism. Parasitoids. Vector Biology: Vectors and its importance in transmission of parasites, (protozoan and helminth vectors). Symbiotic association of microbes with vectors. Role of microbes as controlling agents of vectors.		
MODULE 2:	Salient Features of Protozoa And Helminths	9 Hrs
General characteristics, Classification, Reproduction, General life cycle and feeding in Protozoa and helminths. Importance of protozoan and helminths.		
MODULE 3:	Protozoa	9 Hrs
Morphology, Life Cycle, Pathogenicity, Diagnosis, Prophylaxis and antiprotozoal agents. of subphyla: Sarcomastigophora: Mastigophora (flagellate- Leishmania), the Sarcodina (Entamoeba) and the Opalinata. Apicomplexa: Disease causing agents- Malaria		

(Plasmodium), Toxoplasmosis (Toxoplasma). Ciliophora: (Balantidium).		
MODULE 4:	Helminths	9 Hrs
Morphology, General Life Cycle, Classification, Pathogenicity, Diagnosis, Prophylaxis and Anthelmintic drugs. Intestinal Tape worms (<i>Taenia solium</i>). Trematodes. Liverfluke (<i>Fasciola</i>), Intestinal Fluke (<i>Fasciolopsis</i>). Intestinal Nematodes (<i>Ascaris</i>), Blood and tissue nematodes (<i>Wuchereria</i>).		
MODULE 5:	Epidemiology	9 Hrs
Endemic, Epidemic, Pandemic Infectious disease epidemiology- Recognition of an infectious disease in a population, epidemic. The infectious disease cycle: Virulence and mode of transmission. Emerging and reemerging infectious disease and pathogens. Measuring frequency-as an epidemiologist's tool; Control of epidemics. Geographic medicine: Implications and applications and future perspectives		

TEXT BOOKS/REFERENCES:	
1) Jeyaram Paniker, C.K. (2006) Text Book of Parasitology. Jay Pee Brothers, New Delhi. 2) Schmidt, G.D. and Roberts, L.S. (1981) Foundations of Parasitology, 2nd Edn, Mosby, St. Louis. 3) Arora, D.R. and Arora, B.(2002) Medical Parasitology, 1st Edn. CBS Publishers & Distributors, New Delhi. 4) Parija SC. (2013) Textbook of Medical Parasitology: Protozoology & Helminthology, 4th Edn. All India Publishers & Distributors 5) Ochei J. and Kolhatkar A. (2000) Medical laboratory science theory and practice, McGraw-Hill. 6) Bogitish, B.J., Carter, C. E. & Oeltman, T, N, (2012) Human Parasitology. Academic Press. 7) Bush, A.O., Fernandez, J.C., Esch, G.W., & Seed, J.R. (2001) Parasitism: The diversity and ecology of Animal parasite. Cambridge University Press. 8) Chaterjee, K.D. (2009) Parasitology: Protozoology & Helminthology. CBS Publishers & Distributors Private Limited. 9) Cheng, T.C. (1986) General Parasitology. Academic Press. 10) Joshi A.B. and Banjara M.R. (2007). Fundamentals of Epidemiology. Published by Institute of Medicine	

**B.Sc. – MICROBIOLOGY (Minor) SYLLABUS
SEMESTER – IV**

SEMESTER	IV					
YEAR	II					
COURSE CODE	23MY2404					
TITLE OF THE COURSE	EXTREMOPHILES					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To introduce concepts of extremophiles and their applications - The course will provide the conceptual basis of ubiquity of microbes in extreme environment. - To enable the students to understand the commercial relevance of extremophiles	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will acquire awareness regarding the ubiquity of microbes in extremes habitats.	L1
CO2	Enable the students to describe the primitive life form and adaptation of microbes to it	L2
CO3	The course will help the students to describe distribution, classification of Extremophiles	L3
CO4	The course will help to understand their use in commercial applications	L4

COURSE CONTENT:		
MODULE 1:	Thermophiles	9 Hrs
Introduction to Extremophiles, Habitat and Classification. Thermophiles: Classification, Hyper-thermophilic habitat and ecological aspects. Adaptations based on thermo-stability, Heat stable enzymes and metabolism. Commercial aspects of thermophiles and applications.		
MODULE 2:	Psychrophiles	9 Hrs
Microbial diversity at cold ecosystem, psychropiezophiles, permafrost, anaerobic and cyanobacteria in cold ecosystem, microalgae in Polar Regions. Adaptations to cold habitats – Membrane components and cold sensing, cold adapted enzymes, cryoprotectants, ice binding proteins and applications.		
MODULE 3:	Acidophiles and Alkalophiles	9 Hrs
Acidophiles: Cell Structures, Physiology- Growth conditions, Classification, life at low pH, acido-		

tolerance, applications.

Alkalophiles- Cell Structures, Physiology- Growth conditions, Antiporters and intracellular enzymes. Alkaliphiles and their applications.

MODULE 4: Halophiles and Barophiles

9 Hrs

Halophiles-Classification, Halophilicity and Osmotic protection, Hypersaline Environments, Eukaryotic and prokaryotic halophiles. Adaptations or halotolerance, Applications of halophiles. Barophiles- Classification, high pressure habitat, life under pressure and applications.

MODULE 5: Other Extremophiles and Applications

9 Hrs

Xerophilic, Radiophilic, methanogens, Osmophiles, Oligotrophs, Metalophiles: Habitat and ecological aspects, adaptations and applications. Introduction to Panspermia, types and applications.

TEXT BOOKS/REFERENCES:

- 1) Extremophiles: Microbial Life in Extreme Environments. Wiley Publications.
- 2) Rampleotto, Paulo H. (2016). Biotechnology of Extremophiles: Advances and Challenges. Springer Publications.
- 3) Extreme environment. Metabolism of microbial Adaptation. Milton R., Heinrich Academic Press.
- 4) Extremophiles by Johri B.N. 2000. Springer Verlag, New York.
- 5) Microbial diversity by Colwell D., 1999, Academic Press.
- 6) Microbial ecology. Fundamental and applications by Ronald M. Atlas and Richard Bartha. II and IV edition.
- 7) Microbial Ecology. II edition by R. Campbell. Blackwell scientific publication.
- 8) Microbial life in extreme Environment. Edited by D.J. Kushner. Academic Press.
- 8) Microbiology: Dynamics and Diversity by Perry.
- 9) Microbiology of Extreme Environment. Edited by Clive Edward. Open University Press. Milton Keynes.
- 10) Microbiology of extreme Environment and its potentials for Biotechnology. Edited by N. S. Da Costa, J. C. Duarte, R.A.D. Williams. Elsevier applied science, London
- 11) Thermophiles. General, Molecular and applied Microbiology. Thomas D. Brock. Wiley Interscience publication.

SEMESTER	IV					
YEAR	II					
COURSE CODE	23MY2405					
TITLE OF THE COURSE	MICROBIAL DIVERSITY AND KINETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	-	-	45	3

		Perquisite Courses (if any)	
#	Sem/ Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- Deliberate existing theories about the origin of life, microbial evolution and systematics. - Make simple calculations of microbial growth kinetics in batch and continuous culture and describe how microbial growth can be controlled.	

COURSE OUTCOMES		
CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	The course will enable students to relate the principles in classifying microbial systems and know their beneficial and harmful effects.	L2
CO2	Enable to apply this knowledge in microbial biotechnology starting from screening of desired microbe	L4

COURSE CONTENT:		
MODULE 1:	Bacteriology	9 Hrs
Ultra structure of Bacteria: Classification, Structure external to the cell wall- Slime layer, Capsule, Flagella, Pilus/ Fimbriae. Cell wall, Cytoplasmic membrane; Cytoplasmic inclusion bodies. Bacterial Chromosome, Plasmids and episomes, Ribosomes, Exospores, Endospore and Cysts. General account of Archaeobacteria, Actinomycetes.		
MODULE 2:	Virology	9 Hrs
Classification, General structure, characteristics, cultivation, assay and replication of viruses. Bacteriophages: Lytic and lysogenic cycle. Type study: TMV and Lambda phage. Applications of viruses and bacteriophage. Viroids and Prions.		
MODULE 3:	Mycology and Protozoology	9 Hrs
Fungi: Classification, General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal cell wall structure and synthesis. Reproduction asexual and sexual. Economic importance of fungi. Type study: Zygomycetes (<i>Rhizopus</i>), Ascomycetes (<i>Aspergillus</i>). Protozoa: General characteristics, habitat, distribution, nutritional requirements. Type study: <i>Paramecium</i> , <i>Plasmodium</i> .		

MODULE 4:	Phycology	9 Hrs
Classification, General characteristics of algae including occurrence, thallus organization. Algal Ultrastructure, flagella, eyespot food reserves, pigments. Reproduction: vegetative, asexual and sexual. Types of life cycles: Haplontic, Diplontic, Haplobiontic and Diplobiontic. Economic importance of algae. Type study: Cyanophyta (<i>Spirulina</i>), Chlorophyta (<i>Spirogyra</i>).		
MODULE 5:	Growth Kinetics	9 Hrs
Definition of microbial growth, factors affecting microbial growth (pH, temperature, oxygen concentration, pressure and radiations). Cell division, Bacterial growth curve, Generation time; Growth Kinetics; Batch culture, Continuous culture - Chemostat and Turbidostat. Synchronous culture, diauxic growth. Physical factors influencing the growth. Measurement of growth: Measurement of cell numbers- Counting chambers, viable counting techniques, Measurement of cell mass- dry weight and turbidity measurement.		

TEXT BOOKS/REFERENCES
1) 1. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2007. Introductory Mycology; Fourth 2) edition, Wiley India Private Limited 3) 2. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec 4) Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing 5) Company, New York. 6) Benson, H. J. 1994. Microbiological Application. WCB McGraw-Hill of India Private 7) Limited. 8) Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, 9) Eagle wood cliffs N. J. 10) Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 11) 1999. 12) Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern 13) Virology: 5th edition, Blackwell Publishing, 2005 14) Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th 15) Edition. Pub. 1986. 16) Pommerville, J.C. 2007. Alcamo's Fundamentals of Microbiology. Eighth Edition. 17) Jones and Bartlett Publishers, USA. 18) Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005. 19) Salle, A. J. 1984. Fundamental Principles of Bacteriology. Tata McGraw-Hill 20) Publishing Company Limited, New Delhi. 21) Salle, A.J. Principles of Microbiology, 2nd edition., 1997, Mc Graw Hill. 1997. 22) Stainer, R. Y., et al., General Microbiology 5th edition MacMillan Press. 2005. 23) 14. Tortora, Funke and Case. Microbiology, 9th Edition. Benjamin Cummings. 2009.

DAYANANDA SAGAR UNIVERSITY
SHAVIGE MALLESHWARA HILLS, KUMARASWAMY LAYOUT
BENGALURU – 560 111, KARNATAKA.

SCHOOL OF BASIC & APPLIED SCIENCES



SCHEME & SYLLABUS
FOR
BACHELOR OF SCIENCE (B.Sc.) – 2020
BIOTECHNOLOGY, BIOCHEMISTRY & GENETICS
(BBG)

(With effect from 2020 – 21)

SCHEME – B.Sc. – 2020-21 ONWARDS

I SEM – BBG

(BIOTECHNOLOGY, BIOCHEMISTRY & GENETICS)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	111	20BT1101	FUNDAMENTALS OF CELL BIOLOGY	CR	4	-	-	-	4	*	***
2	111	20BC1101	BASIC BIOCHEMISTRY	CR	4	-	-	-	4	*	***
3	111	20GN1101	BASIC GENETICS	CR	4	-	-	-	4	*	***
4	111	20BS1101	BASIC CHEMISTRY	CR	4	-	-	-	4	*	***
5	111	20BT1171	TECHNIQUES IN CELL BIOLOGY - LAB	CR	-	-	4	-	2	*	***
6	111	20BC1171	BASIC BIOCHEMISTRY - LAB	CR	-	-	4	-	2	*	***
7	111	20GN1171	BASIC GENETICS - LAB	CR	-	-	4	-	2	*	***
8	111	20BS1102	COMMUNICATIVE ENGLISH	CR	2	-	-	-	2	*	***
					18	-	12	-	24		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SCHEME – B.Sc. – 2020-21 ONWARDS

II SEM – BBG

(BIOTECHNOLOGY, BIOCHEMISTRY & GENETICS)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	111	20BT1201	PRINCIPLES OF IMMUNOLOGY	CR	4	-	-	-	4	*	***
2	111	20BC1201	BIO ANALYTICAL TECHNIQUES	CR	4	-	-	-	4	*	***
3	111	20GN1201	FUNDAMENTALS OF CYTOGENETICS	CR	4	-	-	-	4	*	***
4	111	20BS1201	BIOINFORMATICS AND BIOSTATISTICS	CR	4	-	-	-	4	*	***
5	111	20BT1271	IMMUNO-TECHNIQUES – LAB	CR	-	-	4	-	2	*	***
6	111	20BC1271	BIO ANALYTICAL SEPARATIONS - LAB	CR	-	-	4	-	2	*	***
7	111	20GN1271	FUNDAMENTALS OF CYTOGENETICS LAB	CR	-	-	4	-	2	*	***
8	111	20BS1202	COMPUTER APPLICATIONS AND INFORMATION TECHNOLOGY	CR	2	-	-	-	2	*	***
					18	-	12	-	24		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SCHEME – B.Sc. – 2020-21 ONWARDS

III SEM – BBG

(BIOTECHNOLOGY, BIOCHEMISTRY & GENETICS)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	111	20BT2301	PRINCIPLES OF RECOMBINANT DNA TECHNOLOGY	CR	4	-	-	-	4	*	***
2	111	20BC2301	HUMAN PHYSIOLOGY	CR	4	-	-	-	4	*	***
3	111	20GN2301	BASIC HUMAN GENETICS AND GENETIC ENGINEERING.	CR	4	-	-	-	4	*	***
4	111	20BS2301	MOLECULAR BIOLOGY	CR	4	-	-	-	4	*	***
5	111	20BT2371	TECHNIQUES IN RECOMBINANT DNA TECHNOLOGY - LAB	CR	-	-	4	-	2	*	***
6	111	20BC2371	CLINICAL BIOCHEMISTRY - LAB	CR	-	-	4	-	2	*	***
7	111	20GN2371	BASIC HUMAN GENETICS AND GENETIC ENGINEERING - LAB	CR	-	-	4	-	2	*	***
8	111	20BS2302	ENVIRONMENTAL SCIENCE	CR	2	-	-	-	2	*	***
					18	-	12	-	24		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SCHEME – B.Sc. – 2020-21 ONWARDS

IV SEM – BBG

(BIOTECHNOLOGY, BIOCHEMISTRY & GENETICS)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	111	20BT2401	PRINCIPLES OF ANIMAL AND PLANT BIOTECHNOLOGY	CR	4	-	-	-	4	*	***
2	111	20BC2401	ENZYMOLOGY AND PROTEIN CHEMISTRY	CR	4	-	-	-	4	*	***
3	111	20GN2401	APPLIED GENETICS.	CR	4	-	-	-	4	*	***
4	111	20BS2401	GENOMICS AND PROTEOMICS	CR	4	-	-	-	4	*	***
5	111	20BT2471	TECHNIQUES IN ANIMAL AND PLANT BIOTECHNOLOGY - LAB	CR	-	-	4	-	2	*	***
6	111	20BC2471	ENZYMOLOGY - LAB	CR	-	-	4	-	2	*	***
7	111	20GN2471	APPLIED GENETICS - LAB	CR	-	-	4	-	2	*	***
8	111	20BS2402	BIOETHICS AND IPR	CR	2	-	-	-	2	*	***
					18	-	12	-	24		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SCHEME – B.Sc. – 2020-21 ONWARDS

V SEM – BBG

(BIOTECHNOLOGY, BIOCHEMISTRY & GENETICS)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	111	20BT3501	FERMENTATION BIOTECHNOLOGY	CR	4	-	-	-	4	*	***
2	111	20BC3501	METABOLISM	CR	4	-	-	-	4	*	***
3	111	20GN3501	POPULATION AND EVOLUTIONARY GENETICS	CR	4	-	-	-	4	*	***
4	111	20BS3571	ESTIMATION OF BIOMOLECULES - LAB	CR	-	-	4	-	2	*	***
5	111	20BS3573	FERMENTATION TECHNIQUES AND POPULATION GENETICS - LAB	CR	-	-	4	-	2	*	***
6	111	20AU0003	CONSTITUTION OF INDIA AND HUMAN RIGHTS	AU	2	-	-	-	-	*	***
7	111	20AU0020	KANNADA KALI – I	AU	2	-	-	-	-	*	***
8	111	20AU0022	KANNADA MANASU – I	AU	2	-	-	-	-	*	***
					16	-	08	-	16		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SCHEME – B.Sc. – 2020-21 ONWARDS

VI SEM – BBG

(BIOTECHNOLOGY, BIOCHEMISTRY & GENETICS)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	111	20BS3601	RESEARCH METHODOLOGY	CR	4	-	-	-	2	*	***
2	111	20BS3602	PROJECT	CR	-	-	12	-	6	*	***
					4	-	12	-	08		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SEMESTER	I					
YEAR	I					
COURSE CODE	20BT1101					
TITLE OF THE COURSE	FUNDAMENTALS OF CELL BIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To equip students with the basic understanding of structures and functions of organelles of prokaryotic and eukaryotic cells.
- To impart understanding on the process of cell division, cell cycle and its control.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students should have basic knowledge on the structure and functions of cellular organelles.	L2
CO2	Students should be able to understand the concept of cell cycle	L3
CO3	Cell cycle and its control	L4
CO4	Cell growth; Different stages in cell division: Meiosis and Mitosis and their relevance	L3

COURSE CONTENT:	
MODULE 1: ULTRA STRUCTURE OF CELL	12Hrs
Prokaryotic (Bacteria) and Eukaryotic cells (Animal and Plant) - Characteristics and differences. Cell Wall: Ultrastructure, chemical composition and function. Plasma membrane: Chemical composition (Lipids, Proteins, Carbohydrates), Structure (Fluid mosaic model). Mode of transport across membrane: Active Transport (Pumps) and Passive transport (Osmosis, Diffusion).	
MODULE 2 : CELL ORGANELLES -I	12Hrs
Structure and general functions: Chloroplast (Envelope, Stroma, Thylakoids); Endoplasmic Reticulum (Smooth and Rough); Golgi complex (Cisternae, Tubules, Vesicles); Mitochondria; Ribosomes; Lysosomes (Primary and Secondary); Microsomes.	
MODULE 3: CELL ORGANELLES -II	12Hrs
Structure and general functions: Cytoskeleton (Microtubules, Microfilaments and Intermediate Filaments); Cilia and Flagella. Structure and general functions of Nucleus (Nuclear envelope, Nucleoplasm and Nucleolus). Chromosomes- Discovery, Structure and functions (Centromere, Secondary constrictions, Telomere). Types of Chromatin (Euchromatin and Heterochromatin);	

Dosage Compensation. Organization of Chromatin: Nucleosomes and Solenoid Model; Giant Chromosomes (Polytene and Lampbrush).	
MODULE 4: CELL GROWTH AND CELL DIVISION	12Hrs
Cell cycle: Introduction to cell cycle stages (Interphase and M phase); Introduction to Cell cycle control (Cyclins and Cyclin dependent kinases). Mitosis: Mitotic phases; Cytokinesis; Significance of Mitosis. Meiosis: First meiotic division; Second meiotic division, Synaptonemal complex; Significance of meiosis. Introduction to programmed cell death (Apoptosis & Necrosis).	

List of Laboratory/Practical Experiments activities to be conducted (if any) : NONE
1.
2.

TEXT BOOKS:

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Gerald Karp. Cell and Molecular Biology. 6th Edition (2009) Wiley Publications.

REFERENCES:

1. Bruce Alberts et al. Molecular Biology of the cell - (2002) Garland Publications.
Ambrose and Esty D. M. Cell Biology - (1997) ELBS Publications.
2. Robertis E. D. F. and Robertis E. M. F. Genetics and Molecular Biology - (2001) Saunders College.

SEMESTER	I					
YEAR	I					
COURSE CODE	20BC1101					
TITLE OF THE COURSE	BASIC BIOCHEMISTRY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To familiarize the students with basic concepts and principles of conformation and energy transfer in biological systems.
- To create general understanding about fundamentals of biomolecules, and their structure and significance.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will know about pH, buffer and will be able to decide the importance of biological reactions.	L2
CO2	The students will have an insight of structure and functions of biomolecules	L3
CO3	Students will have a better insight of basics of biochemistry with a detailed understanding of the clinical significance of biomolecules	L4

COURSE CONTENT:	
MODULE 1	
12Hrs	
Water and Buffers: Modern concepts of acids and bases; Ionization of acids. Dissociation of water and ionic product of water, Hydrogen bonding properties of water, Definition and determination of pH and associated numerical; Common ion effect with examples, Buffer preparation by H-H equation, buffer types. Numerical problems on preparation of buffer solutions, Biological buffers and their reactions.	
MODULE 2	
12Hrs	
Conformation and energy transfer <i>Stereoisomerism:</i> Optical isomerism: Chirality, Nomenclature of enantiomers -The RS and the DL system. Optical rotation, racemisation and resolution. Fischer projection formula. Geometrical isomerism: Cis trans-isomerism, examples of chirality in the biological world. <i>Thermodynamics:</i> First and second law, free energy, entropy, chemical potential, standard free energy change, exergonic and endergonic reactions with examples. Relationship between free energy change and equilibrium constant. Oxidation and reduction reactions in biology	
MODULE 3	
12Hrs	

Carbohydrates and lipids <i>Carbohydrates:</i> Classification– monosachharides, disaccharides, oligosaccharides with examples; Polysaccharides – structural and storage; mucopolysaccharides – peptidoglycan and teichoic acid. <i>Lipids:</i> classification – simple, complex and derived with examples. Properties of lipids: interaction with water; micelle, layer, liposome and membrane formation; Saponification, rancidity and iodine number.	
MODULE 4	12Hrs
Amino acids and nucleic acids <i>Amino acids:</i> General structure of amino acids, acid base property, isoelectric point, peptide bond, classification of proteins based on solubility – fibrous and globular, classification of protein based on location: intracellular, extracellular and membrane bound proteins, introduction to protein hierarchy. Native state and denatured state of proteins <i>Nucleic acid:</i> Structure of nitrogen base – purine and pyrimidine, general structure of nucleosides and nucleotides. Melting of DNA, melting temperature, renaturation of nucleic acids.	

List of Laboratory/Practical Experiments activities to be conducted (if any) : NONE
1.
2.

TEXT BOOKS:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Zubay's Principles of Biochemistry – Rastogi and Aneja. MedTech 5th Edition
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Stereochemistry of Carbon Compounds, Eliel (1977) Tata-McGrawHill

SEMESTER	I					
YEAR	I					
COURSE CODE	20GN1101					
TITLE OF THE COURSE	BASIC GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To gain insight on the historical perspective of the evolution of genetics.
- To comprehend and identify the different types of mendelian and non-mendelian inheritance.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will have clarity to the background of genetics before getting into details in the forthcoming semesters	L3
CO2	They will be capable differentiate between mendelian and non mendelian inheritance sources along with associated intricacies.	L3
CO3	Student will gain the ability to analyze and relate phenotype to genotype and potential factors influencing the interaction.	L3

COURSE CONTENT:

MODULE 1: HISTORY OF GENETICS AND MENDELIAN PRINCIPLES		12Hrs
Pre- formation, History and scope of Genetics, Pre- Mendelian genetic concepts epigenesis, pangensis, germplasm theory. Mendel- Life and his experiments on pea plants. Principle of Dominance (Dominance and Recessiveness); Laws of Inheritance and their applications. Monohybrid Cross, Dihybrid Cross, Back Cross, Test Cross		
MODULE 2: EXTENSIONS OF MENDELISM AND GENE INTERACTIONS		12Hrs
Co-dominance and incomplete dominance - definition, examples. Multiple allelism- definition, Eye color in Drosophila, Blood groups and Rh factor in Human; Allelic series; Lethal alleles; Multi- factorial inheritance- Skin colour in Humans; Penetrance and Expressivity; Plieotropy. Epistasis- dominant, recessive. Supplementary and Complementary gene interactions; Non epistatic inter allelic gene interaction, Position effect.		
MODULE 3: SEX DETERMINATION AND EXTRA CHROMOSOMAL INHERITANCE		12Hrs
Chromosomal theory of Inheritance - Concepts and evidences. Mechanism of sex determination- XX-XY; XX-XO; ZZ-ZW; Bridges genetic balance theory. Environmental and hormonal control of sex determination Gynandromorphs /		

Intersexes, Super sexes in <i>Drosophila</i> . Sex differentiation and dosage compensation (<i>Drosophila</i> and Man). Sex linked and sex-limited traits in Humans. Hemophilia, Hypertrichosis. Extra Chromosomal inheritance, flower colour in <i>Mirabilis jalapa</i> , kappa particle in <i>Paramecium</i> , sigma factor in <i>Drosophila</i> , Cytoplasmic Male Sterility (CMS) in maize.	
MODULE 4 MODEL ORGANISMS IN GENETICS	12Hrs
Bacteria - <i>E. coli</i> ; Viruses - Tobacco Mosaic Virus; Bacteriophage - Lambda Phage; Fungi- <i>Neurospora</i> species, <i>N. crassa</i> , <i>Saccharomyces cerevisiae</i> ; Nematode - <i>Caenorhabditis elegans</i> , Plant - <i>Arabidopsis thaliana</i> , Fly - <i>Drosophila melanogaster</i> , Fish - Zebra fish (<i>Danio rerio</i>), Mammal - Mice (<i>Mus musculus</i>) and Rat (<i>Rattus rattus</i>).	

TEXT BOOK:

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Strickberger M. W., Genetics. (1968) Macmillan Publishers.

REFERENCES:

1. Mathew Hamilton, (2009) Population Genetics, Wiley-Blackwell
2. Snustad D. P., Simmons M. J., Principles of Genetics. 5th Edition (2008) John Wiley & Sons.
3. Brooker R. B., Genetics Analysis and Principles. Fourth Edition (2009) McGraw-Hill.
4. Tamarin R. H., Principle of Genetics. Seventh Edition. (2002) Tata-McGraw Hill.
5. Hart D and Jones E.W., Genetics Principles and Analysis. 4th Edition (1998) Jones and Bartlett Publication.
6. Atherly A. G., Girton J. R. and Donald M. C. J. F. The Science of Genetics (1999) Sounders College Publication / Harcourt Brace.
7. Sturtevant A. H., A History of Genetics (1965). Harper and Row New York. Mendel G. The First Geneticist by Orel V. (1996) Oxford University Press, New York.
8. Ross S. A first course in Probability. 4th Edition (1994). McMillan, New York.
9. Stansfield W. D., Theory and problems of Genetics (Schaum s Outline Series). (2002) McGraw Hill.
10. Stubbe H., History of Genetics (1972). Harper and Row New York.
11. Prasad S. Fundamentals of Biostatistics (1993). Emkay publications, New Delhi.
12. Khan and Khanum. Fundamentals of Biostatistics. II Revised Edition. (2004). Ukaaz Publication.

SEMESTER	I					
YEAR	I					
COURSE CODE	20BS1101					
TITLE OF THE COURSE	BASIC CHEMISTRY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To make the students to understand basic facts and concepts in chemistry while retaining the exciting aspects of chemistry so as to develop interest in the study of chemistry as a discipline.
- To make the students to familiarize with the basic concepts related to modern atomic theory, quantum chemistry, acids and bases, chemical bonds in molecules and basics of organic chemistry and different organic reactions.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will learn about handling of data and basics of acids and bases	L1
CO2	Students will learn about advanced principles of atomic structure	L2
CO3	Students will get in depth knowledge about chemical bonding and various theories related to that.	L3
CO4	Students will learn about the basic principles of organic chemistry	L1

COURSE CONTENT:

MODULE 1	12Hrs
GENERAL CHEMISTRY: Handling of analytical data: SI and CGS units of measurements and physical constants and their inter conversion; Significant figures and calculations, accuracy, precision and errors in quantitative analysis. Stoichiometry: atomic weights, molecular weights, mole concept, molarity, molality, normality, mole fraction, ppt, ppb and ppm. Numerical problems related to the above concepts. Acids and Bases: Theories of acids and bases – Arrhenius - Bronsted-Lowry theory - Lewis theory -Solvent system definition. Relative strengths of acids and bases – Dissociation constant of acids and bases - Levelling effect of water. Hard and soft acids and bases (HSAB). Non-aqueous solvents – classification - Liquid ammonia as solvent. Acid-base equilibria in aqueous solution and pH. Acid- base neutralisation curves; indicator, choice of indicators.	
MODULE 2	12Hrs

ATOMIC STRUCTURE: Review of Bohr's theory and its limitations, dual behavior of matter and radiation, de Broglie's equation-derivation, Heisenberg's uncertainty principle. Hydrogen atomic spectra. Need of a new approach to atomic structure. Elements of Quantum chemistry- Schrodinger wave equation and meaning of various terms in it. Significance of ψ and ψ^2 , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Quantum numbers and their Significance. Shapes of s, p and d atomic orbitals, nodal planes. Rules for filling up of electrons in various orbitals (Aufbau principle, Pauli's exclusion principle, Hund's rule of maximum multiplicity and n+l rule), Electronic configuration of the elements (up to Z=30) and anomalous electronic configurations. Stability of half-filled and completely filled orbitals- concept of pairing and exchange energy.

MODULE 3

12Hrs

Introduction: Need for the atoms to form molecules, and types of chemical bonds with examples *Ionic Bond:* Definition and conditions for formation of an ionic bond between atoms, examples of formation of an ionic compound between alkali metal/alkaline earth metals and chalcogen/halogen group elements. Lattice energy, its effect on stability and solubility of ionic solids, Born – Haber cycle for NaCl, KBr, KI, and MgO and CaCl₂). *Covalent Bond:* Definition, octet rule, Lewis dot formulae of a few simple molecules and ions, electron deficient and excess molecules (BeCl₂, BF₃, PCl₅, SF₆). *Geometry of covalent molecules:* (VSEPR concept and hybridisation concepts) basic concepts and definitions: Examples simple inorganic molecules and ions. such as NH₃, H₂O, H₃O⁺, SF₄, ClF₃. *Theories of covalent bonds (VBT and MOT):* *Valence bond theory (VBT):* postulates and its limitations, directional characteristics of covalent bonds, Application of VBT to BeCl₂, BF₃, SiCl₄, PCl₅, SF₆ molecules. *Molecular orbital theory:* postulates, linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals, pictorial representation of formation of s and p MOs from the corresponding atomic orbitals, Molecular orbital energy level diagram and molecular orbital configuration involving s and p orbitals their importance for the following molecules, (H₂, N₂, O₂, HF and CO). *Metallic Bond:* Definition, properties of metals and band theory. *Weak Intermolecular interactions:* van der Waals forces, dipole-dipole interactions and their significance. *Hydrogen Bond:* Definition, types, importance

MODULE 4

12Hrs

Representation of structural formula of organic compounds: condensed formula and bond line formula of organic compounds, classification of organic compounds based on functional groups with examples *IUPAC nomenclature:* IUPAC nomenclature of organic compounds including Bifunctional compounds and substituted benzenes. (o, p and m). *Delocalisation of electrons:* Inductive effect, electrometric effect, resonance (mesomeric effect, EWG and EDG, +M and –M effects) and hyper conjugation. *Reactive intermediates:* Types of bond cleavage, curly arrow rules in representation of mechanistic steps; electrophiles, nucleophiles, carbocations, carbanions, free radicals and carbenes— generation, structures, stability and examples. *Types of organic reactions:* Types of organic reactions with examples (electrophilic/ nucleophilic substitution/addition/free radical reaction with examples. *Aromaticity:* Kekule structure of benzene - molecular orbital picture of benzene – resonance energy and stability of benzene - Huckel's rule (aromatic,

non-aromatic, and antiaromatic molecules) - aromaticity of benzene and benzenoid compounds – aromaticity of three, four, five, six, seven and eight-membered systems - annulenes.

TEXT BOOKS:

1. A New Concise Inorganic Chemistry”, J. D. Lee, 5th Ed, Chapman & Hall, London (1996).
2. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992)
3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)

REFERENCES :

1. A New Concise Inorganic Chemistry”, J. D. Lee, 5th Ed, Chapman & Hall, London (1996).
2. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992)

SEMESTER	I					
YEAR	I					
COURSE CODE	20BT1171					
TITLE OF THE COURSE	TECHNIQUES IN CELL BIOLOGY - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
			4	-	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To equip students with the basic techniques used in cell biology
- To facilitate the study of cell size, cell count, stages in cell division, staining of cells

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Able to perform staining of cells	L3
CO2	Identify stages of mitosis and meiosis	L3
CO3	Be well versed with the use of simple and compound microscope	L4

List of Laboratory/Practical Experiments activities to be conducted (if any):
1. Introduction to Microscopy (Bright Field, Dark Field, Phase Contrast Microscopy)
2. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.
3. Cell division: Study of mitosis using onion root tips.
4. Preparation of Buccal smears for study of Barr bodies.
5. Vital Staining of mitochondria (yeast).
6. Blood smear-differential staining.
7. Study of model organisms - -Tobacco Mosaic Virus, Lambda Phage, Neurospora crassa, Caenorhabditis elegans, Arabidopsis thaliana, Drosophila.

TEXT BOOKS:

1. Dr. Renu Gupta , Dr. Seema Makhija , Dr. Ravi Toteja. Cell Biology: Practical Manual. Prestige Publishers, 2018.

REFERENCES:

1. Amit Gupta and Bipin Kumar Sati . Practical laboratory manual- CELL BIOLOGY. LAP Lambert Academic Publishing, 2019.
2. Alberts et al., (2002). Molecular Biology of the Cell, Garland Publishing, Inc., 4th ed.

SEMESTER	I					
YEAR	I					
COURSE CODE	20BC1171					
TITLE OF THE COURSE	BASIC BIOCHEMISTRY - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	0	NA	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To familiarize the students with good lab practise how to make buffers.
- To create general understanding about detection of biomolecules.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will be familiarized with handling laboratory equipment like weighing balance, pH meter and potentiometer and learn the importance and preparation of buffers.	L2
CO2	They will have an understanding of biomolecule composition of edible materials	L3

EXPERIMENTS/PRACTICALS:

1. Calculation and preparation of buffers
2. Potentiometric titration of potassium hydrogen phthalate/HCl and sodium carbonate
3. Potentiometric titration of HCl and sodium bicarbonate/ sodium hydroxide
4. Potentiometric titration of amino acid against NaOH and HCl
5. Estimation of proteins milk.
6. Estimation of carbohydrates in vegetables (Potatoes etc)
7. Estimation of lipids in milk/vegetables (avocadoes etc)
8. Estimation of iodine number of edible oils
9. Estimation of ascorbic acid in fruits by titrimetric method.

TEXT BOOKS:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7th ed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER	I					
YEAR	I					
COURSE CODE	20GN1171					
TITLE OF THE COURSE	BASIC GENETICS - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	0	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To differentiate between the various stages of meiosis in animal and plant cells.
- To gain insight as to the different genetic interactions and their effect on phenotype.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will gain skills to process tissue into slides and distinguish various meiotic stages.	L3
CO2	Students will be capable to analyse and identify gene interactions, predict crosses and understand its role in inheritance.	L4

List of Laboratory/Practical Experiments activities to be conducted (if any):
1. Temporary squash preparation of : Grasshopper Testes, Onion flower bud
2. Observation of meiotic stages in permanent slides
3. Blood Typing
4. Sex differentiation in <i>Drosophila</i>
5. Detection of sex chromatin bodies: Preparation of Barr bodies from bucal smears.
6. Genetic problems on: (a) Probability (b) multiple alleles (c) Gene interactions (d) Sex Linkage
7. Study of: (a) Flower color in <i>Mirabilis jalapa</i> (b) Coat color in Mice (c) Comb pattern in fowl.

REFERENCES

1. Brooker, R. J. 1999. Genetics: Analysis and Principles. Benjamin Cummings, Longman, INC.
2. Gardner E. J. M. J. Simmons and D.P. Snustad 1991 Principles of Genetics. John Wiley & Sons. INC. New York.
3. Klug, W. S. and M. R. Cummings 1994 Concepts of Genetics MacMillan Colley Publishing and Company NY.
4. Strickberger M. W. 1996. Genetics. Mac Millan Publishing Co. New York
5. Tamarin, R H. 1999. Principles of Genetics. McGraw-Hill.

SEMESTER	I					
YEAR	I					
COURSE CODE	20BS1102					
TITLE OF THE COURSE	COMMUNICATIVE ENGLISH					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	24	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To encourage the students to speak English confidently and enable them to communicate for day-to-day needs
- To build up their confidence in the usage of English and to enhance their written communicative competence also helping them for competitive exams

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students are confident in oral and written communication	L1
CO2	Have enhanced competence for competitive exams	L2

COURSE CONTENT:	
MODULE 1	
6Hrs	
COMMUNICATION SKILLS	
Definition, importance of communication, communication process – source, message, encoding, channel, decoding, receiver, feedback, context, levels of communication, Flow of Communication, Verbal and Non-Verbal Communication, Barriers to Communication - physiological, physical, cultural, language, gender, interpersonal, psychological, emotional. Perspective in communication/ Communication styles: introduction, visual perception, language, other factors affecting our perspective – past experiences, prejudices, feelings, environment	
MODULE 2	
6Hrs	
Elements of communication – introduction, face to face communication – tone of voice, body language (non-verbal communication), verbal communication, physical communication;	
Basic listening skills: introduction, self-awareness, active listening, becoming an active listener, listening in difficult situations;	
Interview skills: purpose of an interview, do's and don't's of an interview;	
Giving presentations: dealing with fears, planning your presentation, structuring your	

presentation, delivering your presentation, techniques of delivery; Group discussion: introduction, communication skills in group discussion, do's and don't's of group discussion; Phonetics: The Organs of Speech, The Description and Classification of Speech Sounds, The Description and Classification of Vowels, The Description and Classification of Consonants, Phonetic symbols and the IPA, Phonemic and Phonetic Transcription Phonology, Phoneme sequences and Consonant Cluster, The Syllable, Word Accent, Accent and Rhythm in Connected Speech, Intonation, Varieties of English Pronunciation.	
MODULE 3	6Hrs
EFFECTIVE WRITING SKILLS Effective written communication: introduction, when and when not to use written communication – complexity of the topic, amount of discussion required, shades of meaning, formal communication Writing effectively: subject lines, put the main point first, and know your audience, organisation of the message, Paragraph Writing, Letter Writing, Report Writing, Book Review, Scientific writing, Making a message – Transitivity/ intransitivity – complementation – talking about closely linked action – using two verbs together (eg: She started laughing), Transforming messages – Making statements, questions, orders and suggestions – denying – rejecting – disagreeing – possibility – ability, permission, obligation etc.	
MODULE 4	6Hrs
GRAMMAR Word Classes: Open Word Classes: - Nouns, Verbs, Adjectives, Adverbs, Pronouns; Closed Word Classes: - Pre-determiners, Determiners, Numerals, Enumrators, Prepositions, Conjunctions, Auxiliary Verbs, Interjection; Morphology: Bound and Free Morphemes; Affixes, Stems and Roots; Morphological Analysis; Phrases: Noun Phrase, Verb Phrase, Genetive Phrase, Adjective Phrase, Adverb Phrase, Prepositional Phrase, Phrases and its types, Clauses and its types, Sentences and its types, Common errors, phonetics; Clauses: Clause Elements, Clause Types, Kinds, Concord; Sentences: Simple Sentences, Compound Sentences, Complex Sentences; Sub Ordination: Sub-Clauses, Finite and Non-Finite Sub-Clauses; Co-ordination: Linked and Unlinked Coordination, Synthesis; Ambiguity: Types of Ambiguity, Structural and Lexical Ambiguity; Common Errors: Nouns and Pronouns, Articles, Verbs, Concord, Adjectives, Adverbs, Prepositions, Vocabulary, Expressing time, Referring to present, past and future time - use of adjuncts - frequency and duration, Talking about manner and place, Information about place, manner - position of adjuncts - types of adverbs (time, frequency, duration etc), Reporting what people say/think, Reporting verbs - reporting someone's actual words - reporting in one's own words, The structure of information, Focusing on the thing affected (passive voice) - selecting focus (left structure) taking the focus off the subject (impersonal 'it' etc.) – Introducing something new (with 'there') - focusing on information using adjuncts.	

TEXT BOOKS:

1. Crystal, David. 1985, Rediscover Grammar with David Crystal. Longman
2. Bakshi, R. N. A Course in English Grammar. Orient Longman Close, R. A.

- Reference Grammar for Students of English. Orient Longman
3. Krishnaswamy, N. Modern English – A Book of Grammar, Usage & Composition. Macmillan India, Ltd.
 4. Aroor, Usha (Ed.) Word Master Learner's Dictionary of Modern English. Orient Longman 17
 5. Hewings, M. 1999, Advanced English Grammar. Cambridge University Press
 6. Basic communication skills for technology, Andreja J. Ruther Ford, 2nd Edition, Pearson Education, 2011.
 7. Communication Skills, Sanjay Kumar, Pushpalata, 1st Edition, Oxford Press, 2011.
 8. Brilliant – Communication Skills, Gill Hasson, 1st Edition, Pearson Life, 2011.
 9. Soft Skill and Professional Communication, Francis Peters SJ, 1st Edition, Mc Graw Hill Education, 2011.

SEMESTER	II					
YEAR	I					
COURSE CODE	20BT1201					
TITLE OF THE COURSE	PRINCIPLES OF IMMUNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To provide basic understanding on Immune system: Cells and organs of the immune system and its fundamentals.
- To give basic framework and knowledge on structure and functions of antibodies, antigens and antigen specificity of antibodies. antigen -antibody interactions, generation of immune response and to equip the students with knowledge on immunological techniques, vaccines.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be acquainted with the basic understanding of immune system in its entirety: the big picture.	L1
CO2	Acquaintance with the basic working of antibodies, functions of antibodies and their antigen specificity.	L2
CO3	Basic concepts of immune response: antigen processing and presentation, clonal selection and expansion. To enable critical thinking about its protective role in infectious diseases and their control; vaccinations.	L4
CO4	Fundamental understanding of basic immunological techniques and their applications.	L3

COURSE CONTENT:	
MODULE 1: COMPONENTS, CELLS AND TISSUES OF THE IMMUNE SYSTEM	
	12Hrs
Elements of Immune System: History and scope of Immunology, Innate, and Acquired immunity, Humoral and Cell mediated Immunity. Cells and organs of immune system and their functions – Primary and secondary lymphoid organs, T cells, B Cells, macrophage, NK cells Basic outline or scheme of clonal selection in the humoral (B cell) and cellular (T cell) branches of immunity. Immunological memory.	
MODULE 2: ANTIGENS AND ANTIBODIES	
	12Hrs
Antigens and Antibodies: Antigens – types, epitopes, haptens, factors affecting	

immunogenicity, adjuvant concept; Antibodies – structure, isotypes, and functions of Immunoglobulins. Antibody production: Polyclonal and monoclonal. Complement system – components, functions, activation pathways (classical, alternative, lectin mediated).	
MODULE 3: IMMUNE RESPONSES	12Hrs
Antigen processing and presentation, antigen presenting cells (APCs), target cell concept; Major Histocompatibility Complex (MHC) – MHC I and II. Interleukins and Interferons – brief introduction and their important functions. Products and factors produced by T-cell activation; dendritic cells; cytokines (interleukins and interferons) Primary and secondary Immune response.	
MODULE 4: IMMUNOLOGICAL TECHNIQUES AND VACCINES	12Hrs
Antigen-Antibody reactions – Precipitation, Immunoelectrophoresis, Hemagglutination – Blood grouping, ELISA, RIA, Immunofluorescence. Vaccines and Immunization: Passive and Active immunization, immunization schedules. Types of Vaccines – Inactivated, Attenuated, and Recombinant vaccines – Peptide and DNA Vaccines.	

List of Laboratory/Practical Experiments activities to be conducted (if any) : NONE
1.
2.

TEXT BOOKS:

1. Kindt TJ, Osborne BA, Goldsby RA. Kuby Immunology, Sixth Edition. 6th edition. New York: W. H. Freeman & Company; 2006.
2. C Vaman Rao (2007) Immunology (2nd Ed), Narosa Publishing.
3. Abbas, Lichtman, Pillai (2011) Cellular and Molecular Immunology (7th Ed), Elsevier

REFERENCES:

1. Roitt IM (2001) Essentials of Immunology, Blackwell Scientific Publishers, London. Murphy, K., Weaver, C., Weaver, C., 2016. Janeway's Immunobiology. W.W.Norton & Company. <https://doi.org/10.1201/9781315533247>.
2. Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J., Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J., 2001. Immunobiology, 5th ed. Garland Science.
3. Kuby Immunology 7th edition. Macmillan Publishers 2014.
4. Kuby Immunology, 8th Edition. Macmillan Publishers 2019.

SEMESTER	II					
YEAR	I					
COURSE CODE	20BC1201					
TITLE OF THE COURSE	BIOANALYTICAL TECHNIQUES					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To create general understanding about theoretical concepts of techniques used to detect and assay biomolecules.
- To familiarize the students with basic concepts and principles of biophysical and biochemical techniques used in biological sciences.
- To give holistic view for understanding the screening, isolation, separation and characterization of molecules.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be scientifically equipped with understanding of the about the different biomolecules and their important functions.	L3
CO2	Student will be aware of the analytical tools and their instrumentation used in biotechnology/biological sciences.	L3
CO3	Students will have a basic understanding of biomedical equipments	L4
CO4	Students will be empowered for better prospects leading to project design and execution.	L3

COURSE CONTENT:	
MODULE 1	
12Hrs	
Spectroscopy: Wave particle duality, the concepts of electromagnetic spectrum, Concepts of Absorbance and Emission Spectroscopy, Beer-Lambert's law, application and its limitations. Extinction coefficient, Concepts of chromophore/auxochrome and Chromic shifts. Principle, schematics and applications of Colourimeter and UV-Vis Spectroscopy. Assay of biomolecules (Carbohydrates and Proteins). Principle, schematics and application of Luminometry, Tubidometry, Klett Photometry, Flame photometry and IR spectroscopy.	
MODULE 2	
12Hrs	
Chromatography History and principle of Chromatography. Distribution/partition coefficient, Absorption and Adsorption phenomenon, Retention factor (R _f & R _t concepts). Types: Planar and columnar, S-L, L- L, G-S, G-L and G-G. Paper and thin layer chromatography, types and their	

application in separation of biomolecules. Plate theory and Rate of theory; resolution, selectivity and effectiveness of columns, Types of matrices used, separation of biomolecules using gel permeation, ion exchange, affinity and adsorption chromatography with applications. Brief idea about High Performance Liquid Chromatography (HPLC) and Gas Chromatography (GC).	
MODULE 3	12Hrs
Electrophoresis: Migration of ions in electric field, Factors affecting electrophoretic mobility. Paper electrophoresis, Cellulose acetate electrophoresis, High voltage electrophoresis and their Applications. Gel electrophoresis - Types of gels, Procedure, for gel making. Detection, Recovery & characterization of macromolecules (molecular weight determination and subunit enumeration). Principle and application of Poly acrylamide Gel Electrophoresis (PAGE), Iso-electric focussing (IEF) and 2D-PAGE, Submerged agarose gel electrophoresis (SAGE). Application of electrophoresis in molecular biology (genomics, transcriptomics and proteomics).	
MODULE 4	12Hrs
Isotopic tracer technique: Radioactive & stable isotopes, Pattern and rate of radioactive decay. Measurement of radioactivity: Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique), Autoradiography their advantages and limitations. Centrifugation: Basic principles, RCF, Svedberg constant and Sedimentation coefficient. Preparative centrifugation: Differential & density gradient centrifugation, Applications. Analytical centrifugation: Determination of molecular weight of biomolecules. Immunological techniques: Immuno-diffusion, immuno-electrophoresis and immuno-fluorescence.	

TEXT BOOKS :

1. Principles and Techniques of Practical Biochemistry – Keith Wilson and John Walker. Cambridge low price edition.
2. Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications

REFERENCES:

1. Analytical Techniques in Biochemistry and Molecular biology – Katoch. Springer.
2. Fundamentals of Analytical Chemistry - Skoog, Holler and West. Saunders.
3. Handbook of Analytical Techniques – Gunzler and Williams. Wiley & Sons.
4. Immunology – Kubly. Freeman Publishers.
5. A Textbook of Practical Biochemistry- Joshi and Saraswat. Jain Publishers.

SEMESTER	II					
YEAR	I					
COURSE CODE	20GN1201					
TITLE OF THE COURSE	FUNDAMENTALS OF CYTOGENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Understand the characteristics of chromosome and its related anomalies.
- Elucidation on the versatility of the chromosomes and its different interactions.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will learn details on chromosomes, its conformations to bring about genetic variability.	L2
CO2	The students will get insight on chromosome abnormality which leads to cytogenetic aberrations and disease.	L3

COURSE CONTENT:

MODULE 1 CHROMSOME CHARACTERISTICS		12Hrs
Physical basis of inheritance: chromosome theory of inheritance, Eukaryotic Chromosome-Macro- molecular organisation. Primary and Secondary constriction, Sat-bodies, telomeres, chromosome types. Heterochromatin and Euchromatin and its significance. Ultra structure of chromosome, Nucleosome model and Nucleosome Structure. Karyotype and Ideogram. Special types of chromosomes: Polytene chromosome- Salivary gland chromosome in Drosophila, Lamp- brush chromosome in amphibian Oocyte, B Chromosome.		
MODULE 2 LINKAGE		12Hrs
Introduction and definition of Linkage, Discovery of linkage, Coupling and Repulsion hypothesis, Linkage group- Drosophila, maize and man, Types of linkage-complete linkage and incomplete linkage, Factors affecting linkage - distance between genes, age, temperature, radiation, sex, chemicals, nutrition, etc. Sex Linkage: Meiotic behavior of chromosome and non- disjunction. Bridges theories of non-disjunction. Sex linkage in Drosophila.		
MODULE 3 CROSSING OVER		12Hrs
Crossing over- definition and types of crossing over-germinal and somatic crossing over. Cytological basis of crossing over- Sterns experiments in Drosophila.		

Mechanism of crossing over - chiasma type theory, the breakage first theory, the contact first theory, strain or torsion theory. Molecular mechanism of crossing over- Holliday model, single strand breaks.	
MODULE 4 CHROMOSOMAL ABERRATIONS	12Hrs
Numerical- Euploidy (Monoploidy, Haploidy and Polyploidy). Polyploidy- Autopolyploidy and Allopolyploidy. Aneuploidy- Monosomes, Nullisomes and Trisomes. Structural- Deletions, Duplication, Translocation, Inversions, Centric fusion and centric fission. Evolutionary significance of chromosomal aberrations. Genetic diseases and disorders.	

TEXT BOOK:

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Strickberger M. W., Genetics. (1968) Macmillan Publishers.

REFERENCES:

1. Gupta P. K. 2009. Cytology, Genetics and Molecular Biology. Rastogi Publications.
2. Winter P. C., Hickey G. I. & Fletcher H. L. 2003. Instant notes in Genetics. Viva Books Pvt.Ltd.
3. Weaver R. F., Hendrick P. W. and Brown W.C. 1992. Genetics, 2nd Edition.
4. Sinha U., Sunita and Sunita Sinha.1981 Cytogenetics: Plant Breeding and evolution. Vikas publishing House.
5. Snustad D. P. and Simmons M. J. 2009. Principles of Genetics. John Wiley and Sons, INC.
6. Phundan Singh. 2013. Elements of Genetics, Edition 4, Kalyani Publishers.
7. Edgar Altenburg. 1970. Genetics. Oxford & IBH Publications.
8. Gardener E. J., Simmons M. J. and Snustad D. P. 1998. Principles of Genetics J. Wiley and Sons pubs.
9. Obe. G. and Natarajan A.T. 1990 Chromosomal Aberrations: Basic and Applied aspects Springer Verlag, Berlin.

SEMESTER	II					
YEAR	I					
COURSE CODE	20BS1201					
TITLE OF THE COURSE	BIOINFORMATICS AND BIOSTATISTICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To create general interest in applied domain towards using computers for biological applications.
- To familiarize the students with basic concepts and principles statistics and their applications in biological sciences.
- To give holistic view for understanding the scientific validation and biomodelling.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be aware of various applied and allied scientifically domains to innovative and creative think.	L2
CO2	Student will be aware of the computer tools and applications which can be implemented in biological sciences.	L2
CO3	Students will be empowered for better prospects leading to project design and execution.	L3

COURSE CONTENT:	
MODULE 1	
12Hrs	
Introduction to computers: History of Computers, Components of computers (Hardware, Software and accessories). Concepts on Computer software, operating system (Windows), tools and applications of MS Office (notepad, word processor, spread sheet & presentation). Introduction to networks: LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls. Concepts on encryption of data. Relational Databases Management (RDMS): Codd Rules and concepts of databases, Data mining and applications, accessing bibliographic databases and Basics on citation and indexing (Pub Med and Google scholar).	
MODULE 2	
12Hrs	
Bioinformatics (Genomics): Nucleic acid sequence databank – NCBI, EMBL and DDBJ. Microbial genomic database	

(MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER. Gene Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs.	
MODULE 3	12Hrs
Bioinformatics (Proteomics): Introduction to protein structure – Primary, secondary structure prediction, tertiary structure prediction. Concepts on Protein Data Bank (PDB). Protein Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of proteins, domain and motif and Phylogenetic analysis. Protein sequence databank – NBRF-PIR, SWISSPROT and Swiss ExPASy. Metabolic pathway data bank (KEGG/Pub gene). Protein modeling - principles of homology and comparative modeling phylogenetics. Applications - Molecular docking – Patchdoc /Autodoc.	
MODULE 4	12Hrs
Biostatistics: Introduction to Biostatistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error. Sampling methods and their significance. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Statistical package - Features of statistical software. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases.	

TEXT BOOKS:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Bioinformatics. Keith, J. Humana Press, 2008.
4. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.

REFERENCES:

1. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists.
2. Bazin, M.J. (1983). Mathematics in microbiology Academic press.
3. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
4. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge.
5. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.
6. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
7. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series.
8. Higgins & Taylor (2000). Bioinformatics, OUP.
9. Baxavanis (1998). Bioinformatics.
10. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.

SEMESTER	II					
YEAR	I					
COURSE CODE	20BT1271					
TITLE OF THE COURSE	IMMUNO-TECHNIQUES – LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	32	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To acquaint the student with some basic techniques in immunology, to sensitize them to antigen antibody reactions and their applications
- To enable the students to get hands on learning to count viable cell in a hemocytometer and enable them to learn staining and identification of different white blood cells from the peripheral blood.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be familiarized with immunological techniques utilized for diagnostic assays.	L2
CO2	Student will be able to use hemocytometer to do cell counting and be able to stain and identify leucocytes from peripheral blood.	L2
CO3	Principle of ELISA and working of dot ELISA. ELISA as a quantitative tool to measure specific analytes.	L3
CO4	Know the principles behind hemagglutination vs Immunoprecipitation techniques and correlate differentiate between soluble to insoluble(particulate) antigen concepts	L3

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Blood group identification and Rh Typing
2. Precipitation Reactions – I. Radial Immuno Diffusion II. Ouchterlony double diffusion III. Rocket Immuno Electrophoresis
3. Dot ELISA
4. Serum separation and quantification of serum proteins
5. Introduction to instruments and laboratory set up for animal biotechnology
6. Determination of the concentration of viable cells in a suspension by Hemocytometer counting (trypan blue)
7. Study of different cells in whole blood using Giemsa/Leishman stain.

TEXT BOOKS:

1. Balakrishnan, Senthilkumar & Karthik, Kaliaperumal & Duraisamy, Senbagam. (2015). Practical Immunology- A Laboratory Manual. 10.13140/RG.2.1.4075.4728
2. Hay, F.C., Westwood, O.M.R., 2002. Practical Immunology, 4th edition. ed. Wiley-Blackwell, Malden, MA.

REFERENCES:

1. Lab Manual in Biochemistry, Immunology and Biotechnology by Nigam, Arti - AbeBooks.” McGraw-Hill Education (India) (2008)

SEMESTER	II					
YEAR	I					
COURSE CODE	20BC1271					
TITLE OF THE COURSE	BIOANALYTICAL SEPARATIONS - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
		0	4	0	NA	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To make students learn quantitative and qualitative methods for study of biomolecules.
- To provide hands-on training to physico-chemical methods.
- To give insights on isolation, separation and characterization of biomolecules.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be equipped with methodology to study biomolecules using spectroscopic, electrophoretic and chromatographic techniques.	L2
CO2	Students will have a complete understanding on methods to analyse biomolecules.	L3
CO3	Students will be empowered for better prospects leading to project design and execution.	L4

EXPERIMENTS/PRACTICAL:
1. Determination of extinction coefficient using colorimetry.
2. Determination of lambda maximum of biomolecules using UV spectroscopy.
3. Estimation of protein by Lowry method or Estimation of sugar by Miller method.
4. Estimation of pKa of amino acid (glycine).
5. Determination of density & viscosity of given unknown solution.
6. Circular Paper chromatography for amino acid/ sugars and Rf calculations.
7. Separation of amino acid by Thin Layer Chromatography (TLC).
8. Column chromatography of phyto-pigments on adsorbent (silica/alumina).

TEXT BOOKS:

1. Principles and Techniques of Practical Biochemistry – Keith Wilson and John Walker. Cambridge low price edition.
2. Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications.
3. Analytical Techniques in Biochemistry and Molecular biology – Katoch. Springer.

4. Fundamentals of Analytical Chemistry - Skoog, Holler and West. Saunders.
5. Handbook of Analytical Techniques - Gunzler and Williams. Wiley & Sons.
6. A Textbook of Practical Biochemistry- Joshi and Saraswat. Jain Publishers.

SEMESTER	II					
YEAR	I					
COURSE CODE	20GN1271					
TITLE OF THE COURSE	FUNDAMENTALS OF CYTOGENETICS - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	0	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Identifying chromosome features and their status in animal and plants.
- Analyse linkage and crossing over problems by mapping method.
- Understanding cytogenetics using Drosophila as a model organism.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will gain skill to prepare and visualize chromosomal slides from various sources.	L3
CO2	Students can solve genetic linkage analysis by construction of cytogenetic maps on linkage. gene interactions, predict crosses and understand its role in inheritance.	L4
CO3	Students will become skilled in handling and maintaining Drosophila cultures.	L2

List of Laboratory/Practical Experiments activities to be conducted (if any):
1. Micronuclei from buccal cell (H&E basic staining)
2. Preparation of Metaphase spreads from blood for Karyotyping.
3. Genetic Problems on linkage & crossing over - Drosophila, Maize, Human (Sex Linkage)
4. Study of chromosomal aberration using karyotype information by observation of permanent slides of chromosomal aberrations. Cytogenetics using Drosophila as a model organism.
5. Culturing and Handling of Drosophila - Media preparation, Handling drosophila.
6. Study of different types of Drosophila- Body color mutant- Ebony body and Yellow body, Wing mutant- Curly wing and vestigial wing and Eye color mutant- Bar eye, white eye, sepia eye.
7. Mounting of Sex Comb and Genital plate of Drosophila melanogaster
8. Salivary gland Chromosome - Dissection of Salivary glands and preparation of polytene chromosome.

REFERENCES

1. *Drosophila Cytogenetics Protocols*, Methods in Molecular Biology, Volume 247, Daryl S Henderson, Humana Press.
2. *The AGT Cytogenetics Laboratory Manual*, Marilyn S Arsham, Margaret J, March, Helen J Lawce, Fourth Edition, Wiley Blackwell.

SEMESTER	II					
YEAR	I					
COURSE CODE	21BS1202					
TITLE OF THE COURSE	COMPUTER APPLICATIONS AND INFORMATION TECHNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	24	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To create general interest in applied domain towards using computers for biological applications.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be aware of the computer tools and applications which can be implemented in biological sciences.	L2
CO2	Students will be empowered for better prospects leading to project design and execution.	L2

COURSE CONTENT:

MODULE 1 History and Generations of Computers		4Hrs
Evolution, Generations of computers (I, II, III, IV, V) Classification of computers (mainframes, mini computers, microcomputers, special purpose) Comparison with respect to memory, power, cost and size, Real-Time, Online, Offline, Overview and functions of a computer systems, Input and output devices, Storage devices: Hard disk, Diskette, Magnetic tape, RAID, ZIP, devices, Digital tape, CD-ROM, DVD (capacity and access time), Main Circuit Board of a PC: Chips, Ports, Expansion.		
MODULE 2 Categories of Computers and Operating Systems		4Hrs
The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer & the Super Computer, Operating System concepts, Windows 98/XP and later versions, Windows server NT/2000, Unix/Linux & servers. Introduction to networking: various terminologies, Associated hardware devices, gadgets (Router, Switch) tools, services, and resources, Network Topologies and Protocols, LAN, WAN and MAN World Wide Web (WWW) Network security: fire walls.		
MODULE 3		8Hrs
Data processing & presentation: Introduction, Office Automation Software (Open Source Software).		

Computer viruses and Internet Searches: An overview of Computer viruses, What is a virus? Virus symptoms, How do they get transmitted? What are the dangers? General Precautions, Search engines: Google, Yahoo, Concepts in text-based searching, searching Medline, PubMed, and bibliographic databases.	
MODULE 4 Algorithms, Flowcharts, Programming concepts & Bioinformatics	8Hrs
Algorithms: Concepts & definitions, converting algorithms to flowchart; Coding: flowcharts to programs, Comparing algorithms, flowcharts & programs; Introduction & Overview of Biological databases. Introduction to Bio-informatics: Definition, Introduction to data mining, Computational gene finding – multiple alignment and sequence search (BLAST, FASTA, CLUSTALW). Applications of Bioinformatics.	

REFERENCES:

1. Computer Fundamentals, 4th edition (2004) P.K. Sinha, BPB publication, India
2. Computer Networks. 4th edition (2008). Tanenbaum. Pearson Education, India
3. Biostatistics: P.N. Arora, P.K. Malha.
4. Introduction to Database Management Systems, 1st edition, (2004), Atul Kahate, Pearson education, India.

SEMESTER	III					
YEAR	II					
COURSE CODE	20BT2301					
TITLE OF THE COURSE	PRINCIPLES OF RECOMBINANT DNA TECHNOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
	-	-	-

COURSE OBJECTIVES :

- To give foundation of tools, vehicles used in cloning DNA.
- To impart basic principles of various vectors used in rDNA technology, their uses and limitations.
- To inculcate good fundamental knowledge in basics of gene cloning, including detection methods for screening the recombinants.
- To provide basic principles of analysis techniques employed in characterize the cloned recombinant DNA and to promote scope of application of rDNA technology.
- Principles of techniques to characterize cloned DNA, applications of rDNA technology.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand the basic paradigm of rDNA technology and various enzymatic tools, vectors and their utility.	L2
CO2	The sound in knowledge of steps involved in basic gene cloning	L1
CO3	A comprehensive knowledge on the various applications and scope of recombinant DNA technology.	L3

COURSE CONTENT:

MODULE 1: INTRODUCTION TO rDNA TECHNOLOGY

12Hrs

History and fundamentals of r-DNA technology. Molecular tools for gene cloning: Nucleases -Endo and Exonucleases – Nomenclature, Types and characteristic features. Modification of cut ends. DNA ligases and DNA Recombinases. DNA Modifying Enzymes - Alkaline phosphatase, Polynucleotide kinase, DNase, RNase, DNA polymerase and Klenow fragment, terminal nucleotidyl transferase, RNA dependent DNA Polymerase.

MODULE 2: VEHICLES FOR CLONING

12Hrs

Properties of an ideal vector. Types: Cloning and expression vectors. Cloning vectors:

Prokaryotic vectors: Plasmids- pBR 322; pUC 18; Bacteriophages -Lambda phage, Cosmids. Eukaryotic vectors: YAC vectors; Shuttle vectors- Yeast and <i>E. coli</i> . For higher plants: Integrative DNA transfer- Agrobacterium vectors-Ti plasmid-Binary and Co integrated vectors; Non integrative DNA transfer-Plant viral vectors (CaMV) For animals: Animal viral vectors- SV 40 (3 types); Expression vectors in Prokaryotes and Eukaryotes	
MODULE 3: GENE ISOLATION AND TRANSFER	12Hrs
Isolation of passenger DNA. Cutting of DNA molecules - Physical methods, chemical and enzymatic methods. Joining of DNA molecules-Homopolymer tails, Linkers, Adapters. Transformation. Indirect methods - Colony hybridization, Immunochemical detection. Use of selectable and scorable genes: Selectable genes: Plants-npt; Animals-TK. Scorable genes: Plants-Gus; Animals-lux.	
MODULE 4: CHARACTERIZATION OF CLONED DNA	12Hrs
Electrophoresis: AGE and SDS-PAGE. Hybridization: Southern; Northern; Western; Dot blots, Autoradiography, DNA sequencing: Sanger's Dideoxy method, Molecular probes. Application of rDNA technology: Expression vectors (E coli/eukaryotic), Transgenic animals: Mouse (Knock-out; Methodology, applications); A brief account of Transgenic Sheep, Poultry, Fish, Cow, with value added attributes. Transgenic Plants: Resistance to diseases (Pathogen resistant-viral, fungal and bacterial); insects (Bt gene transfer); Fertilizer management- Nif gene transfer.	

TEXT BOOKS :

1. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,
2. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers
3. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publications.

REFERENCES :

1. Glick and Pasternak (2010) Molecular Biotechnology (4th Ed.), Wiley, Washington DC
2. Howe, C. (2007). Contents. In Gene Cloning and Manipulation (pp. V-Vi). Cambridge: Cambridge University Press.
3. Primrose, Twyman and Old (2002). Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
4. Brown TA, Genomes, 3rd ed. Garland Science 2006
5. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER	III					
YEAR	II					
COURSE CODE	20BC2301					
TITLE OF THE COURSE	HUMAN PHYSIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I/I	20BC1101	BASIC BIOCHEMISTRY

COURSE OBJECTIVES:

1. To illustrate the general human physiology in terms of nutrition and energy synthesis.
2. To have an insight into the cellular to organ level differentiation and their related biochemical concepts

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The student will understand the mechanism of action of the energy generation machinery and the organs associated with it.	L2 & L3
CO2	The cell to organ system to organism architecture will be better understood.	L4

COURSE CONTENT:

MODULE 1	12Hrs
Nutrition: Basic principles of a balanced diet to provide energy and nutrients. Respiratory quotient, BMR, SDA and factors affecting them. Role of carbohydrates, protein, lipid and as fuel molecules. Hematology: Blood components and their functions, blood groups: the ABO system. role of hemoglobin in oxygen transport. Various buffer systems of the blood, acid base balance, factors affecting acid-base balance. Respiration: Components of respiratory system: nasal cavity, trachea, pharynx, lungs, bronchi, bronchioles and alveoli and their functions.	
MODULE 2	12Hrs
Biochemistry Cardiovascular System: Basic anatomy of the heart, Physiology of heart, blood vessels and circulation. Basic understanding of Cardiac cycle. Blood pressure and its regulation. Brief outline of cardiovascular disorder (hypertension, arteriosclerosis, myocardial infarction and congestive heart failure). Skeletal system: Tissues - introduction. Extracellular matrix and its components, Bone-ultra structure, composition, cells: osteoblasts, osteocytes and osteoclasts. Bone growth, remodeling and regulation by hormones Muscle: Types – smooth, striated and cardiac. Contractile and regulatory proteins of	

muscle structure of actin and myosin. The sarcomere, sliding filament model of skeletal muscle contraction. Brief idea of contraction of smooth muscles.	
MODULE 3	12Hrs
Digestion: Anatomy of GIT and accessory organs, Regulation of GIT movement, Digestion, absorption and transport of carbohydrates, lipids and proteins. Excretion: Structure of nephron in brief, mechanism of urine formation: Glomerular filtration, Tubular re-absorption & Active secretion, Regulation of acid–base balance by the kidney, Acidosis and alkalosis. Reproduction: Brief account of histological structure of ovary & testis. Structure & functions of male & female sex hormones. Menstrual Cycle.	
MODULE 4	12Hrs
Neurobiology: Structure of Neurons, Physiological properties of Nerve fibers, Detailed account of impulse generation, Membrane potential, development, depolarization and repolarization. Transmission of impulse in myelinated and nonmyelinated nerve fibers. Nernst's and Goldman Equation, Nernst's potential. Synapse and mechanism of synaptic transmission: Cholinergic and adrenergic transmission, Functions of acetyl choline, GABA, dopamine and glutamate as neurotransmitters.	

TEXT BOOKS:

1. Textbook of Medical Physiology – Guyton and Hall. Elsevier.
2. Human Physiology – Chatterjee. Sapna Publishers.
3. Fundamentals of Biochemistry - Deb. Central Publishers.
4. Medical Biochemistry – Chatterjee and Shindey.
5. Biochemistry – Das. Central Publishers.
6. Biochemistry –Jain. Himalaya Publications.
7. Principles of Nutrition – Swaminathan. Himalaya Publications.
8. Laboratory Manual for Practical Biochemistry –Hemavathi, Shivraja and Ganesh. Jaypee Publishers.

SEMESTER	III					
YEAR	II					
COURSE CODE	20GN2301					
TITLE OF THE COURSE	BASIC HUMAN GENETICS AND GENETIC ENGINEERING					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To provide students with basic principles of human genetic engineering including the techniques, applications and limitations.
- To demonstrate the ability to design recombinant molecules and apply information extracted from a variety of sources including journal articles, technical bulletins, product manuals, and drug information sheet to solve problems.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will have knowledge of tools and strategies used in genetic engineering.	L3
CO2	Understanding of applications of recombinant DNA technology and genetics	L4

COURSE CONTENT:	
MODULE 1 HUMAN CHROMOSOMES, INHERITANCE	14Hrs
Human Chromosomes: Normal Human Karyotype: Paris Nomenclature, karyotyping (Quantification of DNA of individual chromosomes), Pedigree studies: Symbols used in pedigree studies, Pedigree analysis & construction, Pedigree analysis for the inheritance pattern of genetic diseases.	
MODULE 2 GENETIC DISEASES AND INHERITANCE PATTERN	5Hrs
Autosomal Dominant Inheritance (Ex.- Adult polycystic kidney, Achondroplasia and Neurofibromatosis). Autosomal Recessive Inheritance (Ex.- Albinism, Sickle cell anemia, Phenylketonuria). X-linked Recessive Inheritance (Ex.- Duchenne muscular dystrophy-DMD). X-linked Dominant Inheritance (Ex.- Xg blood group). Y-linked inheritance (Holandric gene Ex.- Testes determining factor - TDF). Multi-factorial inheritance (Ex.-Congenital malformations- Cleft lip and palate, Rheumatoid arthritis and Diabetes). Mitochondrial diseases (Ex.- Leber's hereditary optic neuropathy).	
MODULE 3 INTRODUCTION TO rDNA TECHNOLOGY	14Hrs
History and fundamentals of r-DNA technology, Tools for r-DNA technology. Molecular	

tools for gene cloning: Nucleases -Endo and Exonucleases – Nomenclature, Types and characteristic features. Modification of cut ends. DNA ligases and DNA Recombinases. DNA Modifying Enzymes - Alkaline phosphatase, Polynucleotide kinase, Klenow fragment, terminal nucleotidyl transferase.

MODULE 4 VEHICLES FOR CLONING

15Hrs

Properties of an ideal vector. Types: Cloning and expression vectors. Cloning vectors: Prokaryotic vectors: Plasmids- pBR322; pUC18; Bacteriophages -Lambda phage, Cosmids. Eukaryotic vectors: YAC vectors; Shuttle vectors- Yeast and E. coli. For higher plants: Integrative DNA transfer- Agrobacterium vectors-Ti plasmid-Binary and Co integrated vectors; Non integrative DNA transfer-Plant viral vectors (CaMV).

REFERENCES:

1. Nicholl D. S. T. An introduction to Genetic engineering (2nd ED), Cambridge University Press, 2002.
2. Satyanarayana U. Biotechnology, Books and Allied (P) Ltd., Kolkata, 2008.
3. Purohit S. S. Biotechnology Fundamentals and applications, student Edition, Jodhpur, 2003.
4. Sandhya M. Genetic engineering: Principles and practice, MacMillan. India Ltd. 2008.
5. Channarayappa. Molecular Biotechnology- Principles and practices, University press (India) Private Limited, 2006.

SEMESTER	III					
YEAR	II					
COURSE CODE	20BS2301					
TITLE OF THE COURSE	MOLECULAR BIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Understand the general principles of central dogma, DNA and RNA types structure and their role in cells.
- Explain the mechanisms of DNA replication, RNA synthesis and repair, various levels of gene expression, regulation and protein function.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Know the importance of recent discoveries and the applications and potential of molecular biology with these technologies.	L1
CO2	Student will gain understanding of chemical and molecular processes that occur in and between cell.	L2

COURSE CONTENT:

MODULE 1 THE MOLECULAR BASIS OF LIFE		12Hrs
Central dogma, DNA and RNA as genetic material – experimental proof. Evidences for DNA as the genetic material- Griffith's transformation experiment, Hershey and Chase experiment, evidence for RNA as the genetic material of viruses (TMV, Retroviruses). Nucleic acids: DNA structure and types (A, B and Z model), Denaturation and renaturation kinetics of DNA, Types of RNA – mRNA, tRNA and rRNA, mi RNA and siRNA.		
MODULE 2 DNA REPLICATION AND ITS COMPONENTS		12Hrs
Replication of DNA (Conservative, Dispersive and Semi Conservative DNA replication, Meselson and Stahl experiment), theta and rolling circle model of replication. Prokaryotic and Eukaryotic – Enzymes and proteins involved in replication.		
MODULE 3 DNA TRANSCRIPTION AND ITS COMPONENTS		12Hrs
RNA polymerases, Mechanism of transcription – initiation, elongation and termination in prokaryotes and eukaryotes. Post-transcriptional modifications of Eukaryotic mRNA (Poly A tailing, 5' capping and splicing mechanisms)		
MODULE 4 TRANSLATION AND REGULATION OF GENE EXPRESSION		12Hrs

Genetic code, wobble hypothesis, Mechanism of translation in prokaryotes and eukaryotes, Post translational modification of Proteins. Regulation of Gene expression in Prokaryotes – Operon concepts, induction, repression, attenuation, examples of Lac and Trp operons. Regulation of Gene expression in Eukaryotes –galactose metabolism in yeast.

TEXT BOOKS:

1. Cell & Molecular Biology by Gerald Karp, 3rd Edition, John Wiley & Sons (2009)
2. Molecular Biology of the Gene by James Watson et al, Pearson Education (2013)
3. Molecular Biology of the Cell, Bruce Alberts et al, Garland Science Publication (2007)
4. Principles of Biochemistry by Nelson and Cox, WH Freeman Publications (2008)
5. Textbook of Cell and Molecular Biology by Ajoy Paul, Books and Allied Ltd (2011).
6. Molecular Biology and Genetic Engineering by P K Gupta, Deep and Deep Publications (2008).
7. Cell Biology, Genetics, Molecular Biology, evolution and Ecology by PS Verma and VK Agarwal, S. Chand Publications (2006).

SEMESTER	III					
YEAR	II					
COURSE CODE	20BT2371					
TITLE OF THE COURSE	TECHNIQUES IN RECOMBINANT DNA TECHNOLOGY - LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	-	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- Understand basic instrumentation and vectors used in routine cloning experiments
- To integrate the theoretical/conceptual principles with experiments
- To develop the ability amongst the students to apply modern genetic engineering techniques in industry and research.
- To enable students to work in a team with multidisciplinary approach.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Be able to gain fundamental working knowledge of basic principles of gene cloning.	L1
CO2	Critically analyse, evaluate and compile received results	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Extraction of DNA from plant/bacteria and animal sources(2 Units)
2. Separation of DNA on agarose gel electrophoresis , Visualization of DNA (2 units)
3. Quantification of DNA by spectrophotometry or DPA method
4. Preparation of competent cells
5. Transformation of bacterial competent cells with plasmid DNA
6. Plasmid extraction
7. Linearization of plasmid DNA

TEXT BOOKS :

1. Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz. Scientific American books. USA. 1983.
2. Biotechnology A Laboratory Course by Becker JM, Caldwell GA, Zachgo EA. Second edition. Elsevier. 1996.

REFERENCES :

1. Primrose, S. B., and R. M. Twyman. Principles of gene manipulation and Genomics, Blackwell Publishing MA. USA. 2006.
2. From Genes to Genomes: Concepts and Applications of DNA Technology by JW Dale and M Schantz. Wiley-Blackwell Publishing. UK. 2012.
3. Molecular Biotechnology: Principles & Applications of Recombinant DNA Glick BR and Pasternak JJ, ASM Press. USA. 2017.

SEMESTER	III					
YEAR	II					
COURSE CODE	20BC2371					
TITLE OF THE COURSE	CLINICAL BIOCHEMISTRY -LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	0	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

1. To provide an advanced understanding and applied knowledge of clinical biochemistry using biological samples (Urine or Blood).

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to perform a range of diagnostic techniques relevant to the field of laboratory medicine.	L3

EXPERIMENTS/PRACTICALS:
1. Qualitative analysis of normal components of urine.
2. Qualitative analysis of abnormal components of urine.
3. Estimation of Glucose estimation by Miller's method /DNS method.
4. Protein/DNA by UV absorption spectroscopy.
5. Estimation of Protein by Folin - Ciocalteu method.
6. Estimation of Iron by Wong's method.
7. Estimation of Phosphate by Fiske – Subbarow's method.
8. Estimation of Creatinine by Jaffe's method.

TEXT BOOKS:

1. Practical Clinical Biochemistry, ed. Harold Varley, 4th edn. CBS Publishers (2088).
2. Practical Clinical Biochemistry: Methods and Interpretation, ed. Ranjna Chawla, Jaypee Brothers Medical Publishers (2096).
3. Practical and Clinical Biochemistry for Medical Students, ed. T.N. Pattabhiraman, Gajanna Publishers (2094).
4. Hawk's Physiological Chemistry, ed. Oser, 14th Edn. (2076), Tata-McGrawHill. Biochemistry, ed. Plummer Tata-McGraw Hill, (2071).

SEMESTER	III					
YEAR	II					
COURSE CODE	20GN2371					
TITLE OF THE COURSE	BASIC HUMAN GENETICS AND GENETIC ENGINEERING-LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	0	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To prepare students for successful career in industry and research institutes.
- To develop the ability amongst the students to apply modern genetic engineering techniques in industry and research.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Proficient in preparing human chromosomes for karyotyping analysis.	L3
CO2	Describe gene cloning, restriction endonucleases, use modern gene technologies are used to elucidate genetic issues	L4
CO3	Critically analyse, evaluate and compile received results	L3

List of Laboratory/Practical Experiments activities to be conducted (if any):
1. Preparation of Human Metaphase Chromosomes
2. Identification of inactivated X chromosome as Barr body.
3. Resolution and molecular weight estimation of fragmented DNA using agarose gel electrophoresis.
4. Preparation of Pedigree chart of some common phenotypic characters of human.
5. Molecular cloning. Demonstrations: i. Plasmid DNA isolation ii. Restriction Digestion iii. DNA ligation iv. Preparation of competent cells and Transformation.

REFERENCES

1. Jocelyn, E. K., Elliot, S. G., Stephen, T. K. (2009), Lewin's Gene X. Jones & Barlett.
2. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. (2014). Lewin's Genes XI. Jones and Bartlet India Pvt. Ltd.
3. Freshney, R.I. (2011). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley online library.

4. Primrose, S. B., and R. M. Twyman. Principles of gene manipulation and Genomics. Blackwell Publishing MA. USA. 2006.
5. 2. Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz. Scientific American books. USA. 1983.

SEMESTER	III					
YEAR	II					
COURSE CODE	20BS2302					
TITLE OF THE COURSE	ENVIRONMENTAL SCIENCE					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	26	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- The course will offer extensive knowledge on environment and the impact it has on life.
- The course equally focusses on the importance of ecological balance.
- The programme is designed to evoke awareness amongst students who seek careers in the environment sector.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO 1	With an understanding of environmental management, students will be able to solve deleterious impacts on the ecosystem.	L2
CO 2	With a background on environmental science, graduates have bright career opportunities in wild life conservation, and other environment sectors.	L3

COURSE CONTENT:

MODULE 1 FOUNDATION ON ECOLOGY & ENVIRONMENT	10Hrs
Organizational level of ecological systems, Abiotic and biotic environment, limiting factors, adaptation, habitat and niche, concept of biosphere, population parameters, structure, growth regulation, interactions between populations, life history strategies (r and k species), the concept of carrying capacity. Structure and function of ecosystems, productivity, decomposition, energy flow, ecological efficiencies, global pattern of productivity, nutrient cycling (Carbon, Nitrogen and Phosphorus), major biomes of India and the world.	
MODULE 2 ENVIRONMENTAL BIOGEOCHEMISTRY	6Hrs
Structure and composition of the atmosphere, radiation budgets, general circulation of the atmosphere, prevailing and adiabatic lapse rates, air masses and fronts, monsoon, vertical profiles of major and trace gases, atmospheric photochemistry, reaction of nitrogen, oxygen, ozone, chlorides etc., properties of dust and aerosols in the atmosphere.	
MODULE 3 ENVIRONMENTAL POLLUTION	5Hrs
Types and major sources of air pollutants, effects of air pollutants on physico-chemical and	

biological properties surrounding atmosphere, air borne diseases and their effects on health. Types and major sources of water pollutants, effects of water pollutants on physicochemical and biological properties of water bodies, water borne diseases with special reference to water pollution. Types and major sources of soil pollutants, effects of soil pollutants on physico-chemical and biological properties of soil. Major sources of noise pollution, effects of noise pollution on health, noise level standard in industrial, commercial, residential and silence zones. Radioactive and thermal pollution sources and their effects on surrounding environment.

MODULE 4 ENVIRONMENTAL MANAGEMENT	5Hrs

Introduction and scope of environmental management, basic concepts of sustainable development, industrial ecology and recycling industry. Role of natural products and bio-diversity in international trade, fundamentals of fossil fuels use, energy production and trade, energy balance and energy audit. Eco-marketing. Environmental Impact Assessment (EIA), general guidelines for the preparation of environmental impact statement (EIS).

REFERENCES

1. Ramesh Vijaya K. (2005). Environmental Microbiology. MGP Publishers, Chennai.
2. Edward Alcamo I. (2001). Fundamentals of Microbiology, Jones and Bartlett Publishers, INC. VI Edition.
3. Kumar H.D. (1995). General Ecology, I Ed. Vikas Publishing House Pvt. Ltd., NewDelhi.
4. Pepper W. (1995). Environmental Microbiology. A.P. Publishers.
5. William C. Frazier and Dennis C. Westhoff. (1995). Food Microbiology, Tata McGraw-Hill Publishing Company limited, New Delhi, IVth Edition.
6. Odum E.P. (1971). Fundamental Ecology, 5th Ed., Saunders.
7. Kormondy E.J. (1962). Concepts of Ecology, Prentice Hall. 8.Singh H.R. (1989). Animal Ecology and Environmental Biology. Nagin Chand & Co. Shoban Lal (1992). Ecology.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20BT2401					
TITLE OF THE COURSE	PRINCIPLES OF ANIMAL AND PLANT BIOTECHNOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4		-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	-	-	-

COURSE OBJECTIVES :

- To acquaint the students with the basic concepts of animal and plant cell culture set up and conditions.
- To familiarize the students with knowledge on various ways to produce transgenic plants and animals with novel traits.
- To equip the student's wide area of important applications of animal biotechnology

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Have understanding of basic fundamentals of animal Biotechnology and its uses	L3
CO2	Have understanding of basic fundamentals of plant cell culture conditions, media formulations, techniques and its uses.	L3
CO3	The students will learn the fundamentals of culturing animal and plant cells & tissues and the modes to change and improve genetic traits of animal and plants.	L4
CO4	Will be equipped with the wide area of applications of biotechnology in modern world.	L3

COURSE CONTENT:

MODULE 1 BASICS OF ANIMAL TISSUE CULTURE

12Hrs

Basics of animal tissue culture, Facilities in Animal Cell Culture, Media – natural and chemically defined, importance of serum in the media. Growth factors promoting proliferation of animal cells – EGF, FGF, PDGF. Stem Cell Types and its characteristics. Primary Cell Culture: Isolation of tissue – disaggregation techniques (mechanical, enzymatic), explant method Secondary Cell Culture: Transformed and continuous cell lines (Hela, CHO, BHK).

MODULE 2 APPLICATION OF ANIMAL BIOTECHNOLOGY

11Hrs

Applications of Animal Tissue Culture: Transfection of animal cell lines, HAT selection,

Expression of cloned genes in animal cells – expression vector, over-production and downstream processing of the expressed protein, production of vaccines in animal cells, Hybridoma Technology for Monoclonal antibody production, Transgenic animals – techniques and applications (examples of mice and sheep). Basics of Tissue Engineering. Biosafety and Good Lab practices.	
MODULE 3 BASICS OF PLANT TISSUE CULTURE	11Hrs
Introduction to Plant Tissue Culture: Aseptic techniques, sterilization methods - (Steam and Dry), media and explant sterilization techniques, post sterilization care of the instruments, contaminants, components of tissue culture media, growth hormones (auxin and cytokinin), Tissue and Organ Culture: Micro-propagation, bud and meristem tip culture, stages, factors affecting micro-propagation, callus culture, cell culture, protoplast culture and fusion, organogenesis and somatic embryogenesis, Soma clonal Variants.	
MODULE 4	11Hrs
Genetic Transformation Techniques: Transgenic plants- Agrobacterium mediated (Ti and Ri plasmid), physical and chemical methods of gene transfer. GM technology and Plant Trait improvement: GM Strategies for Biotic and Abiotic Stress Resistance/Tolerance, Herbicide, bacterial and fungal resistance crops. Bt cotton, Bt brinjal, Golden Rice. Application of tissue culture for crop improvement in agriculture, horticulture and forestry. Edible vaccines, secondary metabolites (in-vitro production).	

TEXT BOOKS :

1. Singh, Gautam, Chauhan, Singla (2013) Textbook of Animal Biotechnology, TERI
2. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
3. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell
4. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Son

REFERENCES :

1. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing.
2. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford Publishing.
3. Santosh Nagar and Madhav Aadhi (2010) Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications
4. B D Singh (2014) Biotechnology: Expanding horizons, Kalyani Publishers.
5. S.S. Bhojwani and M.K. Razdan (1996) - Plant Tissue Culture- Theory and Practice, a Revised Edition (1996, Elsevier Science)

SEMESTER	IV					
YEAR	II					
COURSE CODE	20BC2401					
TITLE OF THE COURSE	ENZYMOLGY AND PROTEIN CHEMISTRY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I/I	19BS1207	BASIC BIOCHEMISTRY

COURSE OBJECTIVES:

1. To have a comprehensive understanding about the enzymes present in different systems, and their structure and functions.
2. To enhance the knowledge of kinetics, active sites and mechanism of action of different classes of enzymes from different biological systems.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Will be able to understand the biological significance of enzymes, their critical roles in different systems and their efficiency in biological reactions.	L2 & L3
CO1	Will be able to apply skills/knowledge to calculate different kinetic parameter of enzymes and also the will be equipped with information about the enzyme technologies and enzymatic assays and their medicinal/industrial applications.	L4

COURSE CONTENT:	
MODULE 1	
	11Hrs
Introduction, classification & nomenclature of enzymes; Active site, Lock & key model, induced fit model and strain/TS theory-taking lysozyme and chymotrypsin as examples; Enzyme specificity- bond, group, absolute and stereo-chemical specificity; Enzyme catalysis: Proximity & Orientation effect; Regulatory enzymes: - Allosteric (ATCase) and covalently modulated (Glycogen phosphorylase) enzymes, MODULEs-Katal & IU; Effect of physical and chemical parameters on enzyme activity with examples.	
MODULE 2	
	11Hrs
Enzyme Kinetics: Importance of measuring initial velocities, Derivation of Michaelis-Menten equation, Single & double reciprocal plots, Inhibition (Competitive, Noncompetitive & Uncompetitive) on Lineweaver-Burke plots; Importance of Kcat / Km. Bisubstrate reactions – brief introduction.	

Enzyme Assay and Purification: Enzyme assay, Specific activity; Enzyme isolation and purification, criteria for enzyme purity; Isoenzymes; Coenzymes and their significance. Clinical and Industrial applications of enzymes.	
MODULE 3	11Hrs
Classification based on composition, shape and function; Peptide bond; Ramachandran Plot; Structural organization: primary, secondary, tertiary and quaternary structures; Structure of Haemoglobin, Immunoglobulin, Collagen, myosin and Keratin; Denaturation of proteins and melting temperature; Hofmeister series; Protein assays and quantification methods; Peptide synthesis.	
MODULE 4	11Hrs
Protein purification & Proteomics: Vectors and hosts, downstream processing; Protein Expression; Isolation and purification of proteins (non-enzymatic), Characterization through gel permeation, ion exchange and affinity chromatography; Sequence determination by Sanger and Edman degradation methods; Protein fragmentation and Peptide purification; Derivatization of peptides and mass spectroscopy of peptides; mass determination; Applications of proteomics.	

TEXT BOOKS:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed.
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Protein Protocols Handbook – Walker. Humana Press.
7. Protein Purification Applications – Roe. Oxford University Press.
8. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20GN2401					
TITLE OF THE COURSE	APPLIED GENETICS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

1. To go through basic and specialized knowledge and understanding the aspects of genetics is essential to applying concepts in Genetics.
2. To take the students through the basics of applied genetics and disease gene mapping.
3. To teach various techniques that students can apply in their future career in biological research as well as in industry.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO 1	Applied Genetics deals with the application of Genetics in Molecular Biology, Developmental Biology, Medicine, Pharmaceutical Industries, Medical Sciences, Agriculture and Horticulture based industries etc.	L3
CO 2	Students will have a deeper understanding of several facets of applied genetics.	L3
CO 3	Students will be equipped to pursue a fitting career in academia or industry.	L4

COURSE CONTENT:

MODULE 1 GENETIC RESOURCES AND BIODIVERSITY		8Hrs
Germplasm, classification, Germplasm activities, and organizations associated with germplasm (NBPGR, IBPGR). Genetic Erosion, biodiversity, centres of Diversity, Vavilovian Centres of Diversity, Law of Parallelism, Gene sanctuaries, Gene bank and Cryopreservation.		
MODULE 2 INTRODUCTION TO TISSUE CULTURE		7Hrs
Types of cell culture media for plants and animals; Preparation and sterilization of cell culture media <i>ANIMAL CELL CULTURES TECHNIQUES:</i> History of animal cell culture; Different tissue culture techniques; Types of primary culture; Chicken embryo, fibroblast culture; Secondary culture; Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organ culture; estimation of cell number; Characterization and maintenance of cell lines, Cryopreservation; Application of animal cell culture for in vitro testing of drugs.		

<i>PLANT CELL CULTURES TECHNIQUES</i> : Embryo, Anther and Ovary cultures, Shoot and Root Meristem cultures, Callus culture from undifferentiated cells, Protoplast culture. Economic benefits of Tissue Culture: Resistance to pests and Pathogens, Improvement in Nutritive value etc.	
MODULE 3 HETEROSIS IN ANIMALS AND PLANTS	15Hrs
Introduction to Heterosis and characteristics. Introduction to animal breeds, inbreeding, grading, cross breeding. Fish breeding: Selection, Induced Polyploidy, Gynogenesis and Androgenesis, Inbreeding. Production of breeds: crossing of inbred lines for commercial production. Breeding strategies for improvement of livestock for milk, meat, wool production. Breeding strategies for improvement of Poultry. Introduction to plants breeding: Estimation of heterosis - Heterobeltosis, Economic heterosis, Standard heterosis. Hybridization techniques- intergeneric and interspecific hybridization. Identification of hybrid plants. Inbreeding depression. Hybrid vigor exploitation in Rice, Tomato.	
MODULE 4 GENETICS IN MEDICAL & INDUSTRIAL BIOTECHNOLOGY	10Hrs
Production of recombinant Insulin, Interferon and Human Growth hormone (HGH). Vaccines-Hepatitis B vaccine. Preparation of DNA probes, Monoclonal antibodies and Diagnostic kits (Typhoid, Syphilis). DNA Fingerprinting: Methodology of DNA fingerprinting. Molecular markers-RFLP & RAPD, Micro satellite, SNPs, STR. Applications with examples in forensic science, medico legal aspects, wild life crying	
MODULE 5 BIOINFORMATICS	10Hrs
Introduction to Bioinformatics Databases, Nucleic acid Sequence databases (NCBI, EBI), Protein Sequence Databases (UNIPROT, SWISS-PROT), Structure Databases (PDB). Applications of bioinformatics.	

REFERENCES:

1. Alcamo I.E. DNA Technology. The Awesome Skill 2nd edition. Harcourt / Academic press. 2000.
2. Gupta P.K. Elements of Biotechnology. Rastogi. 2002-2003.
3. Singh B. D. Biotechnology. Kalyani Publication. 2002.
4. Glide B.R. and Pasternak, J. J. Molecular Biotechnology, 2nd edition. AS press, Washington. 1998.
5. Nicholl D. S. T. An Introduction to Genetic Engineering Second Edition. Cambridge University Press. 2002.
6. Razdan M. K. An Introduction to plant tissue culture. Oxford & IBH, New Delhi. 1993.
7. Lasley. J.E. Genetics of Livestock Improvement. Prentice India.
8. Animal cell culture Techniques by Ian Freshney, Wiley-Liss.
9. Animal Cell Culture – Practical Approach BY Ed. John R.W. Masters, 3rd Edition, Oxford University Press.
10. Animal Cell Culture Techniques BY Ed. Martin Clynes,. Springer

SEMESTER	IV					
YEAR	II					
COURSE CODE	20BS2401					
TITLE OF THE COURSE	GENOMICS AND PROTEOMICS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To go through basic and specialized knowledge and understanding the aspects of genomics and proteomics is essential to understanding Genetics and its architecture.
- To take the students through foundations in genomics and disease gene mapping.
- To teach various approaches to investigating genomics and proteomics that students can apply in their future career in biological research as well as in industry.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be able to understand how genomes are organised and contemplate on the mapping of monogenic and polygenic traits.	L2
CO2	Students should be endowed with strong theoretical knowledge of genomics.	L3
CO3	In conjunction with the practical in bioinformatics, the students should be able to take up biological research as well as find placement in the relevant biotech industry.	L3

COURSE CONTENT:	
MODULE 1 PROKARYOTIC AND EUKARYOTIC GENOME ORGANIZATION	8Hrs
Prokaryotes: Bacteria and Bacteriophages. Eukaryotic nuclear genomes: Arabidopsis, rice, yeast, Drosophila, C. elegans and mouse genome. Eukaryotic organelle genomes - Chloroplast and Mitochondria.	
MODULE 2 GENOME MAPPING TECHNIQUES	8Hrs
Genetic mapping: Cross breeding and pedigree analysis, DNA markers – RFLPs, SSLPs, SNPs. Physical mapping: Restriction mapping, Fluorescent in situ hybridization.	
MODULE 3 HUMAN GENOME PROJECT	8Hrs
History, organization and goals of human genome project. DNA segment nomenclature, Human genome diversity, Organization of human genome, Mitochondrial genome, Gross	

base composition of nuclear genome, Gene density, CpG islands, RNA-encoding genes, Functionally identical genes, Diversity in size and organization of genes.

MODULE 4 COMPARATIVE GENOMICS

5Hrs

Whole genome analysis, Genome sequence, micro assay, molecular phylogeny, C-value, number of genes and complexity of genomes, Conservation and diversity of genomes, Comparative genomics as an aid to gene mapping and study of human disease genes. Comparative genomics of mitochondria and chloroplast genomes.

MODULE 5 PROTEIN PROFILING

5Hrs

Prediction of primary, secondary and tertiary structure of proteins- SCOP, DALIDD, CATH classification. Determining protein structure, Homology modelling. Introduction to proteome and proteomics, protein separation and analysis using 2D Gel Electrophoresis, Liquid chromatography, Mass spectrometry, Interacting proteins by phage display and Yeast two hybrid system.

REFERENCES

1. T.A. Brown, Genomes, Bios, 2002.
2. Coleman and Tsongalis, Molecular Diagnosis, Humana, 1997.
3. Dale and Schartz, From Genes to Genomes, Wiley, 2003.
4. Dunham, I., Genome Mapping and sequencing. Horizon Scientific. 2003.
5. Hawley and Mori, The Human Genome, Academic, 1999.
6. Lewis, Human Genetics, WCB, 1999.
7. Liebler, Introduction to Proteomics, Humana, 2002.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20BT2471					
TITLE OF THE COURSE	TECHNIQUES IN ANIMAL AND PLANT BIOTECHNOLOGY- LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
			4	-	36	2

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	-	-	-

COURSE OBJECTIVES :

- To acquaint the student with the fundamental practical knowledge of the laboratory set up.
- To acquaint the student with basic techniques to use cell culture.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The course will help in making the students learn basic knowledge of the plant and animal tissue culture laboratory.	L3
CO2	The course will help in making the students learn basic techniques for plant and animal tissue culture.	L3

List of Laboratory/Practical Experiments activities to be conducted (if any) :	
1.	Introduction to instruments and laboratory set up for animal biotechnology
2.	Preparation of media for animal cell culture
3.	Isolation of liver parenchyma cells by mechanical method and set up primary culture.
4.	Determination of the concentration of viable cells in a suspension by Hemocytometer counting (trypan blue)
5.	Plant tissue culture laboratory organization and instruments.
6.	Preparation of plant tissue culture media – MS media
7.	Aseptic techniques and surface sterilization of explants
8.	4 hrs Establishment of callus culture, subculture of callus
9.	Production of synthetic seeds.

TEXT BOOKS :

- 1 John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons
- 2 Santosh Nagar and MadhavAadhi (2010) Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications
- 3 HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing

- 4 S. Chand Practical book of biotechnology and plant tissue culture, S Chand & Company

REFERENCES :

1. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.
2. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20BC2471					
TITLE OF THE COURSE	ENZYMOLGY -LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	0	40	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	-	-	-

COURSE OBJECTIVES:

1. To train the students to design the enzymatic assays and learn the calculation of kinetic parameters of the enzymes.
2. To learn isolation, handling and quantification of enzymes from biological samples and to train them to carry out enzymatic assays and interpret the results.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to interpret the kinetic parameters of the enzymes and assay results.	L3
CO2	Students will be able to design and carry out the enzymatic assays and will gain the practical knowledge about the mechanism of action of different enzymes.	L4

EXPERIMENTS/PRACTICALS:

1. Introduction to enzymology Lab and product curve determination
2. Isolation of enzymes (amylase/ phosphatase) from biological source and activity determination through time curve.
3. Determination of kinetic constants through LB plot
4. Effect of pH on enzyme activity
5. Effect of temperature on enzyme activity
6. Determination of Arrhenius constant
7. Effect of enzyme dilution on enzyme activity
8. Effect of activators and inhibitors on enzyme activity
9. Immobilization of enzyme using calcium alginate.

TEXT BOOKS:

1. Practical enzymology – Hans Bisswanger, Wiley-VCH, 2019, 3 rd Ed
2. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house 2001, 1st Ed

3. Principles and Techniques of Practical Biochemistry – Wilson, Wilson and Walker, Cambridge University Press 2000, revised Ed
4. Introduction to practical Biochemistry, Plummer, Tata McGraw-Hill Education 2001, 2nd Ed
5. Basics of Enzyme Immobilization – Alka Dwevedi, Springer International Publishing, 2016, 1 st Ed.

YEAR	IV					
COURSE CODE	20GN2471					
TITLE OF THE COURSE	APPLIED GENETICS -LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	0	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- Experiments will give emphasis on current methods and applications of genetic manipulation in plants and crops.
- Through the use of transgenics, one can produce plants with desired traits and even increased yields.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	After being introduced to the topics students will cover 'methods available for plant transformation through Agrobacterium mediated.	L3
CO2	Students will also study about the role of precise genome modification in crops, role of vectors and markers in gene expressions.	L3
CO3	The students are expected to read, research and discuss papers related to the topic	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1.	Tissue culture techniques: • Sterilization • Explants preparation • Media Composition and preparation • Culturing of all kinds of explants for callus induction, multiple shoot proliferation.
2.	Synthetic seed preparation
3.	Study of different techniques in plant hybridization
4.	Study of pollen fertility
5.	Study of diagnostic kits - WIDAL & VDRL
6.	Study of hybrid plants - Rice, Cotton, Chilly, and Tomato.
7.	Study of hybrid animals - Poultry, dairy, fishery.
8.	Homology sequence analysis using Blast and Fasta.

REFERENCES

1. Pasternak, An Introduction to Molecular Human Genetics, Fitzgerald, 2000.
2. Primrose and Twyman, Principles of Genome Analysis & Genomics, Blackwell, 2003.

3. Razdan M. K. An Introduction to plant tissue culture. Oxford & IBH, New Delhi. 1993.
4. Ravishanker G.A. and Venkataraman L.V. Biotechnology Application of Plant Tissue and cell culture. BH Publications. 1997.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20BS2402					
TITLE OF THE COURSE	BIOETHICS AND IPR					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	26	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To introduce the students to the concepts of biosafety regulatory frameworks concerning genetically modified organisms at national and International levels
- To give elementary essential concepts of Bioethics, IPR and patent laws.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student should develop basic understanding of the concepts of Biosafety, regulations concerning GMOs IPR and patent laws.	L2
CO2	This course should generate interest for avenues for pursuing higher studies and careers in these areas.	L2
CO3	General knowledge should create awareness necessary for higher studies in biotechnological fields.	L2

COURSE CONTENT:

MODULE 1 : BIOSAFETY-REGULATORY FRAMEWORK FOR GMO's IN INDIA 8Hrs

Regulatory framework in India governing GMOs-Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety Committee (IBC), Review Committee on Genetic Manipulation, Genetic Engineering Approval Committee (GEAC), Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic Plants (1998), Seed Policy (2002), Prevention Food Adulteration Act (1955), The Food Safety and Standards Bill (2005), Regulation for Import of GM Products Under Foreign Trade Policy (2006-2007), National Environment Policy (2006). Rules for the manufacture, use/import/export and storage of hazardous microorganisms/ genetically engineered organisms or cells (Ministry of Environment and Forests Notification,1989).

MODULE 2 BIOSAFETY-REGULATORY FRAMEWORK FOR GMO's AT INTERNATIONAL LEVEL 6Hrs

Convention of Biological Diversity (1992) – Cartagena Protocol on Biosafety – Objectives and salient features of Cartagena Protocol – Advanced Information Agreement (AIA) procedure – procedures for GMOs intended for direct use-risk assessment-risk

management-handling, transport, packaging and identification of GMOs- Biosafety Clearing House-unintentional transboundary movement of GMOs-Benefits of becoming a party to the Cartagena Protocol- status of implementation in India.	
MODULE 3 BIOETHICS	4Hrs
What is bioethics- The legal and socioeconomic impacts of biotechnology - Public education of the process of biotechnology involved in generating new forms of life for informed decision-making – ethical concerns of biotechnology research and innovation.	
MODULE 4 INTELLECTUAL PROPERTY RIGHTS	3Hrs
Intellectual property rights-TRIPS, GATT-International conventions patents and methods of application of patents-Legal Implications-Biodiversity and farmer rights.	
MODULE 5 PATENTS AND PATENT LAWS	5Hrs
Objectives of the patent system - Basic principles and general requirements of patent law-biotechnological inventions and patent law-Legal Development-Patentable subjects and protection in biotechnology-The patenting living organisms.	

REFERENCES

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2. Ganguli Prabuddha Gearing up for Patents.The Indian Scenario”, Universities Press (1998)
3. Ganguli Prabuddha “Intellectual Property Rights--Unleashing the Knowledge Economy”, Tata McGrawHill (2001)
4. Ganguli Prabuddha and Jabade Siddharth, “Nanotechnology Intellectual Property Rights. Research, Design, and Commercialisation”, CRC Press, Taylor and Francis Group, USA (2012)
5. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local Communities [Paperback], Darrell A. Posey and Graham Dutfield , IDRC Books; annotated edition (June 1996).
6. F. H. Erbisich and K. M. Maredia. Intellectual property rights in agricultural Biotechnology, University Press.
7. Sivamiah Shantharam, Jane F. Montgomery. Biotechnology, Biosafety and Biodiversity, Oxford & IBH Publ. New Delhi.
8. Tutelyal, VA. Genetically modified Food Sources, Safety Assessment and Control, Academic Press an Imprint of Elsevier, New Delhi.
9. Jecker Nany S, JohsenAlbert, Perlman, Robert A. Bioethics: An Introduction to the History Methods and Practice, John & Bartlett, New Delhi.
10. Sharma, HC Dhillon, MK, Sahrawat, KN. Environmental Safety of Biotech and Conventional IPM Technology, Stadium Press LLC. USA.
11. Jecker Nany S, Jones & Barlet Bioethics: An Introduction to the History Methods and Practice, New Delhi
12. Sathish MK Bioethics and Biosafety, IK International.

SEMESTER	V					
YEAR	III					
COURSE CODE	20BT3501					
TITLE OF THE COURSE	FERMENTATION BIOTECHNOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	44	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

1. To impart basic understanding of principles and key concepts relevant to Fermentation biotechnology.
2. To familiarize students with downstream processing and production of important microbial products.

COURSE OUTCOMES:

CO No.	Outcomes
CO1	Student will be aware of fermentation process, types of fermentation media and strategies for isolating industrially important strains
CO2	The course will enable the student to apply the knowledge in various aspects of biotechnology processes

COURSE CONTENT:

MODULE 1 INTRODUCTION TO FERMENTATION TECHNOLOGY		11Hrs
History, Scope and development of fermentation technology, Isolation and Screening of Industrially important microorganisms-primary and secondary screening, Strain improvement: Mutation, Mutant selection, Recombination, Recombinant DNA technology, Preservation of Industrially important microorganisms. Culture collection centers.		
MODULE 2 FERMENTATION PROCESS AND FERMENTER		11Hrs
Types of fermentation -Batch, fed-batch and continuous fermentation. Surface, submerged and solid-state fermentation. Different parameters affecting fermentation - pH, temperature, dissolved oxygen, foaming and aeration. Basic component and design of typical fermenter. Type fermenter-Laboratory, pilot- scale and production fermenters. Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.		
MODULE 3 UPSTREAM AND DOWNSTREAM PROCESSING		11Hrs

Upstream processing: Formulation of fermentation media. Nutrients: growth factors, carbon, nitrogen, mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization and inoculum preparation.

Downstream processing: Steps in recovery and purification of fermented products. Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid-Liquid extraction, Solvent recovery, chromatography, Drying, Crystallization, Whole broth processing, Effluent treatment.

MODULE 4 INDUSTRIAL BIOPROCESSING

11Hrs

Production of alcohol beverages (wine and beer), organic acid (citric acid), antibiotics (penicillin), amino acids (glutamic acid), Vitamin (Vitamin B12), enzyme (amylase), hormone (Insulin), fermented food (yoghurt, cheese), Single Cell Protein (SCP).

REFERENCES:

1. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 2091.
2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
3. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon Press, Oxford, 2097.
4. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, (2nd Ed). Taylor & Francis Ltd, UK, 2007.
5. Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology (2nd Ed.) Cambridge University Press. 2002.
6. Prescott, Sc and Dunn, C. Industrial Microbiology, McGraw Hill, New York. 2084
7. Michael, L. Shulers and Fikret Kargi. Bioprocess Engineering: Basic concepts (2nd Ed.) Prientice Hall Publishers. 2001 8. Paulins, M. D. Bioprocess Engineering Principles. John Wiley Publishers.2003

SEMESTER	V					
YEAR	III					
COURSE CODE	20BC3501					
TITLE OF THE COURSE	METABOLISM					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	44	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To enhance the comprehensive understanding of biochemical processes/metabolic pathways in the living systems, particularly about the human system. - Educate the students about the concepts of nutrition, pathophysiology and inborn errors associated with the metabolism.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Student will know how the biomolecules play a role in energy production/storage which is an absolute necessity to sustain life.	L3
CO2	Students will have a greater understanding of how the homeostasis of a body is maintained and a slight change in the system could tip the balance which could lead to disease.	L4
CO3	Students will have an idea as to how hormones control the physiology of an organism via signaling mechanisms.	L4
CO4	The students will be able to comprehend the importance of proper diet and nutrition and diseases/disorders associated with improper diet.	L4

COURSE CONTENT:	
MODULE 1 CARBOHYDRATE METABOLISM	11 Hrs
Introduction to anabolic, catabolic, amphibolic pathways and intermediary metabolism. Glycolytic pathway; energetics and regulation, aerobic and anaerobic fates of pyruvate, entry of sugars other than glucose into metabolism, Gluconeogenesis, Cori cycle, TCA cycle. Degradation, synthesis and regulation of glycogen. Disorders of Carbohydrate Metabolism- Diabetes mellitus, glycogen storage disorders and lactose intolerance.	
MODULE 2 LIPID METABOLISM	11 Hrs

Oxidation of fatty acid – α, β and ω types, β-oxidation of even number saturated fatty acids. Energetics of β-oxidation. Schematic representation of biosynthesis of even number saturated fatty acids and cholesterol biosynthesis. Metabolism of ketone bodies with physiological significance. Fatty acid biosynthesis, chain elongation and desaturation. Biosynthesis of triacylglycerol, phospholipids and sphingolipids, sphingolipid storage disorders. Regulation of cholesterol metabolism; Biochemistry of obesity, atherosclerosis and hypercholesterolemia; synthesis of prostaglandins and related compounds.	
MODULE 3 METABOLISM OF AMINO ACIDS AND PEPTIDES	11 Hrs
Biosynthesis of physiologically active amines; serotonin, histamine, dopamine, norepinephrine and epinephrine. General mechanisms of amino acid metabolism and regulations: Role of cofactors; PLP and THF in amino acid metabolism. Deamination, transamination, decarboxylation de-sulphuration process. Urea Cycle and its regulation; Synthesis and degradation of Basic and Aromatic amino acids and their Regulation. In born errors of amino acid degradation; Phenyl Ketonuria, alkaptonuria, maple syrup urine. Introduction to bioactive peptides; Structure, localization and mechanism of action of-leptin, ghrelin, neuropeptides, enkephalin, angiotensin, defensin, vasopressin and oxytocin and associated disorders.	
MODULE 4 METABOLISM OF NUCLEIC ACIDS	11 Hrs
Synthesis of purine and pyrimidine nucleotides – the de novo and the salvage pathway and their regulation. Degradation of purine and pyrimidines and disorders associated with degradation: Lesch-Nyhan syndrome, Gout, SCID, adenosine deaminase deficiency.	

TEXT BOOKS/REFERANCES:

1. Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3rdEd. John Wiley and Sons(2009).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds], 6th Edn. Macmillan Publications (2012).
3. Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and LubertStryer, W H Freeman and Co. (2006).
4. Textbook of Biochemistry with Clinical Correations – Thomas M. Devlin, John Wiley & Sons; 7th edition (22 January 2010)
5. Biochemistry of Foods, Eskin, Elsevier (2012).
6. Biochemistry and Molecular Biology; 5thEd. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University Press (2014).
7. Harpers Illustrated Biochemistry; 30th Ed. V.W. Rodwell , D. Bender , K.M. Botham , P. J. Kennelly, P. A. Weil (2015)

SEMESTER	V					
YEAR	III					
COURSE CODE	20GN3501					
TITLE OF THE COURSE	POPULATION AND EVOLUTIONARY GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	44	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To make student understand the forces that have an impact on levels of genetic variations in natural and/or experimental populations for both qualitative and quantitative traits. - To make the students familiar with different types of DNA markers and the range of tools for their detection to enable advanced studies on molecular population genetics.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	This course will give students exposure towards understanding population health and disease susceptibility.	L3
CO2	This course will be helpful to the students to conceptualize the existence of genetic variation and speciation.	L4

COURSE CONTENT:
MODULE 1 INTRODUCTION TO POPULATION GENETICS 11 Hrs
Mendelian Population and scope of population genetics. Gene and genotype frequencies, mating patterns, Hardy-Weinberg principle, heterozygotes, extension of H-W principle to multiple alleles, sex-linked alleles. Non-random mating, inbreeding and assortative mating, inbreeding coefficient. Factors that change allelic frequencies.
MODULE 2 GENETIC VARIATION AND INHERITANCE OF COMPLEX TRAITS 11 Hrs
Testing gene mutations for alleles: complementation test, intragenic complementation Genotypes & phenotypes: Effect of the environment on phenotype development, Penetrance and expressivity, Visible, sterile and lethal mutations, Gene interactions and modifying genes, Pleiotropy.

MODULE 3 GENETIC POLYMORPHISMS AMONG POPULATIONS	11 Hrs
Genetic polymorphism, transient and stable and factors responsible for stable polymorphism. DNA markers and populations differences. Application of population genetics. Role of population genetics in genetic counselling . Genetic origin and evolution of human races. Genetic Demography, age and gender specific death and birth rates, intrinsic rate of natural increase. Index of opportunity for natural selection.	
MODULE 4 EVOLUTIONARY GENETICS	11 Hrs
Darwinism, Neo Darwinism and Synthetic Theory. Evolution of Sexual Reproduction. Sex Ratio and Sex Determination. Chromosomal evolution, genome evolution, selfish DNA. Competition Among Levels of Organization. Speciation and Phylogeny. Coalescent Theory. Drift versus selection in population. Kin and group Selection. Cancer as an evolutionary process.	

TEXT BOOKS/REFERANCES:

1. Hamilton M.B. (2009). Population Genetics. Wiley-Blackwell, UK.
2. Hedrick P.W.(2011). Genetics of Populations. Jones and Bartlett Publishers, Massachusetts.
3. Jobling, M., Hollox, E., Hurles, M., Kivisild, T. and Tyler-Smith, C. (2013). Human Evolutionary Genetics. Garland Science.
4. Nielsen, R. and Slatkin, M. (2013). An Introduction to Population Genetics: Theory and Applications. Sinauer Associates, Inc.
5. Relethford, J.H. (2012). Human Population Genetics. John Wiley & Sons.
6. Snusted, D.P., Simmons, M. J. (2010). Principles of Genetics. John Wiley & Sons, New York.
7. Knight, J.C. (2009). Human Genetic Diversity –Functional consequences for Health and Disease. Oxford University Press, USA.

SEMESTER	V					
YEAR	III					
COURSE CODE	20BS3571					
TITLE OF THE COURSE	ESTIMATION OF BIOMOLECULES-LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	4	-	-	2
Perquisite Courses (if any)						
#	Sem/Year	Course Code	Title of the Course			
-	-	-	-			

COURSE OBJECTIVES:

- To make students learn Qualitative analysis of biomolecules
- To make students learn Quantitative methods of study of biomolecules

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to learn the procedures and safety precautions while handling the biomolecules	L2 and L3
CO2	Students will be able to learn quantitate biomolecules and estimate using standard graphs	L3

List of Laboratory/Practical Experiments activities to be conducted (if any):
1. Qualitative analysis of Monosaccharides and disaccharides (Glucose, Fructose, Lactose, Sucrose)
2. Estimation of Glucose estimation by Miller's method
3. Qualitative Analysis of amino acids (Tryptophan, Tyrosine, Cystiene, Proline, Arginine, Histidine)
4. Estimation of Protein by Folin - Ciocalteu method/Estimation of aminoacids by Ninhydrin method
5. Lipids (Solubility, acrolein test)
6. Determination of Iodine Number of a fat sample
7. Estimation of DNA by DPA method
8. Estimation of RNA by Orcinol method

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house 2012, 7th edition
2. An Introduction to Practical Biochemistry: Plummer D.T, Tata Mc Graw Hill.
3. Biochemistry – Harper, Lange Publications, 2nd edition
4. Hamilton M.B. (2009). Population Genetics. Wiley-Blackwell, UK.
5. Hedrick P.W.(2011). Genetics of Populations. Jones and Bartlett Publishers, Massachusetts.
6. Jobling, M., Hollox, E., Hurles, M., Kivisild, T. and Tyler-Smith, C. (2013). Human Evolutionary Genetics. Garland Science.
7. Nielsen, R. and Slatkin, M. (2013). An Introduction to Population Genetics: Theory and Applications. Sinauer Associates, Inc.

SEMESTER	V					
YEAR	III					
COURSE CODE	20BS3573					
TITLE OF THE COURSE	FERMENTATION TECHNIQUES AND POPULATION GENETICS-LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	4	-	-	2
Perquisite Courses (if any)						
#	Sem/Year	Course Code	Title of the Course			
-	-	-	-			

COURSE OBJECTIVES:

- To impart basic understanding of principles, and key concepts relevant to industrial biotechnology.
- To familiarize students with downstream processing and production of important microbial products
- To make student understand the forces that have an impact on levels of genetic variations in natural and/or experimental populations for both qualitative and quantitative traits.
- To make the students familiar with different types of DNA markers and the range of tools for their detection to enable advanced studies on molecular population genetics.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be aware of the fermentation process, types of fermentation media and strategies for isolation of Industrially important strains	L2
CO2	The course will enable the student to apply the knowledge in various aspects of fermentation or industrial biotechnology processes.	L3
CO3	This course will give students exposure towards understanding population health and disease	L2 and L3

	susceptibility.	
CO4	This course will be helpful to the students to conceptualize the existence of genetic variation and speciation	L3

List of Laboratory/Practical Experiments activities to be conducted (if any):	
1.	Study of Fermenter (Demonstration using video or Industrial Visit)
2.	Isolation of amylase producing microorganisms and production using solid state fermentation. Estimation of amylase activity.
3.	Preparation of wine (Grapes/ Ginger/ Pomegranate). Estimation of alcohol.
4.	Production and estimation of citric acid/ lactic acid
5.	Immobilization of yeast by calcium alginate gel entrapment and assay for enzyme (Catalase/ Invertase).
6.	Genetic problems on polygenic variance, Heritability.
7.	Disease-risk prediction in population using Hardy-Weinberg equations.
8.	Study of phylogenetic trees
9.	Study on finger and Palmer dermatoglyphic patterns
10.	Pedigree analysis and construction

REFERENCES:

1. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
2. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
3. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
4. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
5. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
6. K.R. Aneja. Experiments in Microbiology, Plant Pathology and Biotechnology.
7. Hamilton M.B. (2009). Population Genetics. Wiley-Blackwell, UK.
8. Hedrick P.W.(2011). Genetics of Populations. Jones and Bartlett Publishers, Massachusetts.
9. Jobling, M., Hollox, E., Hurles, M., Kivisild, T. and Tyler-Smith, C. (2013). Human Evolutionary Genetics. Garland Science.
10. Nielsen, R. and Slatkin, M. (2013). An Introduction to Population Genetics: Theory and Applications. Sinauer Associates, Inc.

SEMESTER	V					
YEAR	III					
COURSE CODE	20AU0003					
TITLE OF THE COURSE	CONSTITUTION OF INDIA AND HUMAN RIGHTS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	0	0	0	22	0

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Define a constitution
- Describe the salient features of the Indian Constitution
- Explain different ways of acquiring Indian Citizenship
- List the Fundamental Rights and Fundamental Duties of Indian citizens
- Describe the Directive Principles of State Policy and their significance

COURSE OUTCOMES:

Sl. No.	Outcomes	Bloom's Taxonomy Level
O1	Students will appreciate the fundamental law of the land	L1
O2	Students will be aware of what kind of government the country will have.	L1
O3	Aid in understanding what lays down the rules to govern the country	L2
O4	It also tells about the rights and also the duties of its citizens	L1

COURSE CONTENT:

MODULE 1

4Hrs

Framing of the Indian Constitution: Role of the Constituent Assembly. Philosophy of the Constitution: Objectives, resolution, preamble, fundamental Rights and Duties. Human rights and Environmental protection.

MODULE 2

4Hrs

Special Rights created in the Constitution of Dalits, Backward Classes, Women and Children, and religious and linguistic minorities. Directive Principles of State policy: The need to balance fundamental rights with directive principles.

MODULE 3	5Hrs
Union Executive: President, Prime Minister and Council of Ministers; powers and functions, coalition Government, problems in their working. Union Legislature: Lok Sabha and Rajya Sabha, powers and functions. Recent trends in their functioning.	
MODULE 4	4Hrs
State Government: Governor, Chief Minister and Council of ministers, Legislature. Centre – State relations: Political, financial, administrative: Recent Trends.	
MODULE 5	5Hrs
Judiciary: Supreme Court, Judicial Review, Writs, Public interest litigations. Enforcing rights through writs. Emergency provisions (Article 356)	

TEXT BOOK:

- 1 D.D. Basu – Introduction to the Indian Constitution.
- 2 A.S. Narang – Indian Constitution, Government and Politics.
- 3 Nani Palkhivala – We, the People, UBS Publishers, New Delhi, 1999.
- 4 A.G. Noorani – Indian Government and Politics
- 5 J.C. Johari – Indian Government and Politics Vol. I & II, Vishal, New Delhi
- 6 Gran Ville Austin – The Indian Constitution – Corner stone of a Nation, Oxford, New Delhi, 2000.
- 7 M.U. Pylee, Constitutional Government in India.
- 8 K.K. Ghai, Indian Constitution.

SEMESTER	V					
YEAR	III					
COURSE CODE	20AU0020					
TITLE OF THE COURSE	KANNADA KALI – I					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	0	0	0	-	0

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To enable students read and write in Kannada
- To make students to communicate in Kannada helping them to interact with local people for their daily needs

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students should be able to read, write and communicate in Kannada	L3

COURSE CONTENT:

1. ALPHABETS – AKSHARAMAALE - ಅಕ್ಷರಮಾಲೆ
2. SIGNS OF VOWELS AND CONJUNCT CONSONANTS –
KAAGMODULEHA MATTHU OTTHAKSHARAGALU
ಕಾಗುಣಿತ ಮತ್ತು ಒತ್ತಕ್ಷರಗಳು
3. DAILY USING WORDS PART – 1
DINANITHYADA PADAGALU BHAAGA – 1
ದಿನನಿತ್ಯದ ಪದಗಳು ಭಾಗ – 1
4. WEEKDAY AND MONTH NAMES –
VAARADA MATTHU THINGALA HESARUGALU
ವಾರದ ಮತ್ತು ತಿಂಗಳ ಹೆಸರುಗಳು
5. TASTE – RUCHI – ರುಚಿ
6. COLOURS – BANNAGALU – ಬಣ್ಣಗಳು
7. NUMBERS – SANKYEGALU - ಸಂಖ್ಯೆಗಳು
8. DAILY USING WORDS PART – 2
DINANITHYADA PADAGALU BHAAGA – 2
ದಿನನಿತ್ಯದ ಪದಗಳು ಭಾಗ – 2
9. QUESTION PATTERNS – PRASHNEYA VIDHAANAGALU
ಪ್ರಶ್ನೆಯ ವಿಧಾನಗಳು
10. MEASUREMENTS – ALATHEGALU - ಅಳತೆಗಳು
11. EDUCATION WORDS – SHAIKSHANIKA PADAGALU
ಶೈಕ್ಷಣಿಕ ಪದಗಳು
12. LIQUID ITEMS – NEERINAAMSHADA PADAGALU
ನೀರಿನಾಂಶದ ಪದಗಳು
13. FRUITS – HANNUGALU – ಹಣ್ಣುಗಳು
14. VEGETABLES – THARAKAARIGALU – ತರಕಾರಿಗಳು

15. FOOD ITEMS – AAHAARA PADAARTHAGALU
ಆಹಾರ ಪದಾರ್ಥಗಳು
16. DAILY USING WORDS PART -3 –
DINANITHYADA PADAGALU BHAAGA -3
ದಿನನಿತ್ಯದ ಪದಗಳು ಭಾಗ -3
17. METALS – LOHAGALU – ಲೋಹಗಳು
18. RELATIVES – SAMBANDHIKARU – ಸಂಬಂಧಿಕರು
19. SEASONS AND CLOTHES –
KAALAGALU MATTHU BATTEGALU
ಕಾಲಗಳು ಮತ್ತು ಬಟ್ಟೆಗಳು
20. HOUSE AND FURNITURE –
MANE MATTHU PEETOPAKARANAGALU
ಮನೆ ಮತ್ತು ಪೀಠೋಪಕರಣಗಳು
21. OPPOSITE WORDS – VIRUDDHA PADAGALU
ವಿರುದ್ಧ ಪದಗಳು
22. VERBS - KRIYAA PADAGALU – ಕ್ರಿಯಾ ಪದಗಳು
23. ANIMALS – PRAANIGALU – ಪ್ರಾಣಿಗಳು
24. INSECTS – KRIMIKEETAGALU – ಕ್ರಿಮಿಕೀಟಗಳು
25. BIRDS – PAKSHIGALU – ಪಕ್ಷಿಗಳು
26. FEELINGS – BHAAVANEGALU – ಭಾವನೆಗಳು
27. TENSES – KAALASOOCHAKAGALU – ಕಾಲಸೂಚಕಗಳು
28. COMMUNICATION WORDS – SAMBHAASHANEYA PADAGALU-
ಸಂಭಾಷಣೆಯ ಪದಗಳು

SEMESTER	V					
YEAR	III					
COURSE CODE	20AU0022					
TITLE OF THE COURSE	KANNADA MANASU-I					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	0	0	0	-	0

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To equip the native Kannada speaking students with advanced skills in Kannada communication and understanding.
- To enrich the students with creative writing.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will have better speaking and writing communication skills in Kannada	L3

COURSE CONTENT:

ಕನ್ನಡ ಪಠ್ಯಕ್ರಮ

1. ಕನ್ನಡ ಭಾಷಾ ವಿಜ್ಞಾನದ ಸ್ವರೂಪಗಳು
2. ಭಾಷಾ ಕಲಿಕೆಯ ವಿವಿಧ ನೆಲೆಗಳು
3. ವ್ಯವಹಾರಿಕ ಭಾಷೆಯಲ್ಲಿ ಕನ್ನಡ
4. ಕಂಪ್ಯೂಟರ್ ಕಲಿಕೆಯಲ್ಲಿ (ಗಣಕಯಂತ್ರ) ಕನ್ನಡ ಬಳಕೆ
5. ಪತ್ರ ಲೇಖನ
 1. ವೈಯಕ್ತಿಕ ಪತ್ರಗಳು
 2. ವ್ಯವಹಾರಿಕ ಪತ್ರಗಳು
6. ಪ್ರಬಂಧ ರಚನೆ
 1. ಸಾಮಾಜಿಕ ಕ್ಷೇತ್ರ
 2. ಶೈಕ್ಷಣಿಕ ಕ್ಷೇತ್ರ
7. ಗಾದೆಗಳ ಬಳಕೆ
 1. ಜನಪದದ ಶೈಲಿ
 2. ಅನುಭವದ ಶೈಲಿ
8. ವಾಕ್ಯ ಸಂಯೋಜನೆ
 1. ಸರಳ ವಾಕ್ಯ
 2. ಮಿಶ್ರವಾಕ್ಯ
 3. ಸಂಯೋಜಿತ ವಾಕ್ಯ _
9. ವ್ಯಾಕರಣ ಭಾಗ
 1. ಅನುಕರಣವಾಚಕ ಪದಗಳು
 2. ವಿರುದ್ಧ ಪದಗಳು, ನುಡಿಗಟ್ಟುಗಳು
 3. ವಿದ್ಯರ್ಥಕ ಪದಗಳು
 4. ಅರ್ಥ, ಸಮಾನಾರ್ಥ, ನಾನಾರ್ಥ ಪದಗಳು
 5. ನಿಷೇಧಾರ್ಥಕ ಪದಗಳು
 6. ಸಂಖ್ಯಾವಾಚಕ, ನಾಮವಾಚಕಗಳು
 7. ವಿಭಕ್ತಿ ಪ್ರತ್ಯಯಗಳು
 8. ಕ್ರಿಯಾಪದಗಳು, ಧಾತುರೂಪ
 9. ಪದ ವಿಂಗಡಣೆ
 10. ದ್ವಿರುಕ್ತಿ, ಜೋಡುನುಡಿ, ಇತ್ಯಾದಿ

10. ಸೃಜನಾತ್ಮಕ ಬರವಣಿಗೆ
- | | |
|----------------|-----------------|
| 1. ವಿಷಯದ ಆಯ್ಕೆ | 2. ಅನಿಸಿಕೆಯ ಭಾಗ |
| 3. ವಿಶ್ಲೇಷಣೆ | 4. ಉಪಸಂಹಾರ |
11. ವಿಷಯದ ಚರ್ಚೆ, ಪ್ರಬಂಧ ಮಂಡನೆ
12. ಸಮೂಹ ಚರ್ಚೆ, ಪಠ್ಯ - ಪದ್ಯ - ನಾಟಕ ಭಾಗ
13. ವಿಷಯ ಸಂಗ್ರಹಣೆ, ವರದಿ, ಲೇಖನ ಕಲೆ
14. ಸಂಪರ್ಕ ಮಾಧ್ಯಮಗಳು - ಅದರ ಬಳಕೆ
15. ಸ್ವತಂತ್ರ ಕಥೆ, ವರ್ಣನೆ, ಪ್ರವಾಸಕಥನ ಮತ್ತು ಅನುಭವಗಳ ನಿರೂಪಣೆ

SEMESTER	VI					
YEAR	III					
COURSE CODE	20BS3601					
TITLE OF THE COURSE	RESEARCH METHODOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2		-	-	22	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	-	-	-

COURSE OBJECTIVES:

1. Students understand research terminology one that can be used to carry out different approaches to research
2. To be aware of the ethical principles of research, challenge and approval processes

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Demonstrate knowledge of research processes (reading, evaluating and developing)	L2
CO2	Compare and contrast qualitative and quantitative research	L4

COURSE CONTENT:	
MODULE I	11Hrs
Meaning, Objectives and Characteristics of research. Research Methods Vs Methodology. Types of research. Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical. Research process. Criteria of good research. Developing a research plan. Defining the research problem. Techniques involved in defining the problem Survey of literature. Primary and secondary sources. Reviews, treatise, monographs patents. Identifying gap areas from literature review. Development of working hypothesis.	
MODULE II:	11Hrs
Research design and methods - Basic Principle. Features of good design. Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan. Exploration, Description, Diagnosis, and Experimentation. Determining experimental and sample designs. Sampling design - Steps and types in sampling design. Measurement and scaling techniques. Methods of data collection. Testing of hypotheses. Procedure for hypotheses testing flow diagram for hypotheses testing. Data analysis with Statistical Packages. Correlation and Regression. Important parametric test. Chi-square test. Analysis of variance and Covariance.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.NO
2. NO

TEXT BOOKS :

REFERENCES

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
6. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications

SEMESTER	VI					
YEAR	III					
COURSE CODE	20BS3602					
TITLE OF THE COURSE	PROJECT					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	-	12	-	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	-	-	-

COURSE OBJECTIVES :

1. Construct a project from Plan, schedule, monitor and control students' own work and to exhibit ideas in discussions and presentations
2. Apply tools and techniques to the applied courses taught and to communicate their findings through a written report and poster presentation

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To provide a postgraduate level knowledge in Microbiology, including understanding, analysis, management, and handling of real life information technology problems in workplace.	L4
CO2	To provide graduate education that will prepare students to become thoughtful, productive members of the competing profession and community.	L4
CO3	To provide a high-quality post graduate education and training in microbiology which prepares students for productive careers and lifelong learning.	L5

DAYANANDA SAGAR UNIVERSITY
SHAVIGE MALLESHWARA HILLS, KUMARASWAMY LAYOUT
BENGALURU – 560 011, KARNATAKA.

SCHOOL OF BASIC & APPLIED SCIENCES



SCHEME & SYLLABUS
FOR
BACHELOR OF SCIENCE (B.Sc.) – 2020

BIOTECHNOLOGY, CHEMISTRY & MICROBIOLOGY
(BCM)

(With effect from 2020 – 21)

SCHEME – B.Sc. – 2020-21 ONWARDS

I SEM – BCM

(BIOTECHNOLOGY, CHEMISTRY & MICROBIOLOGY)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	112	20BT1101	FUNDAMENTALS OF CELL BIOLOGY	CR	4	-	-	-	4	*	***
2	112	20CY1101	ADVANCED CHEMISTRY - I	CR	4	-	-	-	4	*	***
3	112	20MB1101	BASIC MICROBIOLOGY	CR	4	-	-	-	4	*	***
4	112	20BS1101	BASIC CHEMISTRY	CR	4	-	-	-	4	*	***
5	112	20BT1171	TECHNIQUES IN CELL BIOLOGY - LAB	CR	-	-	4	-	2	*	***
6	112	20CY1171	VOLUMETRIC ESTIMATIONS LAB	CR	-	-	4	-	2	*	***
7	112	20MB1171	BASIC TECHNIQUES IN MICROBIOLOGY-LAB	CR	-	-	4	-	2	*	***
8	112	20BS1102	COMMUNICATIVE ENGLISH	CR	2	-	-	-	2	*	***
					18	-	12	-	24		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SCHEME – B.Sc. – 2020-21 ONWARDS

II SEM – BCM

(BIOTECHNOLOGY, CHEMISTRY & MICROBIOLOGY)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	112	20BT1201	PRINCIPLES OF IMMUNOLOGY	CR	4	-	-	-	4	*	***
2	112	20CY1201	ADVANCED CHEMISTRY II	CR	4	-	-	-	4	*	***
3	112	20MB1201	MICROBIAL PHYSIOLOGY	CR	4	-	-	-	4	*	***
4	112	20BS1201	BIOINFORMATICS AND BIOSTATISTICS	CR	4	-	-	-	4	*	***
5	112	20BT1271	IMMUNO-TECHNIQUES-LAB	CR	-	-	4	-	2	*	***
6	112	20CY1271	SYNTHESIS & ANALYSIS OF ORGANIC COMPOUNDS-LAB	CR	-	-	4	-	2	*	***
7	112	20MB1271	MICROBIAL PHYSIOLOGY-LAB	CR	-	-	4	-	2	*	***
8	112	20BS1202	COMPUTER APPLICATIONS AND INFORMATION TECHNOLOGY	CR	2	-	-	-	2	*	***
					18	-	12	-	24		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SCHEME – B.Sc. – 2020-21 ONWARDS

III SEM – BCM

(BIOTECHNOLOGY, CHEMISTRY & MICROBIOLOGY)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	112	20BT2301	PRINCIPLES OF RECOMBINANT DNA TECHNOLOGY	CR	4	-	-	-	4	*	***
2	112	20CY2301	ADVANCED CHEMISTRY III	CR	4	-	-	-	4	*	***
3	112	20MB2301	IMMUNOLOGY AND MEDICAL MICROBIOLOGY	CR	4	-	-	-	4	*	***
4	112	20BS2301	MOLECULAR BIOLOGY	CR	4	-	-	-	4	*	***
5	112	20BT2371	TECHNIQUES IN RECOMBINANT DNA TECHNOLOGY - LAB	CR	-	-	4	-	2	*	***
6	112	20CY2371	SEMI-MICRO QUALITATIVE ANALYSIS OF BINARY SALT MIXTURES - LAB	CR	-	-	4	-	2	*	***
7	112	20MB2371	IMMUNOLOGY AND MEDICAL MICROBIOLOGY - LAB	CR	-	-	4	-	2	*	***
8	112	20BS2302	ENVIRONMENTAL SCIENCE	CR	2	-	-	-	2	*	***
					18	-	12	-	24		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SCHEME – B.Sc. – 2020-21 ONWARDS

IV SEM – BCM

(BIOTECHNOLOGY, CHEMISTRY & MICROBIOLOGY)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	112	20BT2401	PRINCIPLES OF ANIMAL AND PLANT BIOTECHNOLOGY	CR	4	-	-	-	4	*	***
2	112	20CY2401	ELECTROCHEMISTRY AND ADVANCED SPECTROSCOPY	CR	4	-	-	-	4	*	***
3	112	20MB2401	INDUSTRIAL, FOOD AND DAIRY MICROBIOLOGY	CR	4	-	-	-	4	*	***
4	112	20BS2401	GENOMICS AND PROTEOMICS	CR	4	-	-	-	4	*	***
5	112	20BT2471	TECHNIQUES IN ANIMAL AND PLANT BIOTECHNOLOGY - LAB	CR	-	-	4	-	2	*	***
6	112	20CY2471	PHYSICO-ELECTROCHEMICAL TECHNIQUES - LAB	CR	-	-	4	-	2	*	***
7	112	20MB2471	INDUSTRIAL, FOOD AND DAIRY MICROBIOLOGY -LAB	CR	-	-	4	-	2	*	***
8	112	20BS2402	BIOETHICS AND IPR	CR	2	-	-	-	2	*	***
					18	-	12	-	24		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SCHEME – B.Sc. – 2020-21 ONWARDS

V SEM – BCM

(BIOTECHNOLOGY, CHEMISTRY & MICROBIOLOGY)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	112	20BT3501	FERMENTATION BIOTECHNOLOGY	CR	4	-	-	-	4	*	***
2	112	20CY3501	COORDINATION CHEMISTRY AND NANOSCIENCE	CR	4	-	-	-	4	*	***
3	112	20MB3501	AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY	CR	4	-	-	-	4	*	***
4	112	20BS3572	COORDINATION CHEMISTRY-LAB	CR	-	-	4	-	2	*	***
5	112	20BS3575	APPLIED MICROBIOLOGY AND FERMENTATION TECHNIQUES -LAB	CR	-	-	4	-	2	*	***
6	112	20AU0003	CONSTITUTION OF INDIA AND HUMAN RIGHTS	AU	2	-	-	-	-	*	***
7	112	20AU0020	KANNADA KALI – I	AU	2	-	-	-	-	*	***
8	112	20AU0022	KANNADA MANASU – I	AU	2	-	-	-	-	*	***
					16	-	08	-	16		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SCHEME – B.Sc. – 2020-21 ONWARDS

VI SEM – BCM

(BIOTECHNOLOGY, CHEMISTRY & MICROBIOLOGY)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	112	20BS3601	RESEARCH METHODOLOGY	CR	4	-	-	-	2	*	***
2	112	20BS3602	PROJECT	CR	-	-	12	-	6	*	***
					4	-	12	-	08		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SEMESTER	I					
YEAR	I					
COURSE CODE	20BT1101					
TITLE OF THE COURSE	FUNDAMENTALS OF CELL BIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4		-	-	44	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	-	-	-

COURSE OBJECTIVES:

- To equip students with the basic understanding of structures and functions of organelles of prokaryotic and eukaryotic cells.
- To impart understanding on the process of cell division, cell cycle and its control.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students should have basic knowledge on the structure and functions of cellular organelles.	L2
CO2	Students should be able to understand the concept of cell cycle.	L3
CO3	Cell cycle its control.	L4
CO4	Cell growth; Different stages in cell division: Meiosis and Mitosis and their relevance	L3

COURSE CONTENT:	
MODULE 1: ULTRA STRUCTURE OF CELL	
12Hrs	
Prokaryotic (Bacteria) and Eukaryotic cells (Animal and Plant) - Characteristics and differences. Cell Wall: Ultrastructure, chemical composition and function. Plasma membrane: Chemical composition (Lipids, Proteins, Carbohydrates), Structure (Fluid mosaic model). Mode of transport across membrane: Active Transport (Pumps) and Passive transport (Osmosis, Diffusion).	
MODULE 2: CELL ORGANELLES -I	
12Hrs	
Structure and general functions: Chloroplast (Envelope, Stroma, Thylakoids); Endoplasmic Reticulum (Smooth and Rough); Golgi complex (Cisternae, Tubules, Vesicles); Mitochondria; Ribosomes; Lysosomes (Primary and Secondary); Microsomes.	
MODULE 3: CELL ORGANELLES -II	
12Hrs	
Structure and general functions: Cytoskeleton (Microtubules, Microfilaments and Intermediate Filaments); Cilia and Flagella. Structure and general functions of Nucleus	

(Nuclear envelope, Nucleoplasm and Nucleolus). Chromosomes- Discovery, Structure and functions (Centromere, Secondary constrictions, Telomere). Types of Chromatin (Euchromatin and Heterochromatin); Dosage Compensation. Organization of Chromatin: Nucleosomes and Solenoid Model; Giant Chromosomes (Polytene and Lampbrush).	
MODULE 4: CELL GROWTH AND CELL DIVISION	12Hrs
Cell cycle: Introduction to cell cycle stages (Interphase and M phase); Introduction to Cell cycle control (Cyclins and Cyclin dependent kinases). Mitosis: Mitotic phases; Cytokinesis; Significance of Mitosis. Meiosis: First meiotic division; Second meiotic division, Synaptonemal complex; Significance of meiosis. Introduction to programmed cell death (Apoptosis & Necrosis).	

List of Laboratory/Practical Experiments activities to be conducted (if any) : NONE
1.
2.

TEXT BOOKS:

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Gerald Karp. Cell and Molecular Biology. 6th Edition (2009) Wiley Publications.

REFERENCES:

1. Bruce Alberts et al. Molecular Biology of the cell - (2002) Garland Publications.
Ambrose and Esty D. M. Cell Biology - (1997) ELBS Publications.
2. Robertis E. D. F. and Robertis E. M. F. Genetics and Molecular Biology - (2001) Saunders College.

SEMESTER	I					
YEAR	I					
COURSE CODE	20CY1101					
TITLE OF THE COURSE	ADVANCED CHEMISTRY - I					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To develop basic and advance concepts regarding the three states of matter.
- To derive the expressions for determining the physical properties of gases.
- The course is infused with the recapitulation of fundamentals of organic chemistry and the introduction of a new concept of visualizing the organic molecules in a three-dimensional space.
- To establish the applications of these concepts, the functional groups- alkanes, alkenes, alkynes and aromatic hydrocarbons are introduced. The constitution of the course strongly aids in the paramount learning of the concepts and their applications.
- Derive mathematical expressions for different properties of gas understand their physical significance.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students be able to Understand and explain the different nature and behavior of organic compounds based on fundamental concepts learnt.	L1
CO2	Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.	L3
CO3	Apply the concepts of gas equations, pH and electrolytes while studying other chemistry courses and everyday life.	L2

COURSE CONTENT:	
MODULE 1	
12Hrs	
PERIODICITY OF ELEMENTS	
Classification of elements into s, p, d, and f-blocks, cause of periodicity. Brief discussion of the following properties of the elements, with reference to s-& p-block and the trends shown: Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. Atomic and ionic radii ionization enthalpy, Successive ionization enthalpies and factors affecting ionization enthalpy and trends in groups and periods. Electron gain enthalpy and trends in groups and periods. Electronegativity, Pauling's/ Allred Rochow's scales. Variation of electronegativity with	

bond order, partial charge, hybridization, group electronegativity.	
MODULE 2	12Hrs
GASEOUS STATE Gaseous state - laws of gaseous state- gas constant R in different units – deviation from ideal behavior- Van der waals equation for real gases Need for Maxwell-Boltzmann distribution law, mathematical expression for both based on this law (no derivation). Mean free path, collision frequency and collision number. Definition and expressions using SI units (no derivations). Derivation of expression for most probable speed from Maxwell-Boltzmann equation Definitions and expressions for rms velocity and average velocity, relationships between them. Problems. Andrew's isotherm on carbon dioxide and explanation of the curves (no experimental details). Mole and molecule-explanation of the terms only. Explanation of velocity distribution curves. Derivation of critical constants T _c , P _c and V _c from van der Waal's equation and their experimental determination by Cagniard de La Tour method for T _c and P _c . Amagats mean density method for V _c . Problems on the calculation of T _c , P _c and V _c , a and b. Law of corresponding states - statements, reduced equation of state and explanation, Joule-Thomson effect-explanation. Joule-Thomson coefficient, inversion temperature-definition (no derivation). The application of Joule-Thomson effect to the liquefaction of air and hydrogen by Linde's process.	
MODULE 3	12Hrs
ALIPHATIC HYDROCARBONS Alkanes: Sources, Nomenclature of branched chain alkanes, preparation of symmetrical and unsymmetrical alkanes- Corey- House reaction and Wurtz reaction - their merits and demerits. Cycloalkanes: Nomenclature. Method of formation. Explanation for stability based on heat of hydrogenation data, Baeyer's strain theory and its limitation, Sachse - Mohr theory of strain-less rings; cyclopropane ring - banana bonds. Alkenes: Preparation of alkenes by Wittig reaction-stereoselectivity. Addition of HX to unsymmetrical alkene - Markownikov's rule and Antimarkownikov's rule with mechanism. Reactions: Hydroboration- oxidation, reduction, oxymercuration - demercuration, epoxidation. Mechanism of oxidation with KMnO ₄ and OsO ₄ . Ozonolysis-mechanism and importance. Dienes: Classification- isolated, conjugated, cumulated. Structure of allene and butadiene. 1,2 addition and 1,4 addition reactions. Diels Alder reaction-1,3-butadiene with maleic anhydride. Alkynes: Methods of preparation - Dehydrohalogenation of vicinal and geminal dihalides; and higher alkynes from terminal alkynes. Reactions - metal ammonia reduction – significance. Oxidation with KMnO ₄ , acidic nature of terminal alkynes.	
MODULE 4	12Hrs
STEREOCHEMISTRY Configurational isomers - concept of chirality (asymmetry) - stereogenic centres – enantiomers - diastereomers with multiple chiral centres - Fischer projection - predicting the number of stereoisomers of compounds - absolute configuration, (R-S system of nomenclature) - relative configuration (D-L system of nomenclature) optical activity - racemic mixtures - chirality in molecules without a stereocentre. Geometrical isomerism: cis -trans isomerism and E,Z nomenclature in alkenes and oximes.	

Conformations of ethane – propane and butane – Newmann - Sawhorse and Wedge- Dash representations - Conformational isomerism in cycloalkanes – cyclopropane and cyclobutane - Conformations of cyclohexane - Monosubstituted, and disubstituted cyclohexanes.

TEXT BOOKS:

1. Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
2. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002.
3. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
4. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi.

REFERENCES:

1. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
2. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi.

SEMESTER	I					
YEAR	I					
COURSE CODE	20MB1101					
TITLE OF THE COURSE	BASIC MICROBIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To know the importance of microorganisms for our global society
- To understand the structural and functional characteristics of prokaryotic and eukaryotic cells with their classification
- To study the basic techniques for isolation, culturing and identification of prokaryotic microorganisms and their importance
- To study eukaryotic microorganisms in detail and to know their importance

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Provides a strong acquaint in fundamental aspects of basic microbiology	L1
CO2	Enable to understand the diversity of microbial, structure, function and their environment	L2
CO3	Awareness about economic importance of microorganisms	L3
CO4	Students will be equipped with fundamental knowledge of microbial growth patterns and kinetic studies enabling them to apply the same in various allied fields.	L2

COURSE CONTENT:	
MODULE 1	
12Hrs	
HISTORY AND MICROBIAL SYSTEMATICS Development of microbiology as a discipline, spontaneous generation and biogenesis. Contributions of Antony von Leeuwenhoek, Joseph Lister, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Sumbunath Dey, Ananda Chakroborty and Sir Ronald Ross in the field of Microbiology. Scope and disciplines of microbiology. Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems. Brief account of Bergey's manual of bacteriology. Criteria for the classification of bacteria. General account of microbiome.	
MODULE 2	
12Hrs	

MICROBIAL TECHNIQUES	
Microscopy: Principles of resolution and magnification. Types- optical and electron microscopy – Basic principle, sample preparation, applications and limitations of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope (Toppling & sliding mode), Fluorescence and Electron Microscope-TEM and SEM). Staining techniques: Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection-principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic). Microbial Nutrition and kinetics: Growth curve, Macro- and Micronutrients, Factors influencing the growth of microbes. Measurement of microbial growth.	
MODULE 3	12Hrs
PROKARYOTIC MICROBIOLOGY	
Difference between prokaryotic and eukaryotic microorganisms. Virology: General structure and characteristics of viruses, cultivation of viruses, general replication of viruses – lytic and lysogenic cycle with examples (TMV and Lambda phage), significance of viruses, viroids and prions. Bacteriology: Size, shape and arrangement. Ultrastructure of bacteria and functions in detail - Slime layer & Capsule (<i>Klebsiella</i>), Flagella, Pilus/ Fimbriae (<i>E. coli</i>), Cell wall (Gram positive and negative), Cytoplasmic membrane, Cytoplasmic inclusion bodies, Nuclear material, Plasmids and episomes, Ribosomes and Endospore (<i>Bacillus</i> / <i>Clostridium</i>). Reproduction – Binary fission and genetic exchange in bacteria (Conjugation, transformation and transduction). Special microbial forms: Actinomycetes, Spirochetes, Rickettsia, Chlamydiae. Introduction to Archaeobacteria and extremophiles.	
MODULE 4	12Hrs
EUKARYOTIC MICROBIOLOGY	
Fungi: General account of Fungi - General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization. Reproduction - asexual and sexual. Economic importance of fungi. Type study of Zygomycetes (Rhizopus), Ascomycetes (Aspergillus), Basidiomycetes (Agaricus) and Deuteromycetes (Fusarium). Algae: General characteristics of algae including occurrence, thallus organization, algae cell ultrastructure. Reproduction and life cycles-vegetative, asexual and sexual reproduction. Economic importance of algae. Type study of Cyanophyta (Spirulina), Chlorophyta (Chlamydomonas and Spirogyra), Rhodophyta (Gracillaria). Protozoa: General characteristics with special reference to Amoeba, Trypanosoma, Plasmodium, Paramecium.	

TEXT BOOKS:

1. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2007. Introductory Mycology; Fourth edition, Wiley India Private Limited
2. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
3. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
4. Benson, H. J. 1994. Microbiological Application. WCB McGraw-Hill of India Private Limited.
5. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
6. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.

7. Dubey, R.C. Microbiology 1st Edition. Chand and company
8. Edward Alcamo. Microbiology. Cliffs Notes 1996.
9. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015. 9
10. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.
11. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005
12. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1986.
13. Pommerville, J.C. 2007. Alcamo's Fundamentals of Microbiology. Eighth Edition. Jones and Bartlett Publishers, USA.
14. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
15. Salle, A. J. 1984. Fundamental Principles of Bacteriology. Tata McGraw-Hill Publishing Company Limited, New Delhi.
16. Salle, A.J. Principles of Microbiology, 2nd edition., 1997, Mc Graw Hill.1997.
17. Sharma, O. P. 1986. Text Book of Algae. Tata McGraw-Hill Education.
18. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005
19. Tortora, Funke and Case. Microbiology, 9th Edition. Benjamin Cummings. 2009
20. Vashishta, B.R. 2010. Botany for Degree Students – Algae. S. Chand and Co.

SEMESTER	I					
YEAR	I					
COURSE CODE	20BS1101					
TITLE OF THE COURSE	BASIC CHEMISTRY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To make the students to understand basic facts and concepts in chemistry while retaining the exciting aspects of chemistry so as to develop interest in the study of chemistry as a discipline.
- To make the students to familiarize with the basic concepts related to modern atomic theory, quantum chemistry, acids and bases, chemical bonds in molecules and basics of organic chemistry and different organic reactions.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will learn about handling of data and basics of acids and bases	L1
CO2	Students will learn about advanced principles of atomic structure	L2
CO3	Students will get in depth knowledge about chemical bonding and various theories related to that.	L3
CO4	Students will learn about the basic principles of organic chemistry	L1

COURSE CONTENT:

MODULE 1	10Hrs
GENERAL CHEMISTRY Handling of analytical data: SI and CGS units of measurements and physical constants and their inter conversion; Significant figures and calculations, accuracy, precision and errors in quantitative analysis. Stoichiometry: atomic weights, molecular weights, mole concept, molarity, molality, normality, mole fraction, ppt, ppb and ppm. Numerical problems related to the above concepts. Acids and Bases: Theories of acids and bases – Arrhenius - Bronsted-Lowry theory - Lewis theory -Solvent system definition. Relative strengths of acids and bases – Dissociation constant of acids and bases - Levelling effect of water. Hard and soft acids and bases (HSAB). Non-aqueous solvents – classification - Liquid ammonia as solvent. Acid-base equilibria in aqueous solution and pH. Acid- base neutralisation curves; indicator, choice of indicators.	
MODULE 2	12Hrs

ATOMIC STRUCTURE

Review of Bohr's theory and its limitations, dual behavior of matter and radiation, de Broglie's equation-derivation, Heisenberg's uncertainty principle. Hydrogen atomic spectra. Need of a new approach to atomic structure. Elements of Quantum chemistry- Schrodinger wave equation and meaning of various terms in it. Significance of ψ and ψ^2 , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Quantum numbers and their Significance. Shapes of s, p and d atomic orbitals, nodal planes. Rules for filling up of electrons in various orbitals (Aufbau principle, Pauli's exclusion principle, Hund's rule of maximum multiplicity and n+l rule), Electronic configuration of the elements (up to Z=30) and anomalous electronic configurations. Stability of half-filled and completely filled orbitals- concept of pairing and exchange energy.

MODULE 3

12Hrs

Introduction: Need for the atoms to form molecules, and types of chemical bonds with examples
Ionic Bond: Definition and conditions for formation of an ionic bond between atoms, examples of formation of an ionic compound between alkali metal/alkaline earth metals and chalcogen/halogen group elements. Lattice energy, its effect on stability and solubility of ionic solids, Born – Haber cycle for NaCl, KBr, KI, and MgO and CaCl₂). *Covalent Bond:* Definition, octet rule, Lewis dot formulae of a few simple molecules and ions, electron deficient and excess molecules (BeCl₂, BF₃, PCl₅, SF₆).

Geometry of covalent molecules: (VSEPR concept and hybridisation concepts) basic concepts and definitions: Examples simple inorganic molecules and ions. such as NH₃, H₂O, H₃O⁺, SF₄, ClF₃. *Theories of covalent bonds (VBT and MOT):* *Valence bond theory (VBT):* postulates and its limitations, directional characteristics of covalent bonds, Application of VBT to BeCl₂, BF₃, SiCl₄, PCl₅, SF₆ molecules.

Molecular orbital theory: postulates, linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals, pictorial representation of formation of s and p MOs from the corresponding atomic orbitals, Molecular orbital energy level diagram and molecular orbital configuration involving s and p orbitals their importance for the following molecules, (H₂, N₂, O₂, HF and CO).

Metallic Bond: Definition, properties of metals and band theory.

Weak Intermolecular interactions: van der Waals forces, dipole-dipole interactions and their significance. *Hydrogen Bond:* Definition, types, importance

MODULE 4

12Hrs

Representation of structural formula of organic compounds: condensed formula and bond line formula of organic compounds, classification of organic compounds based on functional groups with examples *IUPAC nomenclature:* IUPAC nomenclature of organic compounds including Bifunctional compounds and substituted benzenes. (o, p and m). *Delocalisation of electrons:* Inductive effect, electrometric effect, resonance (mesomeric effect, EWG and EDG, +M and –M effects) and hyper conjugation. *Reactive intermediates:* Types of bond cleavage, curly arrow rules in representation of mechanistic steps; electrophiles, nucleophiles, carbocations, carbanions, free radicals and carbenes– generation, structures, stability and examples. *Types of organic reactions:* Types of organic reactions with examples (electrophilic/ nucleophilic substitution/addition/free radical reaction with examples. *Aromaticity:* Kekule structure of benzene - molecular orbital picture of benzene – resonance energy and stability of benzene - Huckel's rule (aromatic, non-aromatic, and antiaromatic molecules) - aromaticity of benzene and benzenoid compounds – aromaticity of three, four, five, six, seven and eight-membered systems - annulenes.

TEXT BOOKS:

1. A New Concise Inorganic Chemistry”, J. D. Lee, 5th Ed, Chapman & Hall, London (1996).
2. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992)
3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)

REFERENCES:

1. A New Concise Inorganic Chemistry”, J. D. Lee, 5th Ed, Chapman & Hall, London (1996).
2. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992).

SEMESTER	I					
YEAR	I					
COURSE CODE	20BT1171					
TITLE OF THE COURSE	TECHNIQUES IN CELL BIOLOGY - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
			4	-	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To equip students with the basic techniques used in cell biology
- To facilitate the study of cell size, cell count, stages in cell division, staining of cells

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Able to perform staining of cells	L3
CO2	Identify stages of mitosis and meiosis	L3
CO3	Be well versed with the use of simple and compound microscope	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Introduction to Microscopy (Bright Field, Dark Field, Phase Contrast Microscopy)
2. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.
3. Cell division: Study of mitosis using onion root tips.
4. Preparation of Buccal smears for study of Barr bodies.
5. Vital Staining of mitochondria (yeast).
6. Blood smear-differential staining.
7. Study of model organisms - -Tobacco Mosaic Virus, Lambda Phage, Neurospora crassa, Caenorhabditis elegans, Arabidopsis thaliana, Drosophila.

TEXT BOOKS :

1. **Dr. Renu Gupta , Dr. Seema Makhija , Dr. Ravi Toteja. Cell Biology : Practical Manual. Prestige Publishers, 2018.**

REFERENCES:

1. Amit Gupta and Bipin Kumar Sati . Practical laboratory manual- CELL BIOLOGY. LAP Lambert Academic Publishing, 2019.
2. Alberts et al., (2002). Molecular Biology of the Cell, Garland Publishing, Inc., 4th ed.

SEMESTER	I					
YEAR	I					
COURSE CODE	20CY1171					
TITLE OF THE COURSE	VOLUMETRIC ESTIMATIONS - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	-	-	44	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Students will learn about good laboratory practices, various glassware used in the chemistry laboratory and the methods to calibrate them.
- Students will be introduced to various volumetric titrations such as acid-base, redox and idometric etc.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be well versed with various laboratory practices, usage of different glassware and methods to calibrate them.	L1
CO2	Students will be able to use the principles of titration experiments to estimate carbonate, nitrogen, chlorine etc. from the various matrices given.	L3

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Good laboratory practices and calibration of glassware (pipette, burette and standard volumetric flasks etc.
2. Setting up of titration unit, reflux, distillation, steam distillation apparatus from the basic parts and preparation of a standard solution.
3. Estimation of potassium permanganate using standard sodium oxalate solution.
4. Estimation of ferrous sulphate using standard potassium dichromate solution with ferroin indicator.
5. Estimation of ferrous sulphate using standard potassium dichromate solution using external indicator.
6. Estimation of ferrous and ferric iron in a given mixture using standard potassium dichromate solution.
7. Estimation of free alkali present in different soaps/detergents
8. Estimation of carbonate and bicarbonate in a given mixture.
Determination of percentage of manganese dioxide in pyrolusite ore.
Estimation of water of crystallization in Mohr's salt by titrating with KMnO_4 .

TEXT BOOKS:

1. A New Concise Inorganic Chemistry”, J. D. Lee, 5th Ed, Chapman & Hall, London (1996).
2. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992)
3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)

REFERENCES:

1. A New Concise Inorganic Chemistry”, J. D. Lee, 5th Ed, Chapman & Hall, London (1996).
2. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992)

SEMESTER	I					
YEAR	I					
COURSE CODE	20MB1171					
TITLE OF THE COURSE	BASIC TECHNIQUES IN MICROBIOLOGY - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	4	-	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To enable students to understand the microbial structure, microbial growth pattern and techniques to measure cell size.
- To help them understand the isolation of various microorganisms from different sources.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students are aware of microbial diversity and isolation techniques.	L1
CO2	Students will be equipped with fundamental knowledge of microbial growth patterns and kinetic studies enabling them to apply the same in various allied fields.	L2

List of Laboratory/Practical Experiments activities to be conducted (if any) :	
1. Study of basic instruments in Microbiology laboratory (2 Units)	a) Autoclave b) Hot air oven c) Incubator d) pH meter e) High speed centrifuge f) Colorimeter / Spectrophotometer g) Anaerobic jar h) Bacterial Filters i) Laminar air flow
2. Preparation of culture media:	a) Basal media (Nutrient agar and broth, Czapekdox media and MRBA) b) Selective media (EMB agar and McConkey agar), c) Enriched media (Blood agar).
3. Isolation of bacteria and fungi by serial dilution technique from soil, water and air.	
4. Methods of pure culture techniques	a) Pour plate technique b) Spread plate technique c) Streak plate technique
5. Transfer of media and inoculum	

6. a) Slant culture technique b) Broth culture technique c) Stab culture technique
7. Microscopic examination of bacterial smear a) Simple staining b) Gram's staining c) Capsule staining d) Endospore staining
8. Isolation and identification of fungi (Lactophenol cotton blue mount)
9. Micrometry: Microscopic measurement of bacterial cell (Bacillus), yeast (Saccharomyces).
10. Microscopic observation of temporary slides a. Algae: Chlamydomonas and Spirulina b. Fungi: Rhizopus, Aspergillus, Penicillium, Yeast and Fusarium c. Protozoa: Amoeba, Paramecium and Plasmodium
11. Study of growth curve of bacteria by turbidimetric method

REFERENCES

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
3. Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
4. Pelczar, M. J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.
5. Prescott, L.M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, NY.

SEMESTER	I					
YEAR	I					
COURSE CODE	20BS1102					
TITLE OF THE COURSE	COMMUNICATIVE ENGLISH					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	24	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To encourage the students to speak English confidently and enable them to communicate for day-to-day needs
- To build up their confidence in the usage of English and to enhance their written communicative competence also helping them for competitive exams

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students are confident in oral and written communication	L1
CO2	Have enhanced competence for competitive exams	L2

COURSE CONTENT:	
MODULE 1	
6Hrs	
COMMUNICATION SKILLS Definition, importance of communication, communication process – source, message, encoding, channel, decoding, receiver, feedback, context, levels of communication, Flow of Communication, Verbal and Non-Verbal Communication, Barriers to Communication - physiological, physical, cultural, language, gender, interpersonal, psychological, emotional. Perspective in communication/ Communication styles: introduction, visual perception, language, other factors affecting our perspective – past experiences, prejudices, feelings, environment	
MODULE 2	
6Hrs	
Elements of communication – introduction, face to face communication – tone of voice, body language (non-verbal communication), verbal communication, physical communication; Basic listening skills: introduction, self-awareness, active listening, becoming an active listener, listening in difficult situations; Interview skills: purpose of an interview, do's and don't's of an interview; Giving presentations: dealing with fears, planning your presentation, structuring your presentation, delivering your presentation, techniques of delivery; Group discussion: introduction, communication skills in group discussion, do's and don't's of	

group discussion; Phonetics: The Organs of Speech, The Description and Classification of Speech Sounds, The Description and Classification of Vowels, The Description and Classification of Consonants, Phonetic symbols and the IPA, Phonemic and Phonetic Transcription Phonology, Phoneme sequences and Consonant Cluster, The Syllable, Word Accent, Accent and Rhythm in Connected Speech, Intonation, Varieties of English Pronunciation.	
MODULE 3	6Hrs
EFFECTIVE WRITING SKILLS Effective written communication: introduction, when and when not to use written communication – complexity of the topic, amount of discussion required, shades of meaning, formal communication Writing effectively: subject lines, put the main point first, and know your audience, organisation of the message, Paragraph Writing, Letter Writing, Report Writing, Book Review, Scientific writing, Making a message – Transitivity/ intransitivity – complementation – talking about closely linked action – using two verbs together (eg: She started laughing), Transforming messages – Making statements, questions, orders and suggestions – denying – rejecting – disagreeing – possibility – ability, permission, obligation etc.	
MODULE 4	6Hrs
GRAMMAR Word Classes: Open Word Classes: - Nouns, Verbs, Adjectives, Adverbs, Pronouns; Closed Word Classes: - Pre-determiners, Determiners, Numerals, Enumrators, Prepositions, Conjunctions, Auxiliary Verbs, Interjection; Morphology: Bound and Free Morphemes; Affixes, Stems and Roots; Morphological Analysis; Phrases: Noun Phrase, Verb Phrase, Genitive Phrase, Adjective Phrase, Adverb Phrase, Prepositional Phrase, Phrases and its types, Clauses and its types, Sentences and its types, Common errors, phonetics; Clauses: Clause Elements, Clause Types, Kinds, Concord; Sentences: Simple Sentences, Compound Sentences, Complex Sentences; Sub Ordination: Sub-Clauses, Finite and Non-Finite Sub-Clauses; Co-ordination: Linked and Unlinked Coordination, Synthesis; Ambiguity: Types of Ambiguity, Structural and Lexical Ambiguity; Common Errors: Nouns and Pronouns, Articles, Verbs, Concord, Adjectives, Adverbs, Prepositions, Vocabulary, Expressing time, Referring to present, past and future time - use of adjuncts - frequency and duration, Talking about manner and place, Information about place, manner - position of adjuncts - types of adverbs (time, frequency, duration etc), Reporting what people say/think, Reporting verbs - reporting someone's actual words - reporting in one's own words, The structure of information, Focusing on the thing affected (passive voice) - selecting focus (left structure) taking the focus off the subject (impersonal 'it' etc.) – Introducing something new (with 'there') - focusing on information using adjuncts.	

TEXT BOOKS:

1. Crystal, David. 1985, Rediscover Grammar with David Crystal. Longman Bakshi, R. N. A Course in English Grammar. Orient Longman
2. Close, R. A. Reference Grammar for Students of English. Orient Longman
3. Krishnaswamy, N. Modern English – A Book of Grammar, Usage & Composition. Macmillan India, Ltd.
4. Aroor, Usha (Ed.) WordMaster Learner's Dictionary of Modern English. Orient

Longman 17

5. Hewings, M. 1999, Advanced English Grammar. Cambridge University Press
6. Basic communication skills for technology, Andreja J. Ruther Ford, 2nd Edition, Pearson Education, 2011.
7. Communication Skills, Sanjay Kumar, Pushpalata, 1st Edition, Oxford Press, 2011.
8. Brilliant – Communication Skills, Gill Hasson, 1st Edition, Pearson Life, 2011.
9. Soft Skill and Professional Communication, Francis Peters SJ, 1st Edition, Mc GrawHill Education, 2011.

SEMESTER	II					
YEAR	I					
COURSE CODE	20BT1201					
TITLE OF THE COURSE	PRINCIPLES OF IMMUNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To provide basic understanding on Immune system: Cells and organs of the immune system and its fundamentals.
- To give basic framework and knowledge on structure and functions of antibodies, antigens and antigen specificity of antibodies. antigen -antibody interactions, generation of immune response and to equip the students with knowledge on immunological techniques, vaccines.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be acquainted with the basic understanding of immune system in its entirety: the big picture	L1
CO2	Acquaintance with the basic working of antibodies, functions of antibodies and their antigen specificity.	L2
CO3	Basic concepts of immune response: antigen processing and presentation, clonal selection and expansion. To enable critical thinking about its protective role in infectious diseases and their control; vaccinations	L4
CO4	Fundamental understanding of basic immunological techniques and their applications	L3

COURSE CONTENT:	
MODULE 1: COMPONENTS, CELLS AND TISSUES OF THE IMMUNE SYSTEM	
Elements of Immune System: History and scope of Immunology, Innate, and Acquired immunity, Humoral and Cell mediated Immunity. Cells and organs of immune system and their functions – Primary and secondary lymphoid organs, T cells, B Cells, macrophage, NK cells Basic outline or scheme of clonal selection in the humoral (B cell) and cellular (T cell) branches of immunity. Immunological memory.	12Hrs
MODULE 2: ANTIGENS AND ANTIBODIES	
	12Hrs

Antigens and Antibodies: Antigens – types, epitopes, haptens, factors affecting immunogenicity, adjuvant concept; Antibodies – structure, isotypes, and functions of Immunoglobulins. Antibody production: Polyclonal and monoclonal. Complement system – components, functions, activation pathways (classical, alternative, lectin mediated).	
MODULE 3: IMMUNE RESPONSES	12Hrs
Antigen processing and presentation, antigen presenting cells (APCs), target cell concept; Major Histocompatibility Complex (MHC) – MHC I and II. Interleukins and Interferons – brief introduction and their important functions. Products and factors produced by T-cell activation; dendritic cells; cytokines (interleukins and interferons) Primary and secondary Immune response.	
MODULE 4: IMMUNOLOGICAL TECHNIQUES AND VACCINES	12Hrs
Antigen-Antibody reactions – Precipitation, Immuno-electrophoresis, Hemagglutination – Blood grouping, ELISA, RIA, Immunofluorescence. Vaccines and Immunization: Passive and Active immunization, immunization schedules. Types of Vaccines – Inactivated, Attenuated, and Recombinant vaccines – Peptide and DNA Vaccines.	

TEXT BOOKS:

1. Kindt TJ, Osborne BA, Goldsby RA. Kuby Immunology, Sixth Edition. 6th edition. New York: W. H. Freeman & Company; 2006.
2. C Vaman Rao (2007) Immunology (2nd Ed), Narosa Publishing.
3. Abbas, Lichtman, Pillai (2011) Cellular and Molecular Immunology (7th Ed), Elsevier

REFERENCES:

1. Roitt IM (2001) Essentials of Immunology, Blackwell Scientific Publishers, London. Murphy, K., Weaver, C., Weaver, C., 2016. Janeway's Immunobiology. W.W.Norton & Company. <https://doi.org/10.1201/9781315533247>.
2. Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J., Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J., 2001. Immunobiology, 5th ed. Garland Science.
3. Kuby Immunology 7th edition. Macmillan Publishers 2014.
4. Kuby Immunology, 8th Edition. Macmillan Publishers 2019.

SEMESTER	II					
YEAR	I					
COURSE CODE	20CY1201					
TITLE OF THE COURSE	ADVANCED CHEMISTRY - II					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To impart knowledge of advanced chemistry topics such as *s* & *p* block elements, liquid and solutions, thermodynamics and aliphatic organic compounds.
- To make students to understand about liquid state of matter, different properties of liquids, laws governing liquids and colligative properties and their applications.
- To make the students to know about the salient features of alkali and alkaline earth metals and also the chemistry behind *p*-block elements.
- To make students understand fundamental concepts of thermodynamics, thermodynamic laws, heat engine, efficiency, entropy etc.
- To give knowledge about aromatic organic compounds & alkyl halides, their properties, synthesis, reactions and important applications.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be familiar with the basic knowledge of the liquids and solutions and their applications in analytical chemistry. Students will develop the ability of effectively solving practical problems of analytical chemistry of non-aqueous solutions.	L1
CO2	Students will learn the descriptive chemistry of representative elements of <i>s</i> - and <i>p</i> -block elements and recognize the differences in their reactivity, chemical and physical properties	L3
CO3	Students will get the knowledge of different concepts of thermodynamics, thermodynamic laws, heat engines, efficiency, entropy etc.	
CO4	Students will gain knowledge about aromatic organic compounds and alkyl halides their properties, synthesis methods, reactions and applications in different fields.	L2

COURSE CONTENT:	
MODULE 1	12Hrs
s & p BLOCK ELEMENTS Hydrogen: Unique position of hydrogen in the periodic table, isotopes of hydrogen, ortho and para hydrogen, Industrial production of hydrogen by chemically assisted electrolysis and Steam reforming. Heavy water: Physical properties (with comparison to light water), Applications. Hydrates: Chemical nature and their stability. s-block elements: Occurrence, extraction by igneous fusion methods & uses of s-block elements. Comparative study of alkali & alkaline earth metals with respect to Physical properties: density, melting points & boiling points, flame coloration. Solubility of ionic compounds in relation to lattice energy and hydration energy. Complexation tendencies of alkali metals. Characteristics of oxides and basicity of hydroxides.p – block elements: Halides of boron, relative strength of BF ₃ , BCl ₃ & BBr ₃ as Lewis acids, diborane-preparation, structure & bonding. Halogens: Size of atoms & ions, ionization energy, electronegativity, oxidation states and oxidizing power. Types of interhalogen compounds-preparation and structure of IF ₃ , IF ₅ & IF ₇ . Noble gases: Introduction, electronic configuration, isolation of Helium from Natural gas, applications of Noble gases. Burtlet experiment, Preparation properties and structures (based on VBT) of fluorides and oxides of Xenon (XeF ₂ , XeF ₄ , XeF ₆ , XeO ₃ , XeO ₄).	
MODULE 2	12Hrs
LIQUIDS AND SOLUTIONS Properties of liquids-Viscosity, Surface tension and Parachor-Definition, mathematical expression, numerical problems and factors affecting them. Viscosity- Definition, mathematical expression, Coefficient of viscosity, effect of temperature, size, weight, shape of molecules and intermolecular forces on it. Surface Tension-Definition, mathematical expression, effect of temperature and solute on it Parachor-Definition, Sugen equation, calculation and applications. Numerical problems. Liquid Mixture: Review of Raoult's law, ideal and non-ideal solutions. Completely miscible liquids- Fractional distillation Tc curves for all the three types, azeotropic mixtures -examples. Completely miscible liquids-Critical solution temperature (Three types), examples. Effect of addition of salt on CST of phenol-water system. Immiscible liquids-Steam distillation and its applications. Distribution law-Statement, partition coefficient and condition for validity of distribution of distribution law. Application-solvent extraction. Dilute solutions- Review of colligative properties and concentration terms. Determination of molecular mass of a solute by: (i) Berkeley- Hartley method(ii) Beckmanns method Tf) and (iii) Landsberger's method. Numerical problems.	
MODULE 3	12Hrs
THERMODYNAMICS - I First law of thermodynamics: Review of terms, Exact and inexact differentials, I law of Thermodynamics. Work done (derivation with problems) in isothermal and adiabatic expansion and compression of an ideal gas (IUPAC sign conventions to be used). Heat capacity of a gas at constant pressure and constant volume: relation between P, V and	

T in an adiabatic process to be derived. Numerical problems. Spontaneous and non-spontaneous processes.

Second law of thermodynamics: Limitations of I law of thermodynamics with illustrations. Need for II law of thermodynamics, different ways of stating II law with respect to heat and spontaneity.

Other forms of II law of thermodynamics. Concept of entropy and its physical significance-illustrations with order, disorder, physical and chemical processes and probability.

Heat engine-Carnot's cycle and derivation of the expression for its efficiency. Problems based on efficiency equation. II law in terms of efficiency. Change in entropy in reversible and irreversible processes (derivations required). Calculation of entropy changes in reversible isothermal and reversible adiabatic processes.

MODULE 4

12Hrs

AROMATIC HYDROCARBONS & ORGANIC HALOGEN COMPOUNDS

Aromatic Hydrocarbons: General mechanism of aromatic electrophilic substitution. Mechanism of nitration of benzene including evidence for the formation of nitronium ion, energy profile diagram and isotopic effect. Orienting influence of substituents in toluene, chlorobenzene, nitrobenzene and phenol.

Aromatic nucleophilic substitution via benzyne intermediate, mechanism with evidences for the formation of benzyne by trapping with anthracene, Birch reduction. Side chain oxidation of toluene to benzaldehyde and benzoic acid. Oxidation of naphthalene, anthracene and

phenanthrene. Diels-Alder reaction of anthracene with 1,2-dichloroethene. Alkenyl benzenes: Styrene, cis- and trans-stilbenes and their preparations. Biphenyl: Preparation-Ullmann reaction.

Alkyl halides: Nomenclature. Nucleophilic substitution reactions - SN1 and SN2 mechanisms with energy profile diagrams. Effect of (i) nature of alkyl groups, (ii) nature of leaving groups, (iii) nucleophiles and (iv) solvents on SN1 and SN2 mechanisms. Elimination reactions - E1 and E2 mechanisms; Hofmann and Saytzeff eliminations with mechanism.

Aryl halides: Preparation by halogenation. Relative reactivity of alkyl, allyl, vinyl, aryl and aralkyl halides towards nucleophilic substitution.

TEXT BOOKS:

1. Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
2. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002.
3. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
4. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi.

REFERENCES:

1. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
2. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi.

SEMESTER	II					
YEAR	I					
COURSE CODE	20MB1201					
TITLE OF THE COURSE	MICROBIAL PHYSIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- The major features of growth and metabolism of microorganisms including determination of growth with environmental influence on the microbial growth and primary and secondary metabolism
- Energy source for microorganisms and relationship between metabolism and energy source

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To understand the complexity of microbial structures, and metabolism	L3
CO2	Enable to grasp the mechanisms the microbial transport systems and the modes and mechanisms of energy conservation.	L3

COURSE CONTENT:	
MODULE 1	
12Hrs	
ENZYMOLOGY Introduction, properties, nomenclature and classification, specificity, active sites, coenzymes, activators and inhibitors, activity unit-prosthetic groups and Isozymes. Effect of temperature, pH and substrate concentration on reaction rate. Enzymes kinetics: Michaelis-Menten equation for simple enzymes, Regulation of enzymes -Covalent and noncovalent modification; Enzyme inhibition - types of inhibitors – competitive non-competitive and uncompetitive. Ribozymes and abzyme.	
MODULE 2	
12Hrs	
MICROBIAL METABOLISM Primary metabolism: Breakdown of carbohydrates – Glycolytic pathways, HMP shunt/pentose phosphate pathway and ED. TCA and Electron transport chain TCA: Substrate and oxidative phosphorylation. Transamination, oxidative deamination, decarboxylation, Urea cycle. Fermentation: Anaerobic respiration, Fermentative modes in microorganisms – alcoholic, Lactic acid – hetero and homo and Acetic acid. Secondary metabolism: Overview and importance	

of secondary metabolites - antibiotics, aflatoxins, carotenoids	
MODULE 3	12Hrs
PHOTOSYNTHESIS AND BIOENERGETICS Bacterial photosynthesis: Photosynthetic micro-organisms photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation (purple and green bacteria), Carbon dioxide fixation pathways. Chemoautotrophy oxidation of inorganic compounds – Nitrate and sulphate. Bioenergetics: Free energy, ATP, NAD, FAD, FMN and its production, other high energy compounds, Oxidation – Reduction reactions. Electron transport chains in some anaerobic bacteria.	
MODULE 4	12Hrs
MICROBIAL CELL MEMBRANE PHYSIOLOGY Metabolite transport: Structure of biological membranes, Function of membrane proteins, solute transport across cell membranes (osmosis), regulation of ion concentrations (Hypotonic, Hypertonic and Isotonic solution), Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion - PTS, and role of permeases in transport Stress physiology: Osmotic stress and osmoregulation, Oxidative stress – superoxide dismutase and catalase, pH stress and acid tolerance, Thermal stress and heat shock response, Nutrient stress and starvation stress	

TEXT BOOKS:

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atherly, A.G., Girton, J.R. and Mc Donald, J.F. 1999. The Science of Genetics. Diane Pub. Co.
3. Boyer, R.F. 2003. Modern Experimental Biochemistry. Third Edition. Pearson Education.
4. Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
5. David, W. 2000. Physiology and Biochemistry of Prokaryotes. Second Edition. Oxford University Press.
6. Griffin, D.H. 1993. Fungal Physiology. Second Edition. Wiley Liss- A John Willy & Sons, Inc, Publication. USA. p: 1-458.
7. Moat, A.G. and Froster, S.W. 2002. Microbial Physiology. Fourth Edition. John Wiley and Sons, New York.
8. Nelson David L. and Cox Michael M. 2007. Lehninger - Principles of Biochemistry. Fourth
9. edition. MacMillan Press/Worth Publishers, New Delhi.
10. Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York.
11. Stickberger, M.W. 2012. Genetics, Prentice Hall of India Private Limited, New Delhi.
12. Voet, D. and Voet, J.G. 2010. Biochemistry. John Wiley and Sons, New York.
13. Wilson, K., and Walker, J. 2010. Principles and Techniques of Biochemistry and Molecular Biology. 7th edition. Cambridge University Press.

SEMESTER	II					
YEAR	I					
COURSE CODE	20BS1201					
TITLE OF THE COURSE	BIOINFORMATICS AND BIOSTATISTICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To create general interest in applied domain towards using computers for biological applications.
- To familiarize the students with basic concepts and principles statistics and their applications in biological sciences.
- To give holistic view for understanding the scientific validation and biomodelling.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be aware of various applied and allied scientifically domains to innovative and creative think.	L2
CO2	Student will be aware of the computer tools and applications which can be implemented in biological sciences.	L2
CO3	Students will be empowered for better prospects leading to project design and execution.	L3

COURSE CONTENT:	
MODULE 1	12Hrs
Introduction to computers: History of Computers, Components of computers (Hardware, Software and accessories). Concepts on Computer software, operating system (Windows), tools and applications of MS Office (notepad, word processor, spread sheet & presentation). Introduction to networks: LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls. Concepts on encryption of data. Relational Databases Management (RDMS): Codd Rules and concepts of databases, Data mining and applications, accessing bibliographic databases and Basics on citation and indexing (Pub Med and Google scholar).	
MODULE 2	12Hrs
Bioinformatics (Genomics): Nucleic acid sequence databank – NCBI, EMBL and DDBJ. Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER. Gene Sequence alignment - Global and Local, Similarity searching	

(FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs.	
MODULE 3	12Hrs
Bioinformatics (Proteomics): Introduction to protein structure – Primary, secondary structure prediction, tertiary structure prediction. Concepts on Protein Data Bank (PDB). Protein Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of proteins, domain and motif and Phylogenetic analysis. Protein sequence databank – NBRF-PIR, SWISSPROT and Swiss ExPASy. Metabolic pathway data bank (KEGG/Pub gene). Protein modeling - principles of homology and comparative modeling phylogenetics. Applications - Molecular docking – Patchdoc /Autodoc.	
MODULE 4	12Hrs
Biostatistics: Introduction to Biostatistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error. Sampling methods and their significance. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Statistical package - Features of statistical software. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases.	

TEXT BOOKS:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Bioinformatics. Keith, J. Humana Press, 2008.
4. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.

REFERENCES:

1. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists.
2. Bazin, M.J. (1983). Mathematics in microbiology Academic press.
3. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
4. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge.
5. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.
6. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
7. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series.
8. Higgins & Taylor (2000). Bioinformatics, OUP.
9. Baxavanis (1998). Bioinformatics.
10. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.

SEMESTER	II					
YEAR	I					
COURSE CODE	20BT1271					
TITLE OF THE COURSE	IMMUNO-TECHNIQUES – LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	32	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To acquaint the student with some basic techniques in immunology, to sensitize them to antigen antibody reactions and their applications
- To enable the students to get hands on learning to count viable cell in a hemocytometer and enable them to learn staining and identification of different white blood cells from the peripheral blood.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be familiarized with immunological techniques utilized for diagnostic assays.	L2
CO2	Student will be able to use hemocytometer to do cell counting and be able to stain and identify leucocytes from peripheral blood.	L2
CO3	Principle of ELISA and working of dotELISA. ELISA as a quantitative tool to measure specific analytes.	L3
CO4	Know the principles behind hemagglutination vs Immunoprecipitation techniques and correlate differentiate between soluble to insoluble(particulate) antigen concepts	L3

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Blood group identification and Rh Typing

2. Precipitation Reactions –

I. Radial Immuno Diffusion

II. Ouchterlony double diffusion

III. Rocket Immuno Electrophoresis

3. Dot ELISA

4. Serum separation and quantification of serum proteins

5. Introduction to instruments and laboratory set up for animal biotechnology

6. Determination of the concentration of viable cells in a suspension by Haemocytometer counting (trypan blue)

7. Study of different cells in whole blood using Giemsa/Leishman stain.

TEXT BOOKS:

1. Balakrishnan, Senthilkumar & Karthik, Kaliaperumal & Duraisamy, Senbagam. (2015). Practical Immunology- A Laboratory Manual. 10.13140/RG.2.1.4075.4728
2. Hay, F.C., Westwood, O.M.R., 2002. Practical Immunology, 4th edition. ed. Wiley-Blackwell, Malden, MA.

REFERENCES:

1. Lab Manual in Biochemistry, Immunology and Biotechnology by Nigam, Arti - AbeBooks.” McGraw-Hill Education (India) (2008)

SEMESTER	II					
YEAR	I					
COURSE CODE	20CY1271					
TITLE OF THE COURSE	SYNTHESIS AND ANALYSIS OF ORGANIC COMPOUNDS - LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	-	-	44	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- Students will determine various physical properties like density, specific gravity, molar mass, and transition temperature of some of the organic compounds.
- Students will determine distribution coefficients of binary mixtures, effect of surfactants on surface tension of water, determination of hardness of water. and dissolved oxygen. 3. Students will perform Paper chromatography, TLC and Column Chromatography for separation of organic dyes.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will be able to perform the various physical properties like density, specific gravity, molar mass, and transition temperature of some of the organic compounds.	L1
CO2	The students can determine distribution coefficients of binary mixtures, effect of surfactants on surface tension of water, determination of hardness of water. and dissolved oxygen. 3. The students will be well versed with Paper chromatography, TLC and Column Chromatography for separation of organic dyes.	L3

COURSE CONTENT:

List of Laboratory/Practical Experiments activities to be conducted (if any) :

- 1.Determination of the density using specific gravity bottle and viscosity of a liquid using Ostwald's viscometer.
- 2.Determination of the density using specific gravity bottle and surface tension of a liquid using Stalagmometer.
- 3.Determination of molar mass of a non-electrolyte by Walker-Lumsden method.
- 4.Determination of transition temperature of a salt hydrate by thermometric method.
- 5.Determination of distribution coefficient of benzoic acid between water and toluene.

6. Effect of surfactants on the surface tension of water (Stock solution to be given).
7. Estimation of hardness of water by EDTA method.
8. Study the variation of co-efficient of viscosity with different concentration of Poly Vinyl Alcohol (PVA) and determine molar mass of PVA.
9. Determination of percentage of sodium chloride by miscibility temperature method.
10. Paper chromatography: Separation of Methyl red and methylene blue.
11. Thin layer chromatography: Separation of green leaf pigments/separation of a mixture of two organic compounds.
12. Column Chromatography: Separation of Methyl red and methylene blue.

TEXT BOOKS :

1. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford, A.R. Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication.
3. Experimental Organic Chemistry Laboratory Manual, J.I. Garcia, J.A. Dobado, G. Francisco, Elsevier Publication.
4. Chemistry Practical Inorganic Qualitative Analysis For Under Graduate Students, M.J. Mamtara, S.C. Karad, J.S. Makasana, Lap Lambert Academic Publishing.
5. Advanced Practical Chemistry, K. Chelladurai, K. Subbian, Lap Lambert Academic Publishing.

REFERENCES :

1. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford, A.R. Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication.

SEMESTER	II					
YEAR	I					
COURSE CODE	20MB1271					
TITLE OF THE COURSE	MICROBIAL PHYSIOLOGY - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	4	-	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To make students learn quantitative and qualitative methods for study of biomolecules in microbiology lab.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be equipped with coloured based changes given out by microbial tests	L2

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Starch hydrolysis
2. Gelatin hydrolysis
3. Catalase test
4. Sugar/Triple fermentation test
5. Nitrate reduction test
6. H ₂ S production test
7. IMViC test
8. Oxidase test
9. Isolation of antibiotics resistant mutant by gradient plate technique
10. Demonstration of replica plating method for selection of antibiotic resistant mutants

REFERENCES:

- Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
- Boyer, R.F. 2003. Modern Experimental Biochemistry. Third Edition. Pearson Education.
- Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
- David, W. 2000. Physiology and Biochemistry of Prokaryotes. Second Edition. Oxford University Press.
- Griffin, D.H. 1993. Fungal Physiology. Second Edition. Wiley Liss- A John Willy & Sons, Inc, Publication. USA. p: 1-458.
- Moat, A.G. and Froster, S.W. 2002. Microbial Physiology. Fourth Edition. John Wiley and Sons, New York.

SEMESTER	II					
YEAR	I					
COURSE CODE	20BS1202					
TITLE OF THE COURSE	COMPUTER APPLICATIONS AND INFORMATION TECHNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	24	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To create general interest in applied domain towards using computers for biological applications.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be aware of the computer tools and applications which can be implemented in biological sciences.	L2
CO2	Students will be empowered for better prospects leading to project design and execution.	L2

COURSE CONTENT:

MODULE 1 History and Generations of Computers		4Hrs
Evolution, Generations of computers (I, II, III, IV, V) Classification of computers (mainframes, mini computers, microcomputers, special purpose) Comparison with respect to memory, power, cost and size, Real-Time, Online, Offline, Overview and functions of a computer systems, Input and output devices, Storage devices: Hard disk, Diskette, Magnetic tape, RAID, ZIP, devices, Digital tape, CD-ROM, DVD (capacity and access time), Main Circuit Board of a PC: Chips, Ports, Expansion.		
MODULE 2 Categories of Computers and Operating Systems		4Hrs
The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer & the Super Computer, Operating System concepts, Windows 98/XP and later versions, Windows server NT/2000, Unix/Linux & servers. Introduction to networking: various terminologies, Associated hardware devices, gadgets (Router, Switch) tools, services, and resources, Network Topologies and Protocols, LAN, WAN and MAN World Wide Web (WWW) Network security: fire walls.		
MODULE 3		8Hrs
Data processing & presentation: Introduction, Office Automation Software (Open		

Source Software).

Computer viruses and Internet Searches: An overview of Computer viruses, What is a virus? Virus symptoms, How do they get transmitted? What are the dangers? General Precautions, Search engines: Google, Yahoo, Concepts in text-based searching, searching Medline, PubMed, and bibliographic databases.

MODULE 4 Algorithms, Flowcharts, Programming concepts & Bioinformatics	8Hrs

Algorithms: Concepts & definitions, converting algorithms to flowchart; Coding: flowcharts to programs, Comparing algorithms, flowcharts & programs; Introduction & Overview of Biological databases. Introduction to Bio-informatics: Definition, Introduction to data mining, Computational gene finding – multiple alignment and sequence search (BLAST, FASTA, CLUSTALW). Applications of Bioinformatics.

REFERENCES:

1. Computer Fundamentals, 4th edition (2004) P.K. Sinha, BPB publication, India
2. Computer Networks. 4th edition (2008). Tanenbaum. Pearson Education, India
3. Biostatistics: P.N. Arora, P.K. Malha.
4. Introduction to Database Management Systems, 1st edition, (2004), Atul Kahate, Pearson education, India.

SEMESTER	III					
YEAR	II					
COURSE CODE	20BT2301					
TITLE OF THE COURSE	PRINCIPLES OF RECOMBINANT DNA TECHNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
	NA	NA	NA

COURSE OBJECTIVES:

- To give foundation of tools, vehicles used in cloning DNA.
- To impart basic principles of various vectors used in rDNA technology, their uses and limitations.
- To inculcate good fundamental knowledge in basics of gene cloning, including detection methods for screening the recombinants.
- To provide basic principles of analysis techniques employed in characterize the cloned recombinant DNA and to promote scope of application of rDNA technology.
- Principles of techniques to characterize cloned DNA, applications of rDNA technology.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand the basic paradigm of rDNA technology and various enzymatic tools, vectors and their utility.	L2
CO2	The sound in knowledge of steps involved in basic gene cloning	L1
CO3	A comprehensive knowledge on the various applications and scope of recombinant DNA technology.	L3

COURSE CONTENT:	
MODULE 1: INTRODUCTION TO rDNA TECHNOLOGY	
	12Hrs
History and fundamentals of r-DNA technology. Molecular tools for gene cloning: Nucleases - Endo and Exonucleases – Nomenclature, Types and characteristic features. Modification of cut ends. DNA ligases and DNA Recombinases. DNA Modifying Enzymes - Alkaline phosphatase, Polynucleotide kinase, DNase, RNase, DNA polymerase and Klenow fragment, terminal nucleotidyl transferase, RNA dependent DNA Polymerase.	
MODULE 2: VEHICLES FOR CLONING	
	12Hrs
Properties of an ideal vector. Types: Cloning and expression vectors. Cloning vectors: Prokaryotic vectors: Plasmids- pBR 322; pUC 18; Bacteriophages -Lambda phage, Cosmids.	

Eukaryotic vectors: YAC vectors; Shuttle vectors- Yeast and <i>E. coli</i> . For higher plants: Integrative DNA transfer- Agrobacterium vectors-Ti plasmid-Binary and Co integrated vectors; Non integrative DNA transfer-Plant viral vectors (CaMV) For animals: Animal viral vectors-SV 40 (3 types); Expression vectors in Prokaryotes and Eukaryotes	
MODULE 3: GENE ISOLATION AND TRANSFER	12Hrs
Isolation of passenger DNA. Cutting of DNA molecules - Physical methods, chemical and enzymatic methods. Joining of DNA molecules-Homopolymer tails, Linkers, Adapters. Transformation. Indirect methods - Colony hybridization, Immunochemical detection. Use of selectable and scorable genes: Selectable genes: Plants-npt; Animals-TK. Scorable genes: Plants-Gus; Animals-lux.	
MODULE 4: CHARACTERIZATION OF CLONED DNA	12Hrs
Electrophoresis: AGE and SDS-PAGE. Hybridization: Southern; Northern; Western; Dot blots, Autoradiography, DNA sequencing: Sanger's Dideoxy method, Molecular probes. Application of rDNA technology: Expression vectors (E coli/eukaryotic), Transgenic animals: Mouse (Knock-out; Methodology, applications); A brief account of Transgenic Sheep, Poultry, Fish, Cow, with value added attributes. Transgenic Plants: Resistance to diseases (Pathogen resistant-viral, fungal and bacterial); insects (Bt gene transfer); Fertilizer management- Nif gene transfer.	

TEXT BOOKS :

1. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,
2. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers
3. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publications.

REFERENCES :

1. Glick and Pasternak (2010) Molecular Biotechnology (4th Ed.), Wiley, Washington DC
2. Howe, C. (2007). Contents. In Gene Cloning and Manipulation (pp. V-Vi). Cambridge: Cambridge University Press.
3. Primrose, Twyman and Old (2002). Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
4. Brown TA, Genomes, 3rd ed. Garland Science 2006
5. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER	III					
YEAR	II					
COURSE CODE	20CY2301					
TITLE OF THE COURSE	ADVANCED CHEMISTRY - III					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To make students understand about advanced concepts of solid state of matter, phase rule, thermodynamics and chemical kinetics.
- To impart knowledge about different organic compounds such as alcohols, aldehydes, ketones, phenols and carboxylic acids; to make them understand about their properties, synthesis, reactions and important applications.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will get the knowledge of different concepts of solid state of matter, phase rule thermodynamics and chemical kinetics.	L1
CO2	Students will gain knowledge about different organic compounds such as alcohols, aldehydes, ketones, phenols and carboxylic acids; they get to know about their properties, synthesis methods, reactions and applications in different fields.	L3

COURSE CONTENT:

MODULE 1	12Hrs
PHYSICAL CHEMISTRY - I Phase Equilibria: Statement and explanation of the terms with examples for phase (P), component (C) and degree of freedom (F), Definition and significance of phase rule. Application of phase rule to one component systems-water and sulphur, -modified form of phase rule to two component systems. Water-potassium iodide and lead-silver systems. Solid state: Crystalline state, Laws of crystallography. Symmetry elements in cubic systems, crystal systems. Weiss and Miller indices. X-ray diffraction of crystals-derivation of Bragg's equation. Problems Liquid Crystals-Types (Smectic, Nematic and Cholestric) with examples. Applications. Superconducting solids-High temperature superconductors. Applications.	
MODULE 2	12Hrs
PHYSICAL CHEMISTRY - II Chemical Kinetics -2: Theories of reaction rates: Simple collisions theory based on hard sphere model, transition state theory (equilibrium hypothesis). Steady state approximation and Lindemann's hypothesis. Experimental determination of kinetics of: (i) inversion of cane sugar by	

polarimetric method, (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.	
Thermodynamics – 2: Free energy, Work function, chemical potential. Definition and relationship between free energy and work function. Criteria for equilibrium and spontaneous processes. Gibb's-Helmholtz equation (derivation). Change of free energy with respect to temperature and pressure. Mention of temperature coefficient, van't Hoff isotherm (derivations included), $\Delta G = -RT \ln K_p$. Problems. Derivation Clausius-Clapeyron equation. Its applications to ΔT_b and ΔT_f determination (thermodynamic derivation not required). Qualitative treatment of Nernst heat theorem and III law of thermodynamics-statement only. Elementary concept of residual entropy.	
MODULE 3	12Hrs
ORGANIC CHEMISTRY – I	
Alcohols: Introduction, classification and nomenclature. Acidity of alcohols. Methods of preparation - (i) From carbonyl compounds - reduction of aldehydes and ketones (by Meerwein-Ponndorf-Verley reaction); (ii) From acids and esters (by reduction with LiAlH_4). Reactions of alcohols: Comparison of the reactivity of 1° , 2° and 3° alcohols - Lucas test, oxidation with $\text{K}_2\text{Cr}_2\text{O}_7$. Aldehydes and Ketones: Synthesis of aldehydes by the oxidation of primary alcohols and by the reduction of acyl chloride, esters and nitriles. Synthesis of ketones by ozonolysis, oxidation of secondary alcohols, Friedel Craft's reaction and using Grignard reagent. Nucleophilic addition to carbonyl compounds: Mechanism of addition using strong nucleophiles and acid catalyzed nucleophilic addition. Addition of HCN - mechanism. Relative reactivity of aldehydes versus ketones. Addition of alcohols. Mechanism of acid catalyzed acetal formation. Wittig reaction (no mechanism, only a few examples). Oxidation of aldehydes and ketones. Acidity of α -Hydrogen, enolate ion. Keto- enol tautomerism. Base catalysed aldol reaction, dehydration of aldol product (mechanism of both), cross aldol reaction (practical crossed aldol reactions). Claisen-Schmidt reaction (nomenclature).	
MODULE 4	12Hrs
ORGANIC CHEMISTRY – II	
Phenols: Nomenclature, classification. Acidic nature - Comparison of acidic strength of phenol with alcohols and monocarboxylic acids. Effect of electron withdrawing $-\text{NO}_2$ group and electron donating $-\text{CH}_3$ group on acidity of phenols at o-, m-, p- positions, Mechanisms of Reimer-Tiemann and Kolbe-Schmidt reactions. Industrial applications of phenols: Conversion of phenol to (i) aspirin (ii) methyl salicylate (iii) salol (iv) salicyl salicylic acid. Carboxylic Acids and Their Derivatives: Nomenclature. Preparation: Acid hydrolysis of nitriles with mechanism. Acidity of carboxylic acids Acidic strength (pK_a values) - Effect of substituents on the strength of aliphatic and aromatic carboxylic acids. (Comparison of acidic strength of formic and acetic acids; acetic acid and monochloro, dichloro, trichloro acetic acids; benzoic and p-nitrobenzoic acid; benzoic acid and p-aminobenzoic acid). Reactions: Formation of esters, acid chlorides, amides and anhydrides. Hell-Vollhardt-Zelinski reaction, Nucleophilic substitution at the carboxylic carbon- General mechanism. Relative reactivity of acid derivatives.	

TEXT BOOKS :

1. Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
2. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H.
3. Langford, Oxford Univ. Press 2002.
4. Inorganic Chemistry, 4th Edition J. E. Huhe, E. A. Keiter and R. I. Keiter, Pearson

- Education Asia, 2000
5. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi

REFERENCES :

1. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
2. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MB2301					
TITLE OF THE COURSE	IMMUNOLOGY AND MEDICAL MICROBIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Demonstrate an understanding at an advanced level of microbial virulence mechanisms and host response to infection.
- To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To introduce and describe the classification, structure, classification and physiology of bacteria that infect humans	L3
CO2	To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories. To learn about the use of antibiotics and resistant mechanisms encoded in bacteria to neutralise these chemical agents	L3

COURSE CONTENT:

MODULE 1		12Hrs
ELEMENTS OF IMMUNE SYSTEM		
History and scope of immunology, Definition and types of immunity (innate and adaptive). Structure, Functions and Properties of: Immune Cells (Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell and Dendritic cell) and Immune Organs– Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT and CALT. Immune responses- Primary and Secondary Immune Response, Humoral and cell mediated immunity. Complement system – Components, function and activation pathways, Major Histocompatibility Complex.		
MODULE 2		12Hrs
ANTIGENS AND ANTIBODIES		
Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity), Types, Haptens, Super antigens, Epitopes (T & B cell epitopes), Structure of T-cell and B-cell receptors. Structures of antigen presenting cell. Cluster of differentiation and Co-stimulatory signals and its role T-dependent and T-independent antigens, Adjuvants.		

Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic). Hypersensitivity reactions (Definition and types). Immunoglobulin family and class switch mechanism.	
MODULE 3	12Hrs
IMMUNOLOGICAL DISORDERS AND TECHNIQUES	
Clonal selection theory of antibody production; Production and application of Monoclonal antibodies. Autoimmune disorders (Type-1 diabetics and Myasthenia gravis,) Transplantation immunology – Graft, types and rejection of graft. Brief concept of cancer immunology. Immunological techniques: Types and Principles of Ag-Ab reactions - Precipitation, Agglutination, Complement fixation and its applications. Immunodiffusion, Immunoelectrophoresis, ELISA, RIA, Immunofluorescence, Flow cytometry and Immunoelectron microscopy.	
MODULE 4	12Hrs
MEDICAL MICROBIOLOGY	
Normal flora of skin, oral cavity and other body regions. Relationship between normal pathogens and host. Terminologies- Pathogenicity, Virulence, Invasion, Toxins: Exotoxins, Enterotoxins and Endotoxins.	
Epidemiology, etiology, pathogenesis and prophylaxis of the following:	
Bacteria – <i>Salmonella typhi</i> and <i>Mycobacterium tuberculosis</i> . Fungi – <i>Tricophyton spp.</i> And <i>Candida albicans</i> . Viruses –Hepatitis and HIV. Protozoa – <i>Leishmania donovani</i> and <i>Entamoeba histolytica</i> . Antibiotics and their mode of action – Antibacterial, Antifungal, antiviral and antiprotozoal agents. Mechanism of drug resistance. Methods of testing drug sensitivity (Kirby Bauer method, Minimum Inhibitory Concentration).	
Immunoprophylaxis - Vaccines and its types. Immunization schedule and its significance.	

TEXT BOOKS:

1. Anathnarayana and Panikar (2013) Text Book of Microbiology, 9th Edition. University press.
2. Richard A, Goldsby, Thomas J, Kindt, Barbara A and Osborne (2000). Kuby Immunology. 4th Edition. W.H. Freeman and Company, New York.
3. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York.
4. Warren Levinson (2000) Medical Microbiology and Immunology, Examination and Board Review. 8th Edition. McGraw Hill.
5. Tortora, Funke, Case (2009) Microbiology, 9th Edition. Benjamin Cummings.
6. Connie R Mahon (2010) Text book of diagnostic Microbiology. 3rd edition, Pearson.
7. Fritz H Kayser (2005) Medical microbiology. ThiemeVerlag.
8. Mackie and McCarthy (1996) Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchill Livingstone.
9. Frank and Steven A (2002) Immunology and evolution of Infectious Diseases. Princeton University Press.
10. Wadher and Bhoosreddy (2005) Manual of Diagnostic Microbiology. Himalaya Publisher.
11. Kufe (2003) Cancer Medicine. BC Decker Inc.
12. Leslic Collier, John Oxford (2000) Human virology a text book for students of medicine, dentistry and microbiology. 2nd edition. Oxford university press.
13. Jenson, Wright robinson (1997) Microbiology vol 1, Microbial Infection vol 2,

Practical Medical Microbiology, Churchill living stone.

14. Credic, A Mims (2004) Medical Microbiology, 3rd Edition. Mohshy Inc.

15. Nester Roberts Pearsall Anderson (1997) Microbiology- a human perspective, 2nd Edition, McGraw-Hill.

SEMESTER	III					
YEAR	II					
COURSE CODE	20BS2301					
TITLE OF THE COURSE	MOLECULAR BIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Understand the general principles of central dogma, DNA and RNA types structure and their role in cells.
- Explain the mechanisms of DNA replication, RNA synthesis and repair, various levels of gene expression, regulation and protein function.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Know the importance of recent discoveries and the applications and potential of molecular biology with these technologies.	L1
CO2	Student will gain understanding of chemical and molecular processes that occur in and between cell.	L2

COURSE CONTENT:

MODULE 1 THE MOLECULAR BASIS OF LIFE		12Hrs
Central dogma, DNA and RNA as genetic material – experimental proof. Evidences for DNA as the genetic material- Griffith's transformation experiment, Hershey and Chase experiment, evidence for RNA as the genetic material of viruses (TMV, Retroviruses). Nucleic acids: DNA structure and types (A, B and Z model), Denaturation and renaturation kinetics of DNA, Types of RNA – mRNA, tRNA and rRNA, mi RNA and siRNA.		
MODULE 2 DNA REPLICATION AND ITS COMPONENTS		12Hrs
Replication of DNA (Conservative, Dispersive and Semi Conservative DNA replication, Meselson and Stahl experiment), theta and rolling circle model of replication. Prokaryotic and Eukaryotic – Enzymes and proteins involved in replication.		
MODULE 3 DNA TRANSCRIPTION AND ITS COMPONENTS		12Hrs
RNA polymerases, Mechanism of transcription – initiation, elongation and termination in prokaryotes and eukaryotes. Post-transcriptional modifications of Eukaryotic mRNA (Poly A tailing, 5' capping and splicing mechanisms)		
MODULE 4 TRANSLATION AND REGULATION OF GENE EXPRESSION		12Hrs

Genetic code, wobble hypothesis, Mechanism of translation in prokaryotes and eukaryotes, Post translational modification of Proteins. Regulation of Gene expression in Prokaryotes – Operon concepts, induction, repression, attenuation, examples of Lac and Trp operons. Regulation of Gene expression in Eukaryotes –galactose metabolism in yeast.

TEXT BOOKS:

1. Cell & Molecular Biology by Gerald Karp, 3rd Edition, John Wiley & Sons (2009)
2. Molecular Biology of the Gene by James Watson et al, Pearson Education (2013)
3. Molecular Biology of the Cell, Bruce Alberts et al, Garland Science Publication (2007)
4. Principles of Biochemistry by Nelson and Cox, WH Freeman Publications (2008)
5. Textbook of Cell and Molecular Biology by Ajoy Paul, Books and Allied Ltd (2011).
6. Molecular Biology and Genetic Engineering by P K Gupta, Deep and Deep Publications (2008).
7. Cell Biology, Genetics, Molecular Biology, evolution and Ecology by PS Verma and VK Agarwal, S. Chand Publications (2006).

SEMESTER	III					
YEAR	II					
COURSE CODE	20BT2371					
TITLE OF THE COURSE	TECHNIQUES IN ECOMBINANT DNA TECHNOLOGY-LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	36	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- Understand basic instrumentation and vectors used in routine cloning experiments
- To integrate the theoretical/conceptual principles with experiments
- To develop the ability amongst the students to apply modern genetic engineering techniques in industry and research.
- To enable students to work in a team with multidisciplinary approach.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Be able to gain fundamental working knowledge of basic principles of gene cloning.	L1
CO2	Critically analyse, evaluate and compile received results	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Extraction of DNA from plant/bacteria and animal sources(2 Units)
2. Separation of DNA on agarose gel electrophoresis , Visualization of DNA (2 units)
3. Quantification of DNA by spectrophotometry or DPA method
4. Preparation of competent cells
5. Transformation of bacterial competent cells with plasmid DNA
6. Plasmid extraction
7. Linearization of plasmid DNA

TEXT BOOKS :

- Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz. Scientific American books. USA. 1983.
- Biotechnology A Laboratory Course by Becker JM, Caldwell GA, Zachgo EA. Second edition. Elsevier. 1996

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REFERENCES :

1. Primrose, S. B., and R. M. Twyman. Principles of gene manipulation and Genomics, Blackwell Publishing MA. USA. 2006.
2. From Genes to Genomes: Concepts and Applications of DNA Technology by JW Dale and M Schantz. Wiley-Blackwell Publishing. UK. 2012.
3. Molecular Biotechnology: Principles & Applications of Recombinant DNA Glick BR and Pasternak JJ, ASM Press. USA. 2017.

SEMESTER	III					
YEAR	II					
COURSE CODE	20CY2371					
TITLE OF THE COURSE	SEMI-MICRO QUALITATIVE ANALYSIS OF BINARY SALT MIXTURES - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	-	-	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To make students familiar with the semi-micro qualitative analysis technique.
- To make students understand about paper chromatographic techniques and its application in separating different inorganic radicals.
- To give knowledge about solvent extraction technique and its application in ion separation.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be well versed with the semi-micro qualitative analysis techniques and its application in analyzing binary salt mixture.	L1
CO2	Students will gain knowledge about separating different ions through paper chromatographic technique.	L3
CO3	Students understand about separation of ions through solvent extraction technique.	L2

COURSE CONTENT:

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Systematic semi-micro qualitative analysis of a mixture of two simple salts (At least seven mixture of salts with no interfering radicals). (7 Units)
2. Separation of metal ions (Cu²⁺, Co²⁺, Ni²⁺, Fe²⁺) using paper chromatography and calculation of R_f values. (2 Units)
3. Separation of ions by solvent extraction technique. (2 Units)

TEXT BOOKS :

6. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford, A.R. Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
7. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication.
8. Experimental Organic Chemistry Laboratory Manual, J.I. Garcia, J.A. Dobado, G.

Fransicisco, Elsevier Publication.

9. Chemistry Practical Inorganic Qualitaive Analysis For Under Graduate Students, M.J. Mamtora, S.C. Karad, J.S. Makasana, Lap Lambert Academic Publishing.
10. Advanced Practical Chemistry, K. Chelladurai, K. Subbian, Lap Lambert AcademicPublishing.

REFERENCES :

3. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford, A.R.Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
4. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MB2371					
TITLE OF THE COURSE	IMMUNOLOGY AND MEDICAL MICROBIOLOGY - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	4	-	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories.	L3

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Identification of different types of blood cells
2. Precipitation reactions: a. Ouchterlony Double Diffusion b. Radial Immune Diffusion
3. Agglutination Reaction: a. Blood grouping and Rh typing
4. Isolation of normal microflora from skin and oral cavity
5. Snyder's test for dental caries detection
6. Antibiotic sensitivity test
7. Dot ELISA
8. Determination of effectiveness of antiseptics by thumb impression method.

REFERENCES:

- Balakrishnan, Senthilkumar & Karthik, Kaliaperumal & Duraisamy, Senbagam. (2015). Practical Immunology- A Laboratory Manual. 10.13140/RG.2.1.4075.4728.
- Hay, F.C., Westwood, O.M.R., 2002. Practical Immunology, 4th edition. ed. Wiley-Blackwell, Malden, MA.
- Lab Manual in Biochemistry, Immunology and Biotechnology by Nigam, Arti - AbeBooks." McGraw-Hill Education (India) (2008)
- Pharmaceutical Microbiology – Edt. by W.B.Hugo & A.D.Russell Sixth edition.

Blackwell scientific Publications.

5. Pharmaceutical Biotechnology by S.P.Vyas & V.K.Dixit. CBS Publishers & Distributors, New Delhi.
6. Maheshwari, D. K. (2002). *Practical Microbiology*. S. Chand Publishing.

SEMESTER	III					
YEAR	II					
COURSE CODE	20BS2302					
TITLE OF THE COURSE	ENVIRONMENTAL SCIENCE					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	26	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- The course will offer extensive knowledge on environment and the impact it has on life.
- The course equally focusses on the importance of ecological balance.
- The programme is designed to evoke awareness amongst students who seek careers in the environment sector.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	With an understanding of environmental management, students will be able to solve deleterious impacts on the ecosystem.	L2
CO2	With a background on environmental science, graduates have bright career opportunities in wild life conservation, and other environment sectors.	L3

COURSE CONTENT:

MODULE 1 FOUNDATION ON ECOLOGY & ENVIRONMENT		10Hrs
Organizational level of ecological systems, Abiotic and biotic environment, limiting factors, adaptation, habitat and niche, concept of biosphere, population parameters, structure, growth regulation, interactions between populations, life history strategies (r and k species), the concept of carrying capacity. Structure and function of ecosystems, productivity, decomposition, energy flow, ecological efficiencies, global pattern of productivity, nutrient cycling (Carbon, Nitrogen and Phosphorus), major biomes of India and the world.		
MODULE 2 ENVIRONMENTAL BIOGEOCHEMISTRY		6Hrs
Structure and composition of the atmosphere, radiation budgets, general circulation of the atmosphere, prevailing and adiabatic lapse rates, air masses and fronts, monsoon, vertical profiles of major and trace gases, atmospheric photochemistry, reaction of nitrogen, oxygen, ozone, chlorides etc., properties of dust and aerosols in the atmosphere.		
MODULE 3 ENVIRONMENTAL POLLUTION		5Hrs
Types and major sources of air pollutants, effects of air pollutants on physico-chemical and biological properties surrounding atmosphere, air borne diseases and their effects on health.		

Types and major sources of water pollutants, effects of water pollutants on physicochemical and biological properties of water bodies, water borne diseases with special reference to water pollution. Types and major sources of soil pollutants, effects of soil pollutants on physico-chemical and biological properties of soil. Major sources of noise pollution, effects of noise pollution on health, noise level standard in industrial, commercial, residential and silence zones. Radioactive and thermal pollution sources and their effects on surrounding environment.	
MODULE 4 ENVIRONMENTAL MANAGEMENT	5Hrs
Introduction and scope of environmental management, basic concepts of sustainable development, industrial ecology and recycling industry. Role of natural products and biodiversity in international trade, fundamentals of fossil fuels use, energy production and trade, energy balance and energy audit. Eco-marketing. Environmental Impact Assessment (EIA), general guidelines for the preparation of environmental impact statement (EIS).	

REFERENCES

1. Ramesh Vijaya K. (2005). Environmental Microbiology. MGP Publishers, Chennai.
2. Edward Alcamo I. (2001). Fundamentals of Microbiology, Jones and Bartlett Publishers, INC. VI Edition.
3. Kumar H.D. (1995). General Ecology, I Ed. Vikas Publishing House Pvt. Ltd., New Delhi.
4. Pepper W. (1995). Environmental Microbiology. A.P. Publishers.
5. William C. Frazier and Dennis C. Westhoff. (1995). Food Microbiology, Tata McGraw-Hill Publishing Company limited, New Delhi, IVth Edition.
6. Odum E.P. (1971). Fundamental Ecology, 5th Ed., Saunders.
7. Kormondy E.J. (1962). Concepts of Ecology, Prentice Hall. 8. Singh H.R. (1989). Animal Ecology and Environmental Biology. Nagin Chand & Co. Shoban Lal (1992). Ecology.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20BT2401					
TITLE OF THE COURSE	PRINCIPLES OF ANIMAL AND PLANT BIOTECHNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4		-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I		

COURSE OBJECTIVES :

- To acquaint the students with the basic concepts of animal and plant cell culture set up and conditions.
- To familiarize the students with knowledge on various ways to produce transgenic plants and animals with novel traits.
- To equip the student's wide area of important applications of animal biotechnology

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Have understanding of basic fundamentals of animal Biotechnology and its uses	L3
CO2	Have understanding of basic fundamentals of plant cell culture conditions, media formulations, techniques and its uses.	L3
CO3	The students will learn the fundamentals of culturing animal and plant cells & tissues and the modes to change and improve genetic traits of animal and plants.	L4
CO4	Will be equipped with the wide area of applications of biotechnology in modern world.	L3

COURSE CONTENT:	
MODULE 1 BASICS OF ANIMAL TISSUE CULTURE	12Hrs
Basics of animal tissue culture, Facilities in Animal Cell Culture, Media – natural and chemically defined, importance of serum in the media. Growth factors promoting proliferation of animal cells – EGF, FGF, PDGF. Stem Cell Types and its characteristics. Primary Cell Culture: Isolation of tissue – disaggregation techniques (mechanical, enzymatic), explant method Secondary Cell Culture: Transformed and continuous cell lines (Hela, CHO, BHK).	
MODULE 2 APPLICATION OF ANIMAL BIOTECHNOLOGY	11Hrs

Applications of Animal Tissue Culture: Transfection of animal cell lines, HAT selection, Expression of cloned genes in animal cells – expression vector, over-production and downstream processing of the expressed protein, production of vaccines in animal cells, Hybridoma Technology for Monoclonal antibody production, Transgenic animals – techniques and applications (examples of mice and sheep). Basics of Tissue Engineering, Biosafety and Good Lab practices.	
MODULE 3 BASICS OF PLANT TISSUE CULTURE	11Hrs
Introduction to Plant Tissue Culture: Aseptic techniques, sterilization methods - (Steam and Dry), media and explant sterilization techniques, post sterilization care of the instruments, contaminants, components of tissue culture media, growth hormones (auxin and cytokinin), Tissue and Organ Culture: Micro-propagation, bud and meristem tip culture, stages, factors affecting micro-propagation, callus culture, cell culture, protoplast culture and fusion, organogenesis and somatic embryogenesis, Soma clonal Variants.	
MODULE 4	11Hrs
Genetic Transformation Techniques: Transgenic plants- Agrobacterium mediated (Ti and Ri plasmid), physical and chemical methods of gene transfer. GM technology and Plant Trait improvement: GM Strategies for Biotic and Abiotic Stress Resistance/Tolerance, Herbicide, bacterial and fungal resistance crops. Bt cotton, Bt brinjal, Golden Rice. Application of tissue culture for crop improvement in agriculture, horticulture and forestry. Edible vaccines, secondary metabolites (in-vitro production).	

TEXT BOOKS :

1. Singh, Gautam, Chauhan, Singla (2013) Textbook of Animal Biotechnology, TERI
2. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
3. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell
4. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Son

REFERENCES :

1. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing.
2. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford Publishing.
3. Santosh Nagar and Madhav Aadhi (2010) Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications
4. B D Singh (2014) Biotechnology: Expanding horizons, Kalyani Publishers.
5. S.S. Bhojwani and M.K. Razdan (1996) - Plant Tissue Culture- Theory and Practice, a Revised Edition (1996, Elsevier Science)

SEMESTER	IV					
YEAR	II					
COURSE CODE	20CY2401					
TITLE OF THE COURSE	ELECTROCHEMISTRY AND ADVANCED SPECTROSCOPY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To make students understand about advanced concepts of electrochemistry and its applications.
- To impart knowledge about different spectroscopic techniques and their important applications.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will get the knowledge of concepts of electrochemistry and its applications.	L1
CO2	Students will gain knowledge about different spectroscopic techniques and their important applications.	L3

COURSE CONTENT:

MODULE 1	12Hrs
ELECTROCHEMISTRY – I Review of electrolytes and Conductance and related terms. Methods of determination of molar conductance. Conductometric titrations (only acid-base type). Transport numbers: definition – determination by moving boundary method. Causes of abnormal transport numbers observed in certain systems. Ionic mobility. Problems on transport numbers. Conductivity of water. Kohlrausch's law and its applications: (i) evaluation of Λ^∞ and Λ^+ Λ^- (ii) evaluation of degree of dissociation of a weak electrolyte (iii) evaluation of Λ^∞ of a weak electrolyte (iv) determination of solubility from conductance of saturated solutions of sparingly soluble salts (AgCl and BaSO ₄). Problems based on the above concepts. Limitations of Arrhenius theory: qualitative account of Debye-Huckel theory, Debye-Huckel-Onsager equation for aqueous solutions of 1:1 electrolyte. Verification of DHO equation. Galvanic cell: conventions of representing galvanic cells-reversible and irreversible cells, derivation of Nernst equation for single electrode potential (free energy concept).	
MODULE 2	12Hrs
ELECTROCHEMISTRY - II Weston-cadmium cell: Determination of emf of a cell by compensation method.	

Determination of Eo of Zn/Zn²⁺ and Cu/Cu²⁺ electrodes. Liquid junction potentials, elimination of liquid junction potential. Types of electrodes: metals and gas electrodes (chlorine), metal/metal insoluble salt electrodes, redox electrodes. Reference electrodes-standard hydrogen electrode, calomel electrode, quinhydrone electrode and glass electrode. Determination of pH using these electrodes. Problems based on the above concepts. Concentration cells: (i) emf of concentration cells (ii) determination of solubility of sparingly soluble salts and numerical problems. Redox electrodes, emf of redox electrodes. Potentiometric titration involving only redox systems.	
MODULE 3	12Hrs
CHEMICAL SPECTROSCOPY I The interaction of electromagnetic radiation with matter. Regions of electromagnetic spectrum and associated spectroscopic techniques. Origin of molecular absorption spectra: Born-Oppenheimer approximation. Vibrational spectroscopy: Hooke's law-Expression for the frequency of SHO-force constant and its significance. Expression for vibrational energy levels of SHO. Zero point energy. Degrees of freedom of polyatomic molecules– fundamental modes of vibration for CO₂ and H₂O molecules. Raman spectroscopy: Concept of polarisability. Stokes and anti-Stoke's lines-selection rules. Advantages of Raman spectroscopy over IR spectroscopy. Electronic spectroscopy: Electronic spectroscopy of molecules, basic principles, Selection rules and Franck-Condon principle.	
MODULE 4	12Hrs
CHEMICAL SPECTROSCOPY II UV-Visible spectroscopy: Principle, Chromophores and auxochromes; blue shift and redshift. Influence of conjugation on UV absorption; graphical representation of spectra of 1,3-butadiene and benzene. Comparison of UV spectra of acetone and methyl vinyl ketone. IR spectroscopy: Principle and group frequencies Stretching frequencies of -OH (free and H-bonded), alkyl -C-H, C=C, C≡C C=O, C-X and C-O groups (by taking suitable examples). NMR spectroscopy: Basic principle of proton magnetic resonance: Nuclear magnetic spinquantum number I, influence of the magnetic field on the spin of nuclei, spin population, saturation using radio frequency. Chemical shift (δ values), TMS as reference. Nuclear shielding and deshielding (acetylene and benzene). Equivalent and non-equivalent protons. Effect of electronegativity of adjacent atoms on chemical shift values. Applications of NMR spectroscopy including identification of simple organic molecules.	

TEXT BOOKS :

1. Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
2. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002.
3. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
4. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi.

REFERENCES :

1. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
2. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi

SEMESTER	IV					
YEAR	II					
COURSE CODE	20MB2401					
TITLE OF THE COURSE	INDUSTRIAL, FOOD AND DAIRY MICROBIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To exhibit depth of knowledge by demonstrating microbial sciences in the field of applied fields of industrial, food and dairy microbiology.
- To relate microbes in interdisciplinary connections with other sciences, in particular to industrial productions, food sciences and dairy products.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	It will develop depth of understanding on fermentation technology, modern microbial techniques and analysis relating to industrial, food and dairy microbiology.	L3
CO2	It will develop problem solving capabilities in practical working in teams in laboratory-based virtual experiments to gather and evaluate microbial data using a range of current analysis techniques relating to productions, food sciences and dairy products.	L4

COURSE CONTENT:

MODULE 1		12Hrs
INTRODUCTION TO INDUSTRIAL MICROBIOLOGY		
Concepts and scope of microbes in industry. Screening, isolation of industrially important microbes. Strain improvement - Mutation, recombination- gene regulation and genetic manipulation. Preservation: Industrially important microbes. Culture collection centers. Basic components and design of Typical fermenter. Types of fermenter-Laboratory, pilot-scale and production fermenters; constantly stirred tank fermenter, fluidized bed bioreactors and air-lift fermenter. Types of fermentation - Batch, Continuous, chemostat, Turbidostat, submerged and solid-state fermentation. Different parameters affecting fermentation.		
MODULE 2		12Hrs
INDUSTRIAL BIOPROCESSING		
Upstream Processing: Nutrients: growth factors, carbon, nitrogen, mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization; inoculum preparation and inoculum development. Downstream processing: Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption,		

Liquid extraction, Solvent recovery, chromatography, Membrane processes, Drying, Crystallization. Productions and Applications: Alcohol production, organic acids (citric acid), enzymes: amylases- (Fungal and Bacterial). Amino acid - L-Glutamic acid. Vaccines (Hepatitis B), hormones (human insulin), antibiotic (Penicillin). Applications of genetic engineering in industrial bioprocessing. Production economics and IPR.	
MODULE 3	12Hrs
FOOD MICROBIOLOGY Principles and methods of food preservation by Physical, Chemical and food Additives, Biopreservation. Microbial spoilage of food: Causes and sources of food spoilage. Food borne Infections and Intoxications. Bacteria – Clostridium. Virus- Hepatitis A, Sea toxicants; Mycotoxins (Aflatoxins, Ochratoxins,). Fermented foods (Fermented Vegetables, Beverages, Bread, and Idli). Single cell Protein, Probiotics, Prebiotics and Synbiotics; Nutraceuticals, Quorn). Food control Agencies: HACCP, Employees Health standards, GMP. Industrial effluents treatment, Criteria of microbiological quality control.	
MODULE 4	12Hrs
DAIRY MICROBIOLOGY Nutritional level and microbial flora of milk. Sterilization of milk; predominant types of microorganisms in chilled and refrigerated milk and their importance; heat resistant bacteria and their role in milk spoilage. Principles of quality control tests for milk; bacteriological grading. Microbiology of dairy products: Yogurt, acidophilus milk, fat rich products (Cream and butter) and cheese. Biosensors in Food Industry; Food fortification.	

TEXT BOOKS:

1. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
2. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
3. Waites Michael J., Morgan Neil., Rockey John S and Gray Higton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
4. McNeil B and Harvey LM. Fermentation. A Practical Approach, IRL press, New York.
5. Robert H (2006) Microbiology and Technology of Fermented Foods. Blackwell Publishers.
6. Matthew Rimmer (2008) Intellectual Property and Biotechnology: Biological Inventions Edward Elgar. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Limited, New Delhi.
7. Frazier and Wasthoff, Food Microbiology, Tata McGraw-Hill Publishing Company Limited.
8. Hammer B.W and Babal, Dairy Bacteriology, Prentice Hall Incorporated, London.
9. James M.J. Modern Food Microbiology, CBS Publishers and Distributors, Delhi. 1996
10. Mary E.T and Richard E. I. Microbial Food Safety Animal Agriculture: Current Topics, Iowa state University Press. 2003
11. Bibek R. Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press. 2001.
12. Adams M.R. and Moss M.O. Food Microbiology. Royal Publishing Corporation. 2000.
13. John G. Essentials of Food Microbiology. Arnold International Students Edition.
14. Frazer W.C. Food Microbiology. McGraw Hill, New York. 1979.
15. Foster E.M. et al., Dairy Microbiology. Prentice Hall Inc., Englewood. 1975.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20BS2401					
TITLE OF THE COURSE	GENOMICS AND PROTEOMICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To go through basic and specialized knowledge and understanding the aspects of genomics and proteomics is essential to understanding Genetics and its architecture.
- To take the students through foundations in genomics and disease gene mapping.
- To teach various approaches to investigating genomics and proteomics that students can apply in their future career in biological research as well as in industry.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be able to understand how genomes are organised and contemplate on the mapping of monogenic and polygenic traits.	L2
CO2	Students should be endowed with strong theoretical knowledge of genomics.	L3
CO3	In conjunction with the practical in bioinformatics, the students should be able to take up biological research as well as find placement in the relevant biotech industry.	L3

COURSE CONTENT:

MODULE 1 PROKARYOTIC AND EUKARYOTIC GENOME ORGANIZATION		8Hrs
Prokaryotes: Bacteria and Bacteriophages. Eukaryotic nuclear genomes: Arabidopsis, rice, yeast, Drosophila, C. elegans and mouse genome. Eukaryotic organelle genomes - Chloroplast and Mitochondria.		
MODULE 2 GENOME MAPPING TECHNIQUES		8Hrs
Genetic mapping: Cross breeding and pedigree analysis, DNA markers – RFLPs, SSLPs, SNPs. Physical mapping: Restriction mapping, Fluorescent in situ hybridization.		
MODULE 3 HUMAN GENOME PROJECT		8Hrs
History, organization and goals of human genome project. DNA segment nomenclature, Human genome diversity, Organization of human genome, Mitochondrial genome, Gross base composition of nuclear genome, Gene density, CpG islands, RNA-encoding genes, Functionally identical genes, Diversity in size and organization of genes.		

MODULE 4 COMPARATIVE GENOMICS	5Hrs
Whole genome analysis, Genome sequence, micro assay, molecular phylogeny, C-value, number of genes and complexity of genomes, Conservation and diversity of genomes, Comparative genomics as an aid to gene mapping and study of human disease genes. Comparative genomics of mitochondria and chloroplast genomes.	
MODULE 5 PROTEIN PROFILING	5Hrs
Prediction of primary, secondary and tertiary structure of proteins- SCOP, DALIDD, CATH classification. Determining protein structure, Homology modelling. Introduction to proteome and proteomics, protein separation and analysis using 2D Gel Electrophoresis, Liquid chromatography, Mass spectrometry, Interacting proteins by phage display and Yeast two hybrid system.	

REFERENCES

1. T.A. Brown, Genomes, Bios, 2002.
2. Coleman and Tsongalis, Molecular Diagnosis, Humana, 1997.
3. Dale and Scharz, From Genes to Genomes, Wiley, 2003.
4. Dunham, I., Genome Mapping and sequencing. Horizon Scientific. 2003.
5. Hawley and Mori, The Human Genome, Academic, 1999.
6. Lewis, Human Genetics, WCB, 1999.
7. Liebler, Introduction to Proteomics, Humana, 2002.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20BT2471					
TITLE OF THE COURSE	TECHNIQUES IN ANIMAL AND PLANT BIOTECHNOLOGY- LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
			4	-	36	2

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	-	-	-

COURSE OBJECTIVES :

- To acquaint the student with the fundamental practical knowledge of the laboratory set up.
- To acquaint the student with basic techniques to use cell culture.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The course will help in making the students learn basic knowledge of the plant and animal tissue culture laboratory.	L3
CO2	The course will help in making the students learn basic techniques for plant and animal tissue culture.	L3

List of Laboratory/Practical Experiments activities to be conducted (if any) :	
1.	Introduction to instruments and laboratory set up for animal biotechnology
2.	Preparation of media for animal cell culture
3.	Isolation of liver parenchyma cells by mechanical method and set up primary culture.
4.	Determination of the concentration of viable cells in a suspension by Hemocytometer counting (trypan blue)
5.	Plant tissue culture laboratory organization and instruments.
6.	Preparation of plant tissue culture media – MS media
7.	Aseptic techniques and surface sterilization of explants
8.	4 hrs Establishment of callus culture, subculture of callus
9.	Production of synthetic seeds.

TEXT BOOKS :

1. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons
2. Santosh Nagar and MadhavAadhi (2010) Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications
3. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing
4. S. Chand Practical book of biotechnology and plant tissue culture, S Chand & Company

REFERENCES :

1. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.
2. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20CY2471					
TITLE OF THE COURSE	PHYSICO-ELECTROCHEMICAL TECHNIQUES - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	-	-	44	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To make the students learn about the usage of various instruments related to electrochemical analysis.
- To make the students to learn about the experiments related to electrochemistry like conductmetric and potentiometric titrations.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	1. The students will get theoretical and hands on experience in different analytical instruments.	L1
CO2	2. Students learn about experiments related to electrochemistry like conductmetric, and potentiometric titrations.	L3

COURSE CONTENT:
List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation.
1. Determination of velocity constant for the saponification of ethyl acetate ($a = b$).
2. The study of kinetics of potassium persulphate and potassium iodide colorimetrically.
3. Determination of equivalent conductivity of 0.1 N sodium chloride and verification of DHO equation.
4. Determination of dissociation constant of monochloroacetic acid by conductivity method.
5. Conductometric titration of hydrochloric acid with sodium hydroxide.
6. Potentiometric titration of potassium dichromate with ferrous ammonium sulphate.
7. Determination of Critical Micellar Concentration (CMC) by conductivity method.
8. Determination of pKa of a weak acid by pH metric method.

TEXT BOOKS :

1. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford,

- A.R.Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication.
 3. Experimental Organic Chemistry Laboratory Manual, J.I. Garcia, J.A. Dobado, G. Fransicisco, Elsevier Publication.
 4. Chemistry Practical Inorganic Qualitaive Analysis For Under Graduate Students, M.J. Mamtora, S.C. Karad, J.S. Makasana, Lap Lambert Academic Publishing.
 5. Advanced Practical Chemistry, K. Chelladurai, K. Subbian, Lap Lambert AcademicPublishing.

REFERENCES :

1. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford, A.R.Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C.Publication.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20MB2471					
TITLE OF THE COURSE	INDUSTRIAL, FOOD AND DAIRY MICROBIOLOGY - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	4	-	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To apply techniques to industrial microbiology; biochemical and fermentation mechanisms.
- To impart basic understanding of principles, and key concepts relevant to industrial microbiology.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To introduce basic fermentation techniques employed in Microbial industries.	L3
CO2	Course will enable the student to apply the knowledge in various aspects of fermentation or industrial microbiology	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Isolation of microorganisms from fruits.
2. Isolation of microorganisms from vegetables.
3. Production and determination of amylase activity.
4. Preparation of wine.
5. Study of different types of fermenters (Models/ Charts).
6. Cell immobilization techniques (yeast cells).
7. Determination of quality of raw milk by methylene blue reduction test.
8. Estimation of lactic acid from different dairy product.
9. Production of alcohol from different sources and estimation by specific gravity method.

REFERENCES:

1. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
2. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
3. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
4. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi

5. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
6. Robert Mellor (2009) Entrepreneurship for Everyone: A student Textbook. SAGE Publication.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20BS2402					
TITLE OF THE COURSE	BIOETHICS AND IPR					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	26	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To introduce the students to the concepts of biosafety regulatory frameworks concerning genetically modified organisms at national and International levels
- To give elementary essential concepts of Bioethics, IPR and patent laws.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student should develop basic understanding of the concepts of Biosafety, regulations concerning GMOs IPR and patent laws.	L2
CO2	This course should generate interest for avenues for pursuing higher studies and careers in these areas.	L2
CO3	General knowledge should create awareness necessary for higher studies in biotechnological fields.	L2

COURSE CONTENT:

MODULE 1 : BIOSAFETY-REGULATORY FRAMEWORK FOR GMO's IN INDIA 8Hrs

Regulatory framework in India governing GMOs-Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety Committee (IBC), Review Committee on Genetic Manipulation, Genetic Engineering Approval Committee (GEAC), Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic Plants (1998), Seed Policy (2002), Prevention Food Adulteration Act (1955), The Food Safety and Standards Bill (2005), Regulation for Import of GM Products Under Foreign Trade Policy (2006-2007), National Environment Policy (2006). Rules for the manufacture, use/import/export and storage of hazardous microorganisms/ genetically engineered organisms or cells (Ministry of Environment and Forests Notification,1989).

MODULE 2 BIOSAFETY-REGULATORY FRAMEWORK FOR GMO's AT INTERNATIONAL LEVEL 6Hrs

Convention of Biological Diversity (1992) – Cartagena Protocol on Biosafety – Objectives and salient features of Cartagena Protocol – Advanced Information Agreement (AIA) procedure – procedures for GMOs intended for direct use-risk assessment-risk management-handling, transport, packaging and identification of GMOs- Biosafety

Clearing House-unintentional transboundary movement of GMOs-Benefits of becoming a party to the Cartagena Protocol- status of implementation in India.	
MODULE 3 BIOETHICS	4Hrs
What is bioethics- The legal and socioeconomic impacts of biotechnology - Public education of the process of biotechnology involved in generating new forms of life for informed decision-making – ethical concerns of biotechnology research and innovation.	
MODULE 4 INTELLECTUAL PROPERTY RIGHTS	3Hrs
Intellectual property rights-TRIPS, GATT-International conventions patents and methods of application of patents-Legal Implications-Biodiversity and farmer rights.	
MODULE 5 PATENTS AND PATENT LAWS	5Hrs
Objectives of the patent system - Basic principles and general requirements of patent law-biotechnological inventions and patent law-Legal Development-Patentable subjects and protection in biotechnology-The patenting living organisms.	

REFERENCES

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2. Ganguli Prabuddha Gearing up for Patents.....The Indian Scenario” , Universities Press (1998)
3. Ganguli Prabuddha “Intellectual Property Rights--Unleashing the Knowledge Economy”, Tata McGrawHill (2001)
4. Ganguli Prabuddha and Jabade Siddharth, “Nanotechnology Intellectual Property Rights. Research, Design, and Commercialisation”, CRC Press , Taylor and Francis Group, USA (2012)
5. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local Communities [Paperback], Darrell A. Posey and Graham Dutfield , IDRC Books; annotated edition (June 1996).
6. F. H. Erbisich and K. M. Maredia. Intellectual property rights in agricultural Biotechnology, University Press.
7. Sivamiah Shantharam, Jane F. Montgomery. Biotechnology, Biosafety and Biodiversity, Oxford & IBH Publ. New Delhi.
8. Tutelyal, VA. Genetically modified Food Sources, Safety Assessment and Control, Academic Press an Imprint of Elsevier, New Delhi.
9. Jecker Nany S, JohsenAlbert, Perlman, Robert A. Bioethics: An Introduction to the History Methods and Practice, John & Bartlett, New Delhi.
10. Sharma, HC Dhillon, MK, Sahrawat, KN. Environmental Safety of Biotech and Conventional IPM Technology, Stadium Press LLC. USA.
11. Jecker Nany S, Jones & Barlet Bioethics: An Introduction to the History Methods and Practice, New Delhi
12. Sathish MK Bioethics and Biosafety, IK International.

SEMESTER	V					
YEAR	III					
COURSE CODE	20BT3501					
TITLE OF THE COURSE	FERMENTATION BIOTECHNOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	44	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To impart basic understanding of principles and key concepts relevant to Fermentation biotechnology.
- To familiarize students with downstream processing and production of important microbial products

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be aware of fermentation process, types of fermentation media and strategies for isolation of industrially important strains.	L2
CO2	The course will enable the student to apply the knowledge in various aspects of industrial biotechnology processes.	L3

COURSE CONTENT:	
MODULE 1 INTRODUCTION TO FERMENTATION TECHNOLOGY	11Hrs
History, Scope and development of fermentation technology, Isolation and Screening of Industrially important microorganisms-primary and secondary screening, Stain improvement: Mutation, Mutant selection, Recombination, Recombinant DNA technology, Preservation of Industrially important microorganisms. Culture collection centers.	
MODULE 2 FERMENTATION PROCESS AND FERMENTER	11Hrs

Types of fermentation -Batch, fed-batch and continuous fermentation. Surface, submerged and solid-state fermentation. Different parameters affecting fermentation - pH, temperature, dissolved oxygen, foaming and aeration. Basic component and design of typical fermenter. Type fermenter- Laboratory, pilot- scale and production fermenters. Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.	
MODULE 3 UPSTREAM AND DOWNSTREAM PROCESSING	11Hrs
Upstream processing: Formulation of fermentation media. Nutrients: growth factors, carbon, nitrogen, mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization and inoculum preparation. Downstream processing: Steps in recovery and purification of fermented products. Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid- Liquid extraction, Solvent recovery, chromatography, Drying, Crystallization, Whole broth processing, Effluent treatment.	
MODULE 4 INDUSTRIAL BIOPROCESSING	11Hrs
Production of alcohol beverages (wine and beer), organic acid (citric acid), antibiotics (penicillin), amino acids(glutamic acid), Vitamin (Vitamin B12), enzyme (amylase), hormone(Insulin), fermented food (yoghurt, cheese), Single Cell Protein (SCP).	

REFERENCES:

1. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 2091.
2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
- 3 Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon Press, Oxford, 2097.
- 4 Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, (2nd Ed). Taylor & Francis Ltd, UK, 2007.
- 5 Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology (2nd Ed.) Cambridge University Press. 2002.
- 6 Prescott, Sc and Dunn, C. Industrial Microbiology, McGraw Hill, New York. 2084
- 7 Michael, L. Shulers and Fikret Kargi. Bioprocess Engineering: Basic concepts (2nd Ed.) Prientice Hall Publishers. 2001 8. Paulins, M. D. Bioprocess Engineering Principles. John Wiley Publishers.2003

SEMESTER	V					
YEAR	III					
COURSE CODE	20CY3501					
TITLE OF THE COURSE	COORDINATION CHEMISTRY AND NANOSCIENCE					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	44	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To make students understand about co-ordination compounds their synthesis, reactions and applications
- To impart knowledge about organometallic compounds.
- To introduce the basic concepts and principles of nanoscience and nanotechnology.
- To teach the students about fabrication, characterization and applications of nanomaterials.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will get in basic knowledge about co-ordination compounds.	L1
CO2	Students will gain knowledge organo-metallic compounds	L2
CO3	Students will get to know about basic concepts and principles of nanoscience and nanotechnology.	L2
CO4	Students will learn about fabrication, characterization and applications of nano-materials	L3&L4

COURSE CONTENT:	
MODULE 1 CO-ORDINATION COMPOUNDS	
	11 Hrs
Coordination compounds, terminologies, ligands and their classification (mono, bi, tri, tetra, penta and hexa dentate ligands) and ambidentate ligands, coordination number, nomenclature of coordination compounds. Theories of structure and bonding (Explanation for the formation of complexes by Werner's Theory taking cobalt amine complexes). EAN rule, Valence bond theory-postulates, low spin and high spin complexes with examples (cobalt and nickel-based complexes), limitations of VBT. Crystal field theory (octahedral, tetrahedral and squareplanar complexes). Isomerism-Structural: ionization, linkage, hydrate and coordination isomerism with examples. Stereoisomerism geometrical and optical isomerism in cobalt amine complexes.	
MODULE 2 ORGANOMETALLIC COMPOUNDS	11 Hrs

Ligands, classification (hapticity). Synthesis and structure of $K[PtCl_3(\eta^2-C_2H_4)]$ Metal carbonyls – $Cr(CO)_6$, $Mn_2(CO)_{10}$; eighteen electron rule and its deviations with examples. Applications of coordination/organometallic compounds: cis-platin in cancer therapy, Na_2Ca , EDTA in the treatment of heavy metals (Pb, Hg) poisoning, Wilkinson's Catalyst in alkene, hydrogenation, decarbonylation reaction, Rh-catalyst reaction, Zigler natta reaction, Hack reaction and Suzuki coupling reaction.

MODULE 3 FUNDAMENTALS OF NANOMATERIALS	11 Hrs
Introduction, size dependent properties (Surface area, Electrical, Optical and Catalytic properties). Types of nanostructure and properties of nanomaterials: One dimensional, two dimensional and Three-dimensional nanostructured materials, Quantum Dots shell structures, metal oxides, semiconductors, composites, mechanical-physical-chemical properties. Fullerenes, Carbon nanotubes and graphenes –brief Explanation, properties and applications.	
MODULE 4 SYNTHESIS AND CHARACTERIZATION TECHNIQUES OF NANOMATERIALS	11 Hrs
Different methods of production: Top down and bottom-up approach with examples. Physical Methods; Inert gas condensation, Arc discharge, RF-plasma, Plasma arc technique, Ball Milling, Chemical Vapour deposition (CVD), ALD method and other variants, electrodeposition. Chemical Methods: Sol-gel, hydrothermal, solvothermal, combustion method, microwave method, coprecipitation method, photochemical synthesis and electrochemical synthesis. Characterization: X-ray diffraction, SEM, FESEM, TEM, EDS analysis, AFM, XPS, UV-Visible Spectrophotometers with respect to nanoparticles.	

TEXT BOOKS:

1. Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
2. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002.
3. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
4. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi.

REFERENCES:

1. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
2. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi.
3. G.A. Ozin & A.C. Arsenault, "Nanotechnology A Chemical Approach to Nanomaterials". RSC Publishing, 2005.
4. Carbon Nanotechnology: Recent Developments in Chemistry, Physics, Materials Science and Device Applications, L. Dai, Elsevier (2006), Amsterdam.

SEMESTER	V					
YEAR	III					
COURSE CODE	20MB3501					
TITLE OF THE COURSE	AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	44	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To observe the importance of various life cycles carried out in the nature, for plants growing, animal husbandry and processing of plant and animal products.
- Explains the geochemical and environmentally significant processes carried out by microbial communities that include activities controlled by various environmental factors and limiting microbial activities.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will understand Fundamental concepts and techniques in soil microbiology, soil microbial diversity, basic and applied concepts.	L1
CO2	Students will comprehend aspects of soil microbial diversity, basic and applied concepts environmental problems and available solutions towards them.	L2 and L3

PART A: AGRICULTURAL MICROBIOLOGY	
MODULE I: BIOFERTILIZERS AND BIOLOGICAL CONTROL	11 hrs
Types of Biofertilizers, Mass cultivation of biofertilizers- <i>Rhizobium</i> , <i>Azotobacter</i> , VAM and Azolla. Bio-fertilizers: Mode of application of biofertilizers. Advantages and limitations. Bio-inoculants- Mechanisms of biological control , Mass production and field applications of <i>Bacillus thuringiensis</i> , <i>Trichoderma spp.</i> and Nuclear Polyhedrosis Virus. Advantages and limitations. Marketing - Carrier and Legal clearances.	
MODULE II: PLANT PATHOLOGY	11 hrs

Host pathogen interaction, disease triangle, disease cycle, classification of plant pathogens and plant diseases.

Defence mechanisms – Concepts of constitutive defense mechanisms in plants, inducible structural defences (histological-cork layer, abscission layer, tyloses, gums), inducible biochemical defences (hypersensitive response (HR), SAR and ISR, phytoalexins, pathogenesis related (PR) proteins, Plantibodies.

Plant disease control- Principles and practices in disease control – Regulatory (quarantine, crop certification), Cultural (host eradication, crop rotation, sanitation), Chemical (Protectants and Systemic fungicides), Biological (Suppressive soil and microbial antagonism).

Study of different plant diseases- Bacteria –Blight of rice, Fungi – Rust of Wheat, Virus – Tobacco Mosaic Virus, Mycoplasma – Sandal Spike, Nematode- Root knot disease.

PART B- ENVIRONMENTAL MICROBIOLOGY

MODULE III: AEROBIOLOGY AND SOIL MICROBIOLOGY

11 hrs

Aerobiology: Significance of microorganisms in air, air borne pathogens and aeroallergens. Techniques in aerobiology: Gravity slide, Plate exposure, Rotorod sampler, Anderson Samplers, Impingers and Filtration. Control of Air borne microorganisms – Dust control, Filtration, Fumigation and UV light exposure.

Soil Microbiology: Soil profile, Soil microorganisms - Bacteria, fungi, actinomycetes, algae, protozoa and viruses. Biogeochemical cycles - Carbon cycle, Nitrogen cycle and Sulphur cycle. Microbial interactions in soil - Neutralism, Positive interactions (mutualism, commensalism, synergism, syntropism, protocoperation), Negative interactions (amensalism, antagonism and parasitism). General account of bioleaching, biodegradation and bioremediation.

MODULE IV: AQUATIC AND WASTE WATER MICROBIOLOGY

11 hrs

Aquatic Microbiology: Zonation of water system (Fresh and Marine), Factors affecting aquatic flora (Oxygen, Temperature, pH, light, hydrostatic pressure, turbidity and nutrients). Water Pollution: Sources and Eutrophication. Water quality analysis: Collection of water samples, Standard plate count, MPN and membrane filter technique. **Municipal treatment of water:** **Sedimentation,** **Filtration** **and** **Disinfection.**

Waste water Microbiology: Characteristics of sewage (physical, chemical and biological), Concept of BOD and COD. **Sewage Treatment:** Domestic treatment plants (septic tanks), Municipal sewage treatment Primary (coagulation and sedimentation), Secondary (Trickling filter, activated sludge, oxidation pond) and Tertiary treatment (ion exchange, reverse osmosis and dialysis). Brief account on solid waste treatment (Landfills and Composting); Biogas production.

REFERENCES

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.

2. Alexopoulos C.J and Mims C.W., Introductory Mycology, New Age International, New Delhi.
3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. Plant Pathology, Fifth Edition, Elsevier Academic Press, 2005.
5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbarao N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.
7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
7. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
8. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press.
9. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.
10. Jabir Singh. Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
11. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science
12. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
13. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
14. Robert L Tate, Soil Microbiology, 2nd Edition, John Wiley and Sons.
15. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
16. Grant W.D and Long P.E. Environmental Microbiology. Kluwer Academic Publishers, 1981.
17. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
18. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
19. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER	V					
YEAR	III					
COURSE CODE	20BS3572					
TITLE OF THE COURSE	COORDINATION CHEMISTRY-LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	4	-	-	2
Perquisite Courses (if any)						
#	Sem/Year	Course Code	Title of the Course			
-	-	-	-			

COURSE OBJECTIVES:

- To impart basic understanding of principles, and key concepts relevant to industrial biotechnology.
- To familiarize students with downstream processing and production of important microbial products
- To make the students to learn about various inorganic experiments.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be aware of the fermentation process, types of fermentation media and strategies for isolation of Industrially important strains	L2
CO2	The course will enable the student to apply the knowledge in various aspects of fermentation or industrial biotechnology processes.	L3
CO3	Students will get to know about the estimation of different elements like iron, calcium, nickel etc.	L1
CO4	The students will learn the synthesis of coordination compounds.	L2

List of Laboratory/Practical Experiments activities to be conducted (if any):

1. Estimation of zinc using EDTA
2. Estimation of nickel using EDTA and standard zinc sulphate
3. Gravimetric estimation of barium as barium sulphate.
4. Preparation of ferrous oxalate and its analysis (both iron and oxalate).
5. Synthesis of $[\text{Ni}(\text{en})_3]\text{Cl}_2 \cdot 2\text{H}_2\text{O}$. and $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2$.complexes.
6. Estimation of percentage of iron in haematite using barium diphenylamine sulphonate as an internal indicator.

7. Preparation of sodium trioxalatoferrate (III) and estimation of iron.
8. Estimation of calcium in lime stone.

REFERENCES:

1. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford, A.R.Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C.Publication.
3. Experimental Organic Chemistry Laboratory Manual, J.I. Garcia, J.A. Dobado, G.Francisisco, Elsevier Publication.
4. Chemistry Practical Inorganic Qualitaive Analysis For Under Graduate Students, M.J. Mamtora, S.C. Karad, J.S. Makasana, Lap Lambert Academic Publishing.
5. Advanced Practical Chemistry, K. Chelladurai, K. Subbian, Lap Lambert AcademicPublishing.
6. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication

SEMESTER	V					
YEAR	III					
COURSE CODE	20BS3575					
TITLE OF THE COURSE	APPLIED MICROBIOLOGY AND FERMENTATION TECHNIQUES-LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	4	-	-	2
Perquisite Courses (if any)						
#	Sem/Year	Course Code	Title of the Course			
-	-	-	-			

COURSE OBJECTIVES:

- To understand the fundamental concepts and techniques in soil microbiology, soil microbial diversity, basic and applied environmental problems.
- To make the students to learn about various inorganic experiments.
- To make the students to learn about estimation of different elements present in various compounds.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To enable us to know how microorganisms may be utilized in agricultural microbiology.	L2
CO2	Students will get to know about the estimation of different elements like iron, calcium, nickel etc.	
CO3	The students will learn the synthesis of coordination compounds.	

List of Laboratory/Practical Experiments activities to be conducted (if any):
1. Isolation and enumeration of bacteria, fungi and Actinomycetes from rhizosphere soil
2. Examination of Bacteroides from legume root nodules.
3. Demonstration of fungal contaminants in ground nut by standard blotter method.
4. Isolation and enumeration of air borne microbes by Petri plate exposure method.
5. Estimation of Biological Oxygen Demand (BOD)
6. Study of Fermenter (Demonstration using video or Industrial Visit)
7. Isolation of amylase producing microorganisms and production using solid state fermentation. Estimation of amylase activity.
8. Preparation of wine (Grapes/ Ginger/ Pomegranate). Estimation of alcohol.
9. Production and estimation of citric acid/ lactic acid
10. Immobilization of yeast by calcium alginate gel entrapment and assay for enzyme (Catalase/ Invertase).

REFERENCES:

1. Maheshwari, D. K. (2002). Practical Microbiology. S. Chand Publishing.
2. Pepper, I. L., Gerba, C. P., & Bredecke, J. W. (1995). Environmental microbiology: a laboratory manual. Academic Press.
3. Experiments in Microbiology, Plant Pathology and Biotechnology by K.R. Aneja.
4. Microbiology Laboratory Manual – Cappuccino, Sherman, Pearson Education.
5. Manual of Microbiology Kanika Sharma Ane Books Pvt. Ltd.
6. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
7. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
8. Stanbury PF, Whitaker A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
9. Waite Michael J., Morgan Neil., Rockey John S and Gray Highton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
10. Wulfcruiger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
11. K.R. Aneja. Experiments in Microbiology, Plant Pathology and Biotechnology.

SEMESTER	V					
YEAR	III					
COURSE CODE	20AU0003					
TITLE OF THE COURSE	CONSTITUTION OF INDIA AND HUMAN RIGHTS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	0	0	0	22	0

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Define a constitution
- Describe the salient features of the Indian Constitution
- Explain different ways of acquiring Indian Citizenship
- List the Fundamental Rights and Fundamental Duties of Indian citizens
- Describe the Directive Principles of State Policy and their significance

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will appreciate the fundamental law of the land	L1
CO2	Students will be aware of what kind of government the country will have.	L1
CO3	Aid in understanding what lays down the rules to govern the country	L2
CO4	It also tell about the rights and also the duties of its citizens	L1

COURSE CONTENT:	
MODULE 1	4Hrs
Framing of the Indian Constitution: Role of the Constituent Assembly. Philosophy of the Constitution: Objectives, resolution, preamble, fundamental Rights and Duties. Human rights and Environmental protection.	
MODULE 2	4Hrs
Special Rights created in the Constitution of Dalits, Backward Classes, Women and Children, and religious and linguistic minorities. Directive Principles of State policy: The need to balance fundamental rights with directive principles.	
MODULE 3	5Hrs

Union Executive: President, Prime Minister and Council of Ministers; powers and functions, coalition Government, problems in their working. Union Legislature: Lok Sabha and Rajya Sabha, powers and functions. Recent trends in their functioning.	
MODULE 4	4Hrs
State Government: Governor, Chief Minister and Council of ministers, Legislature. Centre – State relations: Political, financial, administrative: Recent Trends.	
MODULE 5	5Hrs
Judiciary: Supreme Court, Judicial Review, Writs, Public interest litigations. Enforcing rights through writs. Emergency provisions (Article 356)	

TEXT BOOK:

- 1 D.D. Basu – Introduction to the Indian Constitution.
- 2 A.S. Narang – Indian Constitution, Government and Politics.
- 3 Nani Palkhivala – We, the People, UBS Publishers, New Delhi, 1999.
- 4 A.G. Noorani – Indian Government and Politics
- 5 J.C. Johari – Indian Government and Politics Vol. I & II, Vishal, New Delhi
- 6 Gran Ville Austin – The Indian Constitution – Corner stone of a Nation, Oxford, New Delhi, 2000.
- 7 M.U. Pylee, Constitutional Government in India.
- 8 K.K. Ghai, Indian Constitution.

SEMESTER	V					
YEAR	III					
COURSE CODE	20AU0020					
TITLE OF THE COURSE	KANNADA KALI – I					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	0	0	0	-	0

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To enable students read and write in Kannada
- To make students to communicate in Kannada helping them to interact with local people for their daily needs

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students should be able to read, write and communicate in Kannada	L3

COURSE CONTENT:

1. ALPHABETS – AKSHARAMAALE - ಅಕ್ಷರಮಾಲೆ
2. SIGNS OF VOWELS AND CONJUNCT CONSONANTS –
KAAGMODULEHA MATTHU OTTHAKSHARAGALU
ಕಾಗುಣಿತ ಮತ್ತು ಒತ್ತಕ್ಷರಗಳು
3. DAILY USING WORDS PART – 1
DINANITHYADA PADAGALU BHAAGA – 1
ದಿನನಿತ್ಯದ ಪದಗಳು ಭಾಗ – 1
4. WEEKDAY AND MONTH NAMES –
VAARADA MATTHU THINGALA HESARUGALU
ವಾರದ ಮತ್ತು ತಿಂಗಳ ಹೆಸರುಗಳು
5. TASTE – RUCHI – ರುಚಿ
6. COLOURS – BANNAGALU – ಬಣ್ಣಗಳು
7. NUMBERS – SANKYEGALU - ಸಂಖ್ಯೆಗಳು
8. DAILY USING WORDS PART – 2
DINANITHYADA PADAGALU BHAAGA – 2
ದಿನನಿತ್ಯದ ಪದಗಳು ಭಾಗ – 2
9. QUESTION PATTERNS – PRASHNEYA VIDHAANAGALU
ಪ್ರಶ್ನೆಯ ವಿಧಾನಗಳು
10. MEASUREMENTS – ALATHEGALU - ಅಳತೆಗಳು
11. EDUCATION WORDS – SHAIKSHANIKA PADAGALU
ಶೈಕ್ಷಣಿಕ ಪದಗಳು
12. LIQUID ITEMS – NEERINAAMSHADA PADAGALU
ನೀರಿನಾಂಶದ ಪದಗಳು
13. FRUITS – HANNUGALU – ಹಣ್ಣುಗಳು
14. VEGETABLES – THARAKAARIGALU – ತರಕಾರಿಗಳು

15. FOOD ITEMS – AAHAARA PADAARTHAGALU
ಆಹಾರ ಪದಾರ್ಥಗಳು
16. DAILY USING WORDS PART -3 –
DINANITHYADA PADAGALU BHAAGA -3
ದಿನನಿತ್ಯದ ಪದಗಳು ಭಾಗ -3
17. METALS – LOHAGALU – ಲೋಹಗಳು
18. RELATIVES – SAMBANDHIKARU – ಸಂಬಂಧಿಕರು
19. SEASONS AND CLOTHES –
KAALAGALU MATTHU BATTEGALU
ಕಾಲಗಳು ಮತ್ತು ಬಟ್ಟೆಗಳು
20. HOUSE AND FURNITURE –
MANE MATTHU PEETOPAKARANAGALU
ಮನೆ ಮತ್ತು ಪೀಠೋಪಕರಣಗಳು
21. OPPOSITE WORDS – VIRUDDHA PADAGALU
ವಿರುದ್ಧ ಪದಗಳು
22. VERBS - KRIYAA PADAGALU – ಕ್ರಿಯಾ ಪದಗಳು
23. ANIMALS – PRAANIGALU – ಪ್ರಾಣಿಗಳು
24. INSECTS – KRIMIKEETAGALU – ಕ್ರಿಮಿಕೀಟಗಳು
25. BIRDS – PAKSHIGALU – ಪಕ್ಷಿಗಳು
26. FEELINGS – BHAAVANEGALU – ಭಾವನೆಗಳು
27. TENSES – KAALASOOCHAKAGALU – ಕಾಲಸೂಚಕಗಳು
28. COMMUNICATION WORDS – SAMBHAASHANEYA PADAGALU-
ಸಂಭಾಷಣೆಯ ಪದಗಳು

SEMESTER	V					
YEAR	III					
COURSE CODE	20AU0022					
TITLE OF THE COURSE	KANNADA MANASU - I					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	0	0	0	-	0

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To equip the native Kannada speaking students with advanced skills in Kannada communication and understanding.
- To enrich the students with creative writing.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will have better speaking and writing communication skills in Kannada	L3

COURSE CONTENT:

ಕನ್ನಡ ಪಠ್ಯಕ್ರಮ

1. ಕನ್ನಡ ಭಾಷಾ ವಿಜ್ಞಾನದ ಸ್ವರೂಪಗಳು
2. ಭಾಷಾ ಕಲಿಕೆಯ ವಿವಿಧ ನೆಲೆಗಳು
3. ವ್ಯವಹಾರಿಕ ಭಾಷೆಯಲ್ಲಿ ಕನ್ನಡ
4. ಕಂಪ್ಯೂಟರ್ ಕಲಿಕೆಯಲ್ಲಿ (ಗಣಕಯಂತ್ರ) ಕನ್ನಡ ಬಳಕೆ
5. ಪತ್ರ ಲೇಖನ
 1. ವೈಯಕ್ತಿಕ ಪತ್ರಗಳು
 2. ವ್ಯವಹಾರಿಕ ಪತ್ರಗಳು
6. ಪ್ರಬಂಧ ರಚನೆ
 1. ಸಾಮಾಜಿಕ ಕ್ಷೇತ್ರ
 2. ಶೈಕ್ಷಣಿಕ ಕ್ಷೇತ್ರ
7. ಗಾದೆಗಳ ಬಳಕೆ
 1. ಜನಪದದ ಶೈಲಿ
 2. ಅನುಭವದ ಶೈಲಿ
8. ವಾಕ್ಯ ಸಂಯೋಜನೆ
 1. ಸರಳ ವಾಕ್ಯ
 2. ಮಿಶ್ರವಾಕ್ಯ
 3. ಸಂಯೋಜಿತ ವಾಕ್ಯ _
9. ವ್ಯಾಕರಣ ಭಾಗ
 1. ಅನುಕರಣವಾಚಕ ಪದಗಳು
 2. ವಿರುದ್ಧ ಪದಗಳು, ನುಡಿಗಟ್ಟುಗಳು
 3. ವಿದ್ಯರ್ಥಕ ಪದಗಳು
 4. ಅರ್ಥ, ಸಮಾನಾರ್ಥ, ನಾನಾರ್ಥ ಪದಗಳು
 5. ನಿಷೇಧಾರ್ಥಕ ಪದಗಳು
 6. ಸಂಖ್ಯಾವಾಚಕ, ನಾಮವಾಚಕಗಳು
 7. ವಿಭಕ್ತಿ ಪ್ರತ್ಯಯಗಳು
 8. ಕ್ರಿಯಾಪದಗಳು, ಧಾತುರೂಪ
 9. ಪದ ವಿಂಗಡಣೆ
 10. ದ್ವಿರುಕ್ತಿ, ಜೋಡುನುಡಿ, ಇತ್ಯಾದಿ

10. ಸೃಜನಾತ್ಮಕ ಬರವಣಿಗೆ
 1. ವಿಷಯದ ಆಯ್ಕೆ
 2. ಅನಿಸಿಕೆಯ ಭಾಗ
 3. ವಿಶ್ಲೇಷಣೆ
 4. ಉಪಸಂಹಾರ
11. ವಿಷಯದ ಚರ್ಚೆ, ಪ್ರಬಂಧ ಮಂಡನೆ
12. ಸಮೂಹ ಚರ್ಚೆ, ಪಠ್ಯ - ಪದ್ಯ - ನಾಟಕ ಭಾಗ
13. ವಿಷಯ ಸಂಗ್ರಹಣೆ, ವರದಿ, ಲೇಖನ ಕಲೆ
14. ಸಂಪರ್ಕ ಮಾಧ್ಯಮಗಳು - ಅದರ ಬಳಕೆ
15. ಸ್ವತಂತ್ರ ಕಥೆ, ವರ್ಣನೆ, ಪ್ರವಾಸಕಥನ ಮತ್ತು ಅನುಭವಗಳ ನಿರೂಪಣೆ

SEMESTER	VI					
YEAR	III					
COURSE CODE	20BS3601					
TITLE OF THE COURSE	RESEARCH METHODOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2		-	-	22	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	-	-	-

COURSE OBJECTIVES :

1. Students understand research terminology one that can be used to carry out different approaches to research
2. To be aware of the ethical principles of research, challenge and approval processes

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Demonstrate knowledge of research processes (reading, evaluating and developing)	L2
CO2	Compare and contrast qualitative and quantitative research	L4

COURSE CONTENT:	
MODULE I	11Hrs
Meaning, Objectives and Characteristics of research. Research Methods Vs Methodology. Types of research. Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical. Research process. Criteria of good research. Developing a research plan. Defining the research problem. Techniques involved in defining the problem Survey of literature. Primary and secondary sources. Reviews, treatise, monographs patents. Identifying gap areas from literature review. Development of working hypothesis.	
MODULE II:	11Hrs
Research design and methods - Basic Principle. Features of good design. Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan. Exploration, Description, Diagnosis, and Experimentation. Determining experimental and sample designs. Sampling design - Steps and types in sampling design. Measurement and scaling techniques. Methods of data collection. Testing of hypotheses. Procedure for hypotheses testing flow diagram for hypotheses testing. Data analysis with Statistical Packages. Correlation and	

Regression. Important parametric test. Chi-square test. Analysis of variance and Covariance.	

REFERENCES

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
6. Day, R.A., 1992. How to Write and Publish a Scientific Paper, Cambridge University Press.
7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications

SEMESTER	VI					
YEAR	III					
COURSE CODE	20BS3602					
TITLE OF THE COURSE	PROJECT					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	-	12	-	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	-	-	-

COURSE OBJECTIVES :

1. Construct a project from Plan, schedule, monitor and control students' own work and to exhibit ideas in discussions and presentations
2. Apply tools and techniques to the applied courses taught and to communicate their findings through a written report and poster presentation

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To provide a postgraduate level knowledge in Microbiology, including understanding, analysis, management, and handling of real life information technology problems in workplace.	L4
CO2	To provide graduate education that will prepare students to become thoughtful, productive members of the competing profession and community.	L4
CO3	To provide a high-quality post graduate education and training in microbiology which prepares students for productive careers and lifelong learning.	L5

DAYANANDA SAGAR UNIVERSITY
SHAVIGE MALLESHWARA HILLS, KUMARASWAMY LAYOUT
BENGALURU – 560 113, KARNATAKA.

SCHOOL OF BASIC & APPLIED SCIENCES



SCHEME & SYLLABUS
FOR
BACHELOR OF SCIENCE (B.Sc.) – 2020
MICROBIOLOGY, BIOCHEMISTRY & GENETICS
(MBG)
(With effect from 2020 – 21)

SCHEME – B.Sc. – 2020-21 ONWARDS

I SEM – MBG

(MICROBIOLOGY, BIOCHEMISTRY & GENETICS)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	113	20MB1101	BASIC MICROBIOLOGY	CR	4	-	-	-	4	*	***
2	113	20BC1101	BASIC BIOCHEMISTRY	CR	4	-	-	-	4	*	***
3	113	20GN1101	BASIC GENETICS	CR	4	-	-	-	4	*	***
4	113	20BS1101	BASIC CHEMISTRY	CR	4	-	-	-	4	*	***
5	113	20MB1171	BASIC TECHNIQUES IN MICROBIOLOGY	CR	-	-	4	-	2	*	***
6	113	20BC1171	BASIC BIOCHEMISTRY - LAB	CR	-	-	4	-	2	*	***
7	113	20GN1171	BASIC GENETICS - LAB	CR	-	-	4	-	2	*	***
8	113	20BS1102	COMMUNICATIVE ENGLISH	CR	2	-	-	-	2	*	***
					18	-	12	-	24		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SCHEME – B.Sc. – 2020-21 ONWARDS

II SEM – MBG

(MICROBIOLOGY, BIOCHEMISTRY & GENETICS)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	113	20MB1201	MICROBIAL PHYSIOLOGY	CR	4	-	-	-	4	*	***
2	113	20BC1201	BIOANALYTICAL TECHNIQUES	CR	4	-	-	-	4	*	***
3	113	20GN1201	FUNDAMENTALS OF CYTOGENETICS	CR	4	-	-	-	4	*	***
4	113	20BS1201	BIOINFORMATICS AND BIOSTATISTICS	CR	4	-	-	-	4	*	***
5	113	20MB1271	MICROBIAL PHYSIOLOGY - LAB	CR	-	-	4	-	2	*	***
6	113	20BC1271	BIOANALYTICAL SEPERATIONS - LAB	CR	-	-	4	-	2	*	***
7	113	20GN1271	FUNDAMENTALS OF CYTOGENETICS - LAB	CR	-	-	4	-	2	*	***
8	113	20BS1202	COMPUTER APPLICATIONS AND INFORMATION TECHNOLOGY	CR	2	-	-	-	2	*	***
					18	-	12	-	24		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SCHEME – B.Sc. – 2020-21 ONWARDS

III SEM – MBG

(MICROBIOLOGY, BIOCHEMISTRY & GENETICS)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	113	20MB2301	IMMUNOLOGY AND MEDICAL MICROBIOLOGY	CR	4	-	-	-	4	*	***
2	113	20BC2301	HUMAN PHYSIOLOGY	CR	4	-	-	-	4	*	***
3	113	20GN2301	BASIC HUMAN GENETICS AND GENETIC ENGINEERING.	CR	4	-	-	-	4	*	***
4	113	20BS2301	MOLECULAR BIOLOGY	CR	4	-	-	-	4	*	***
5	113	20MB2371	IMMUNOLOGY AND MEDICAL MICROBIOLOGY - LAB	CR	-	-	4	-	2	*	***
6	113	20BC2371	CLINICAL BIOCHEMISTRY - LAB	CR	-	-	4	-	2	*	***
7	113	20GN2371	BASIC HUMAN GENETICS AND GENETIC ENGINEERING - LAB	CR	-	-	4	-	2	*	***
8	113	20BS2302	ENVIRONMENTAL SCIENCE	CR	2	-	-	-	2	*	***
					18	-	12	-	24		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SCHEME – B.Sc. – 2020-21 ONWARDS

IV SEM – MBG

(MICROBIOLOGY, BIOCHEMISTRY & GENETICS)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	113	20MB2401	INDUSTRIAL, FOOD AND DAIRY MICROBIOLOGY	CR	4	-	-	-	4	*	***
2	113	20BC2401	ENZYMOLGY AND PROTEIN CHEMISTRY	CR	4	-	-	-	4	*	***
3	113	20GN2401	APPLIED GENETICS	CR	4	-	-	-	4	*	***
4	113	20BS2401	GENOMICS AND PROTEOMICS	CR	4	-	-	-	4	*	***
5	113	20MB2471	INDUSTRIAL, FOOD AND DAIRY MICROBIOLOGY -LAB	CR	-	-	4	-	2	*	***
6	113	20BC2471	ENZYMOLGY - LAB	CR	-	-	4	-	2	*	***
7	113	20GN2471	APPLIED GENETICS - LAB	CR	-	-	4	-	2	*	***
8	113	20BS2402	BIOETHICS AND IPR	CR	2	-	-	-	2	*	***
					18	-	12	-	24		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SCHEME – B.Sc. – 2020-21 ONWARDS

V SEM – MBG

(MICROBIOLOGY, BIOCHEMISTRY & GENETICS)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	113	20MB3501	AGRICULTURE AND ENVIRONMENTAL MICROBIOLOGY	CR	4	-	-	-	4	*	***
2	113	20BC3501	METABOLISM	CR	4	-	-	-	4	*	***
3	113	20GN3501	POPULATION AND EVOLUTIONARY GENETICS	CR	4	-	-	-	4	*	***
4	113	20BS3571	ESTIMATION OF BIOMOLECULES-LAB	CR	-	-	4	-	2	*	***
5	113	20BS3574	APPLIED MICROBIOLOGY AND POPULATION GENETICS-LAB	CR	-	-	4	-	2	*	***
6	113	20AU0003	CONSTITUTION OF INDIA AND HUMAN RIGHTS	AU	2	-	-	-	-	*	***
7	113	20AU0020	KANNADA KALI – I	AU	2	-	-	-	-	*	***
8	113	20AU0022	KANNADA MANASU – I	AU	2	-	-	-	-	*	***
					16	-	08	-	16		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SCHEME – B.Sc. – 2020-21 ONWARDS

VI SEM – MBG

(MICROBIOLOGY, BIOCHEMISTRY & GENETICS)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PRE REQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	113	20BS3601	RESEARCH METHODOLOGY	CR	4	-	-	-	2	*	***
2	113	20BS3602	PROJECT	CR	-	-	12	-	6	*	***
					4	-	12	-	08		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

SEMESTER	I					
YEAR	I					
COURSE CODE	20MB1101					
TITLE OF THE COURSE	BASIC MICROBIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To know the importance of microorganisms for our global society
- To understand the structural and functional characteristics of prokaryotic and eukaryotic cells with their classification
- To study the basic techniques for isolation, culturing and identification of prokaryotic microorganisms and their importance
- To study eukaryotic microorganisms in detail and to know their importance

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Provides a strong acquaint in fundamental aspects of basic microbiology	L1
CO2	Enable to understand the diversity of microbial, structure, function and their environment	L2
CO3	Awareness about economic importance of microorganisms	L3
CO4	Students will be equipped with fundamental knowledge of microbial growth patterns and kinetic studies enabling them to apply the same in various allied fields.	L2

COURSE CONTENT:	
MODULE 1	
12Hrs	
HISTORY AND MICROBIAL SYSTEMATICS Development of microbiology as a discipline, spontaneous generation and biogenesis. Contributions of Antony von Leeuwenhoek, Joseph Lister, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Sumbunath Dey, Ananda Chakroborty and Sir Ronald Ross in the field of Microbiology. Scope and disciplines of microbiology. Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems. Brief account of Bergey's manual of bacteriology. Criteria for the classification of	

bacteria. General account of microbiome.	
MODULE 2	12Hrs
MICROBIAL TECHNIQUES Microscopy: Principles of resolution and magnification. Types- optical and electron microscopy – Basic principle, sample preparation, applications and limitations of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope (Toppling & sliding mode), Fluorescence and Electron Microscope-TEM and SEM). Staining techniques: Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic). Microbial Nutrition and kinetics: Growth curve, Macro- and Micronutrients, Factors influencing the growth of microbes. Measurement of microbial growth.	
MODULE 3	12Hrs
PROKARYOTIC MICROBIOLOGY Difference between prokaryotic and eukaryotic microorganisms. Virology: General structure and characteristics of viruses, cultivation of viruses, general replication of viruses – lytic and lysogenic cycle with examples (TMV and Lambda phage), significance of viruses, viroids and prions. Bacteriology: Size, shape and arrangement. Ultrastructure of bacteria and functions in detail - Slime layer & Capsule (Klebsiella), Flagella, Pilus/ Fimbriae (E. coli), Cell wall (Gram positive and negative), Cytoplasmic membrane, Cytoplasmic inclusion bodies, nuclear material, Plasmids and episomes, Ribosomes and Endospore (Bacillus /Clostridium). Reproduction – Binary fission and genetic exchange in bacteria (Conjugation, transformation and transduction). Special microbial forms: Actinomycetes, Spirochetes, Rickettsia, Chlamydiae. Introduction to Archaeobacteria and extremophiles.	
MODULE 4	12Hrs
EUKARYOTIC MICROBIOLOGY Fungi: General account of Fungi - General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization. Reproduction - asexual and sexual. Economic importance of fungi. Type study of Zygomycetes (Rhizopus), Ascomycetes (Aspergillus), Basidiomycetes (Agaricus) and Deuteromycetes (Fusarium). Algae: General characteristics of algae including occurrence, thallus organization, algae cell ultrastructure. Reproduction and life cycles-vegetative, asexual and sexual reproduction. Economic importance of algae. Type study of Cyanophyta (Spirulina), Chlorophyta (Chlamydomonas and Spirogyra), Rhodophyta (Gracillaria). Protozoa: General characteristics with special reference to Amoeba, Trypanosoma, Plasmodium, Paramecium.	

TEXT BOOKS:

1. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2007. Introductory Mycology. ; Fourth edition, Wiley India Private Limited
2. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
3. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
4. Benson, H. J. 1994. Microbiological Application. WCB McGraw-Hill of India Private Limited.
5. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
6. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.
7. Dubey, R.C. Microbiology 1st Edition. Chand and company
8. Edward Alcamo. Microbiology. Cliffs Notes 1996.
9. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015. 9
10. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.
11. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005
12. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1986.
13. Pommerville, J.C. 2007. Alcamo's Fundamentals of Microbiology. Eighth Edition. Jones and Bartlett Publishers, USA.
14. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
15. Salle, A. J. 1984. Fundamental Principles of Bacteriology. Tata McGraw-Hill Publishing Company Limited, New Delhi.
16. Salle, A.J. Principles of Microbiology, 2nd edition., 1997, Mc Graw Hill.1997.
17. Sharma, O. P. 1986. Text Book of Algae. Tata McGraw-Hill Education.
18. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005
19. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009
20. Vashishta, B.R. 2010. Botany for Degree Students – Algae. S. Chand and Co.

SEMESTER	I					
YEAR	I					
COURSE CODE	20BC1101					
TITLE OF THE COURSE	BASIC BIOCHEMISTRY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To familiarize the students with basic concepts and principles of conformation and energy transfer in biological systems.
- To create general understanding about fundamentals of biomolecules, and their structure and significance.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will know about pH, buffer and will be able to decide the importance of biological reactions.	L2
CO2	The students will have an insight of structure and functions of biomolecules	L3
CO3	Students will have a better insight of basics of biochemistry with a detailed understanding of the clinical significance of biomolecules	L4

COURSE CONTENT:	
MODULE 1	
12Hrs	
Water and Buffers: Modern concepts of acids and bases; Ionization of acids. Dissociation of water and ionic product of water, Hydrogen bonding properties of water, Definition and determination of pH and associated numerical; Common ion effect with examples, Buffer preparation by H-H equation, buffer types. Numerical problems on preparation of buffer solutions, Biological buffers and their reactions.	
MODULE 2	
12Hrs	
Conformation and energy transfer	
<i>Stereoisomerism:</i> Optical isomerism: Chirality, Nomenclature of enantiomers -The RS and the DL system. Optical rotation, racemisation and resolution. Fischer projection formula. Geometrical isomerism: Cis trans-isomerism, examples of chirality in the biological world. <i>Thermodynamics:</i> First and second law, free energy, entropy, chemical potential, standard free energy change, exergonic and endergonic reactions with examples. Relationship between free energy change and equilibrium constant. Oxidation and reduction reactions in biology	

MODULE 3	12Hrs
Carbohydrates and lipids <i>Carbohydrates:</i> Classification– monosaccharides, disaccharides, oligosaccharides with examples; Polysaccharides – structural and storage; mucopolysaccharides – peptidoglycan and teichoic acid. <i>Lipids:</i> classification – simple, complex and derived with examples. Properties of lipids: interaction with water; micelle, layer, liposome and membrane formation; Saponification, rancidity and iodine number.	
MODULE 4	12Hrs
Amino acids and nucleic acids <i>Amino acids:</i> General structure of amino acids, acid base property, isoelectric point, peptide bond, classification of proteins based on solubility – fibrous and globular, classification of protein based on location: intracellular, extracellular and membrane bound proteins, introduction to protein hierarchy. Native state and denatured state of proteins <i>Nucleic acid:</i> Structure of nitrogen base – purine and pyrimidine, general structure of nucleosides and nucleotides. Melting of DNA, melting temperature, renaturation of nucleic acids.	

TEXT BOOKS:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Zubay's Principles of Biochemistry – Rastogi and Aneja. MedTech 5th Edition
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Stereochemistry of Carbon Compounds, Eliel (1977) Tata-McGrawHill

SEMESTER	I					
YEAR	I					
COURSE CODE	20GN1101					
TITLE OF THE COURSE	BASIC GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To gain insight on the historical perspective of the evolution of genetics.
- To comprehend and identify the different types of mendelian and non-mendelian inheritance.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will have clarity to the background of genetics before getting into details in the forthcoming semesters	L3
CO2	They will be capable differentiate between mendelian and non mendelian inheritance sources along with associated intricacies.	L3
CO3	Student will gain the ability to analyse and relate phenotype to genotype and potential factors influencing the interaction.	L3

COURSE CONTENT:

MODULE 1 HISTORY OF GENETICS AND MENDELIAN PRINCIPLES			12Hrs
Pre- formation, History and scope of Genetics, Pre- Mendelian genetic concepts epigenesis, pangenesis, germplasm theory. Mendel- Life and his experiments on pea plants. Principle of Dominance (Dominance and Recessiveness); Laws of Inheritance and their applications. Monohybrid Cross, Dihybrid Cross, Back Cross, Test Cross			
MODULE 2 EXTENSIONS OF MENDELISM AND GENE INTERACTIONS			12Hrs
Co-dominance and incomplete dominance - definition, examples. Multiple allelism- definition, Eye color in Drosophila, Blood groups and Rh factor in Human; Allelic series; Lethal alleles; Multi-factorial inheritance- Skin colour in Humans; Penetrance and Expressivity; Pleiotropy. Epistasis- dominant, recessive. Supplementary and Complementary gene interactions; Non epistatic inter allelic gene interaction, Position effect.			

MODULE 3 SEX DETERMINATION AND EXTRA CHROMOSOMAL INHERITANCE	12Hrs
Chromosomal theory of Inheritance - Concepts and evidences. Mechanism of sex determination- XX-XY; XX-XO; ZZ-ZW; Bridges genetic balance theory. Environmental and hormonal control of sex determination Gynandromorphs / Intersexes, Super sexes in <i>Drosophila</i> . Sex differentiation and dosage compensation (<i>Drosophila</i> and Man). Sex linked and sex limited traits in Humans. Hemophilia, Hypertrichosis. Extra Chromosomal inheritance, flower colour in <i>Mirabilis jalapa</i> , kappa particle in <i>Paramecium</i> , sigma factor in <i>Drosophila</i> , Cytoplasmic Male Sterility (CMS) in maize.	
MODULE 4 MODEL ORGANISMS IN GENETICS	12Hrs
Bacteria - <i>E. coli</i> ; Viruses - Tobacco Mosaic Virus; Bacteriophage - Lambda Phage; Fungi- <i>Neurospora</i> species, <i>N. crassa</i> , <i>Saccharomyces cerevisiae</i> ; Nematode - <i>Caenorhabditis elegans</i> , Plant - <i>Arabidopsis thaliana</i> , Fly - <i>Drosophila melanogaster</i> , Fish - Zebra fish (<i>Danio rerio</i>), Mammal - Mice (<i>Mus musculus</i>) and Rat (<i>Rattus rattus</i>).	

TEXT BOOK:

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Strickberger M. W., Genetics. (1968) Macmillan Publishers.

REFERENCES:

1. Mathew Hamilton, (2009) Population Genetics, Wiley-Blackwell
2. Snustad D. P., Simmons M. J., Principles of Genetics. 5th Edition (2008) John Wiley & Sons.
3. Brooker R. B., Genetics Analysis and Principles. Fourth Edition (2009) McGraw-Hill.
4. Tamarin R. H., Principle of Genetics. Seventh Edition. (2002) Tata-McGraw Hill.
5. Hart D and Jones E.W., Genetics Principles and Analysis. 4th Edition (1998) Jones and Bartlett Publication.
6. Atherly A. G., Girton J. R. and Donald M. C. J. F. The Science of Genetics (1999) Saunders College Publication / Harcourt Brace.
7. Sturtevant A. H., A History of Genetics (1965). Harper and Row New York. Mendel G. The First Geneticist by Orel V. (1996) Oxford University Press, New York.
8. Ross S. A first course in Probability. 4th Edition (1994). McMillan, New York.
9. Stansfield W. D., Theory and problems of Genetics (Schaum's Outline Series). (2002) McGraw Hill.
10. Stubbe H., History of Genetics (1972). Harper and Row New York.
11. Prasad S. Fundamentals of Biostatistics (1993). Emkay publications, New Delhi.
12. Khan and Khanum. Fundamentals of Biostatistics. II Revised Edition. (2004). Ukaaz Publication.

SEMESTER	I					
YEAR	I					
COURSE CODE	20BS1101					
TITLE OF THE COURSE	BASIC CHEMISTRY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-		-	-

COURSE OBJECTIVES:

- To make the students to understand basic facts and concepts in chemistry while retaining the exciting aspects of chemistry so as to develop interest in the study of chemistry as a discipline.
- To make the students to familiarize with the basic concepts related to modern atomic theory, quantum chemistry, acids and bases, chemical bonds in molecules and basics of organic chemistry and different organic reactions.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will learn about handling of data and basics of acids and bases	L1
CO2	Students will learn about advanced principles of atomic structure	L2
CO3	Students will get in depth knowledge about chemical bonding and various theories related to that.	L3
CO4	Students will learn about the basic principles of organic chemistry	L1

COURSE CONTENT:	
MODULE 1	
10Hrs	GENERAL CHEMISTRY Handling of analytical data: SI and CGS units of measurements and physical constants and their inter conversion; Significant figures and calculations, accuracy, precision and errors in quantitative analysis. Stoichiometry: atomic weights, molecular weights, mole concept, molarity, molality, normality, mole fraction, ppt, ppb and ppm. Numerical problems related to the above concepts. Acids and Bases: Theories of acids and bases – Arrhenius - Bronsted-Lowry theory - Lewis theory -Solvent system definition. Relative strengths of acids and bases – Dissociation constant of acids and bases - Levelling effect of water. Hard and soft acids and bases (HSAB). Non-aqueous solvents – classification - Liquid ammonia as solvent. Acid-base equilibria in aqueous solution and pH. Acid- base neutralisation curves; indicator, choice of indicators.

MODULE 2	12Hrs
ATOMIC STRUCTURE Review of Bohr's theory and its limitations, dual behavior of matter and radiation, de Broglie's equation-derivation, Heisenberg's uncertainty principle. Hydrogen atomic spectra. Need of a new approach to Atomic structure. Elements of Quantum chemistry- Schrodinger wave equation and meaning of various terms in it. Significance of ψ and ψ^2 , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Quantum numbers and their Significance. Shapes of s, p and d atomic orbitals, nodal planes. Rules for filling up of electrons in various orbitals (Aufbau principle, Pauli's exclusion principle, Hund's rule of maximum multiplicity and n+l rule), Electronic configuration of the elements (up to Z=30) and anomalous electronic configurations. Stability of half-filled and completely filled orbitals- concept of pairing and exchange energy.	
MODULE 3	12Hrs
<i>Introduction:</i> Need for the atoms to form molecules, and types of chemical bonds with examples <i>Ionic Bond:</i> Definition and conditions for formation of an ionic bond between atoms, examples of formation of an ionic compound between alkali metal/alkaline earth metals and chalcogen/halogen group elements. Lattice energy, its effect on stability and solubility of ionic solids, Born – Haber cycle for NaCl, KBr, KI, and MgO and CaCl₂). <i>Covalent Bond:</i> Definition, octet rule, Lewis dot formulae of a few simple molecules and ions, electron deficient and excess molecules (BeCl₂, BF₃, PCl₅, SF₆). <i>Geometry of covalent molecules:</i> (VSEPR concept and hybridisation concepts) basic concepts and definitions: Examples simple inorganic molecules and ions. such as NH₃, H₂O, H₃O⁺, SF₄, ClF₃. <i>Theories of covalent bonds (VBT and MOT):</i> <i>Valence bond theory (VBT):</i> postulates and its limitations, directional characteristics of covalent bonds, Application of VBT to BeCl₂, BF₃, SiCl₄, PCl₅, SF₆ molecules. <i>Molecular orbital theory:</i> postulates, linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals, pictorial representation of formation of s and p MOs from the corresponding atomic orbitals, Molecular orbital energy level diagram and molecular orbital configuration involving s and p orbitals their importance for the following molecules, (H₂, N₂, O₂, HF and CO). <i>Metallic Bond:</i> Definition, properties of metals and band theory. <i>Weak Intermolecular interactions:</i> van der Waals forces, dipole-dipole interactions and their significance. <i>Hydrogen Bond:</i> Definition, types, importance	
MODULE 4	12Hrs
<i>Representation of structural formula of organic compounds:</i> condensed formula and bond line formula of organic compounds, classification of organic compounds based on functional groups with examples <i>IUPAC nomenclature:</i> IUPAC nomenclature of organic compounds including Bifunctional compounds and substituted benzenes. (o, p and m). <i>Delocalisation of electrons:</i> Inductive effect, electrometric effect, resonance (mesomeric effect, EWG and EDG, +M and –M effects) and hyper conjugation. <i>Reactive intermediates:</i> Types of bond cleavage, curly arrow rules in representation of mechanistic steps; electrophiles, nucleophiles, carbocations, carbanions, free radicals and carbenes– generation, structures, stability and examples. <i>Types of organic reactions:</i> Types of organic reactions with examples (electrophilic/ nucleophilic substitution/addition/free radical reaction with examples.	

<i>Aromaticity:</i> Kekule structure of benzene - molecular orbital picture of benzene – resonance energy and stability of benzene - Huckel's rule (aromatic, non-aromatic, and antiaromatic molecules) - aromaticity of benzene and benzenoid compounds – aromaticity of three, four, five, six, seven and eight-membered systems - annulenes.

List of Laboratory/Practical Experiments activities to be conducted (if any) :NONE

1.

2.

TEXT BOOKS:

1. A New Concise Inorganic Chemistry”, J. D. Lee, 5th Ed, Chapman & Hall, London (1996).
2. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992)
3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)

REFERENCES:

1. A New Concise Inorganic Chemistry”, J. D. Lee, 5th Ed, Chapman & Hall, London (1996).
2. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992)

SEMESTER	I					
YEAR	I					
COURSE CODE	20MB1171					
TITLE OF THE COURSE	BASIC TECHNIQUES IN MICROBIOLOGY-LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	4	-	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To enable students to understand the microbial structure, microbial growth pattern and techniques to measure cell size.
- To help them understand the isolation of various microorganisms from different sources.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students are aware of microbial diversity and isolation techniques.	L1
CO2	Students will be equipped with fundamental knowledge of microbial growth patterns and kinetic studies enabling them to apply the same in various allied fields.	L2

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Study of basic instruments in Microbiology laboratory (2 Units)
a) Autoclave b) Hot air oven c) Incubator d) pH meter e) High speed centrifuge f) Colorimeter / Spectrophotometer g) Anaerobic jar h) Bacterial Filters i) Laminar air flow
2. Preparation of culture media:
a) Basal media (Nutrient agar and broth, Czapekdox media and MRBA) b) Selective media (EMB agar and McConkey agar) c) Enriched media (Blood agar).
3. Isolation of bacteria and fungi by serial dilution technique from soil, water and air.
4. Methods of pure culture techniques
a) Pour plate technique b) Spread plate technique

c) Streak plate technique
5. Transfer of media and inoculum a) Slant culture technique b) Broth culture technique c) Stab culture technique
6. Microscopic examination of bacterial smear a) Simple staining b) Gram's staining c) Capsule staining d) Endospore staining
7. Isolation and identification of fungi (Lactophenol cotton blue mount)
8. Micrometry: Microscopic measurement of bacterial cell (Bacillus), yeast (Saccharomyces).
9. Microscopic observation of temporary slides a. Algae: Chlamydomonas and Spirulina b. Fungi: Rhizopus, Aspergillus, Penicillium, Yeast and Fusarium c. Protozoa: Amoeba, Paramecium and Plasmodium
10. Study of growth curve of bacteria by turbidometric method

REFERENCES

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
3. Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
4. Pelczar, M. J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.
5. Prescott, L.M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, NY.

SEMESTER	I					
YEAR	I					
COURSE CODE	20BC1171					
TITLE OF THE COURSE	BASIC BIOCHEMISTRY - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	0	40	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To familiarize the students with good lab practise how to make buffers.
- To create general understanding about detection of biomolecules.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will be familiarized with handling laboratory equipment like weighing balance, pH meter and potentiometer and learn the importance and preparation of buffers.	L2
CO2	They will have an understanding of biomolecule composition of edible materials	L3

EXPERIMENTS/PRACTICALS:

1. Calculation and preparation of buffers
2. Potentiometric titration of potassium hydrogen phthalate/HCl and sodium carbonate
3. Potentiometric titration of HCl and sodium bicarbonate/ sodium hydroxide
4. Potentiometric titration of amino acid against NaOH and HCl
5. Estimation of proteins milk.
6. Estimation of carbohydrates in vegetables (Potatoes etc)
7. Estimation of lipids in milk/vegetables (avocadoes etc)
8. Estimation of iodine number of edible oils
9. Estimation of ascorbic acid in fruits by titrimetric method.

TEXT BOOKS:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7th ed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER	I					
YEAR	I					
COURSE CODE	20GN1171					
TITLE OF THE COURSE	BASIC GENETICS PRACTICAL					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	0	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To differentiate between the various stages of meiosis in animal and plant cells.
- To gain insight as to the different genetic interactions and their effect on phenotype.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will gain skills to process tissue into slides and distinguish various meiotic stages.	L3
CO2	Students will be capable to analyse and identify gene interactions, predict crosses and understand its role in inheritance.	L4

List of Laboratory/Practical Experiments activities to be conducted (if any):

1. Temporary squash preparation of : Grasshopper Testes, Onion flower bud
2. Observation of meiotic stages in permanent slides
3. Blood Typing
4. Sex differentiation in *Drosophila*
5. Detection of sex chromatin bodies: Preparation of Barr bodies from bucal smears.
6. Genetic problems on : (a) Probability (b) multiple alleles (c) Gene interactions (d) Sex Linkage
7. Study of: (a) Flower color in *Mirabilis jalapa* (b) Coat color in Mice (c) Comb pattern in fowl.

REFERENCES

1. Brooker, R. J. 1999. Genetics: Analysis and Principles. Benjamin Cummings, Longman, INC.
2. Gardner E. J. M. J. Simmons and D.P. Snustad 1991 Principles of Genetics. John Wiley & Sons. INC.New York.
3. Klug, W. S. and M. R. Cummings 1994 Concepts of Genetics MacMillan Colley Publishing and Company NY.
4. Strickberger M. W. 1996. Genetics. Mac Millan Publishing Co. NewYork
5. Tamarin,. R H. 1999. Principles of Genetics. McGraw-Hill.

SEMESTER	I					
YEAR	I					
COURSE CODE	20BS1102					
TITLE OF THE COURSE	COMMUNICATIVE ENGLISH					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	24	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To encourage the students to speak English confidently and enable them to communicate for day-to-day needs
- To build up their confidence in the usage of English and to enhance their written communicative competence also helping them for competitive exams

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students are confident in oral and written communication	L1
CO2	Have enhanced competence for competitive exams	L2

COURSE CONTENT:	
MODULE 1	
6Hrs	
COMMUNICATION SKILLS	
Definition, importance of communication, communication process – source, message, encoding, channel, decoding, receiver, feedback, context, levels of communication, Flow of Communication, Verbal and Non-Verbal Communication, Barriers to Communication - physiological, physical, cultural, language, gender, interpersonal, psychological, emotional. Perspective in communication/ Communication styles: introduction, visual perception, language, other factors affecting our perspective – past experiences, prejudices, feelings, environment	
MODULE 2	
6Hrs	
Elements of communication – introduction, face to face communication – tone of voice, body language (non-verbal communication), verbal communication, physical communication;	
Basic listening skills: introduction, self-awareness, active listening, becoming an active listener, listening in difficult situations;	
Interview skills: purpose of an interview, do's and don'ts of an interview;	
Giving presentations: dealing with fears, planning your presentation, structuring your presentation, delivering your presentation, techniques of delivery;	

Group discussion: introduction, communication skills in group discussion, do's and don't's of group discussion; Phonetics: The Organs of Speech, The Description and Classification of Speech Sounds, The Description and Classification of Vowels, The Description and Classification of Consonants, Phonetic symbols and the IPA, Phonemic and Phonetic Transcription Phonology, Phoneme sequences and Consonant Cluster, The Syllable, Word Accent, Accent and Rhythm in Connected Speech, Intonation, Varieties of English Pronunciation.	
MODULE 3	6Hrs
EFFECTIVE WRITING SKILLS Effective written communication: introduction, when and when not to use written communication – complexity of the topic, amount of discussion required, shades of meaning, formal communication Writing effectively: subject lines, put the main point first, and know your audience, organisation of the message, Paragraph Writing, Letter Writing, Report Writing, Book Review, Scientific writing, Making a message – Transitivity/ intransitivity – complementation – talking about closely linked action – using two verbs together (eg: She started laughing), Transforming messages – Making statements, questions, orders and suggestions – denying – rejecting – disagreeing – possibility – ability, permission, obligation etc.	
MODULE 4	6Hrs
GRAMMAR Word Classes: Open Word Classes: - Nouns, Verbs, Adjectives, Adverbs, Pronouns; Closed Word Classes: - Pre-determiners, Determiners, Numerals, Enumrators, Prepositions, Conjunctions, Auxiliary Verbs, Interjection; Morphology: Bound and Free Morphemes; Affixes, Stems and Roots; Morphological Analysis; Phrases: Noun Phrase, Verb Phrase, Genitive Phrase, Adjective Phrase, Adverb Phrase, Prepositional Phrase, Phrases and its types, Clauses and its types, Sentences and its types, Common errors, phonetics; Clauses: Clause Elements, Clause Types, Kinds, Concord; Sentences: Simple Sentences, Compound Sentences, Complex Sentences; Sub Ordination: Sub-Clauses, Finite and Non-Finite Sub-Clauses; Co-ordination: Linked and Unlinked Coordination, Synthesis; Ambiguity: Types of Ambiguity, Structural and Lexical Ambiguity; Common Errors: Nouns and Pronouns, Articles, Verbs, Concord, Adjectives, Adverbs, Prepositions, Vocabulary, Expressing time, Referring to present, past and future time - use of adjuncts - frequency and duration, Talking about manner and place, Information about place, manner - position of adjuncts - types of adverbs (time, frequency, duration etc), Reporting what people say/think, Reporting verbs - reporting someone's actual words - reporting in one's own words, The structure of information, Focusing on the thing affected (passive voice) - selecting focus (left structure) taking the focus off the subject (impersonal 'it' etc.) – Introducing something new (with 'there') - focusing on information using adjuncts.	

TEXT BOOKS:

1. Crystal, David. 1985, Rediscover Grammar with David Crystal. Longman
2. Bakshi, R. N. A Course in English Grammar. Orient Longman
Close, R. A. Reference Grammar for Students of English. Orient Longman

3. Krishnaswamy, N. Modern English – A Book of Grammar, Usage & Composition. Macmillan India Ltd.
4. Aroor, Usha (Ed.) WordMaster Learner's Dictionary of Modern English. Orient Longman 17
5. Hewings, M. 1999, Advanced English Grammar. Cambridge University Press
6. Basic communication skills for technology, Andreja J. Ruther Ford, 2nd Edition, Pearson Education, 2011.
7. Communication Skills, Sanjay Kumar, Pushpalata, 1st Edition, Oxford Press, 2011.
8. Brilliant – Communication Skills, Gill Hasson, 1st Edition, Pearson Life, 2011.
9. Soft Skill and Professional Communication, Francis Peters SJ, 1st Edition, Mc GrawHill Education, 2011.

SEMESTER	II					
YEAR	I					
COURSE CODE	20MB1201					
TITLE OF THE COURSE	MICROBIAL PHYSIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- The major features of growth and metabolism of microorganisms including determination of growth with environmental influence on the microbial growth and primary and secondary metabolism.
- Energy source for microorganisms and relationship between metabolism and energy source.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To understand the complexity of microbial structures, and metabolism	L3
CO2	Enable to grasp the mechanisms the microbial transport systems and the modes and mechanisms of energy conservation	L3

COURSE CONTENT:

MODULE 1

12Hrs

ENZYMOLGY

Introduction, properties, nomenclature and classification, specificity, active sites, coenzymes, activators and inhibitors, activity unit-prosthetic groups and Isozymes. Effect of temperature, pH and substrate concentration on reaction rate. Enzyme kinetics: Michaelis-Menten equation for simple enzymes, Regulation of enzymes -Covalent and noncovalent modification; Enzyme inhibition - types of inhibitors – competitive non-competitive and uncompetitive. Ribozymes and abzyme.

MODULE 2

12Hrs

MICROBIAL METABOLISM

Primary metabolism: Breakdown of carbohydrates – Glycolytic pathways, HMP shunt/pentose phosphate pathway and ED. TCA and Electron transport chain TCA: Substrate and oxidative phosphorylation. Transamination, oxidative deamination, decarboxylation, Urea cycle. Fermentation: Anaerobic respiration, Fermentative modes in microorganisms – alcoholic, Lactic acid – hetero and homo and Acetic acid. Secondary metabolism: Overview and importance

of secondary metabolites - antibiotics, aflatoxins, carotenoids	
MODULE 3	12Hrs
PHOTOSYNTHESIS AND BIOENERGETICS Bacterial photosynthesis: Photosynthetic micro-organisms photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation (purple and green bacteria), Carbon dioxide fixation pathways. Chemoautotrophy oxidation of inorganic compounds – Nitrate and sulphate. Bioenergetics: Free energy, ATP, NAD, FAD, FMN and its production, other high energy compounds, Oxidation – Reduction reactions. Electron transport chains in some anaerobic bacteria.	
MODULE 4	12Hrs
MICROBIAL CELL MEMBRANE PHYSIOLOGY Metabolite transport: Structure of biological membranes, Function of membrane proteins, solute transport across cell membranes (osmosis), regulation of ion concentrations (Hypotonic, Hypertonic and Isotonic solution), Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion - PTS, and role of permeases in transport Stress physiology: Osmotic stress and osmoregulation, Oxidative stress – superoxide dismutase and catalase, pH stress and acid tolerance, Thermal stress and heat shock response, Nutrient stress and starvation stress	

TEXT BOOKS:

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atherly, A.G., Girton, J.R. and Mc Donald, J.F. 1999. The Science of Genetics. Diane Pub. Co.
3. Boyer, R.F. 2003. Modern Experimental Biochemistry. Third Edition. Pearson Education.
4. Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
5. David, W. 2000. Physiology and Biochemistry of Prokaryotes. Second Edition. Oxford University Press.
6. Griffin, D.H. 1993. Fungal Physiology. Second Edition. Wiley Liss- A John Willy Sons, Inc, Publication. USA. p: 1-458.
7. Moat, A.G. and Froster, S.W. 2002. Microbial Physiology. Fourth Edition. John Wiley and Sons, New York.
8. Nelson David L. and Cox Michael M. 2007. Lehninger - Principles of Biochemistry. Fourth edition. MacMillan Press/Worth Publishers, New Delhi
9. Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York.
10. Stickberger, M.W. 2012. Genetics, Prentice Hall of India Private Limited, New Delhi.
11. Voet, D. and Voet, J.G. 2010. Biochemistry. John Wiley and Sons, New York.
12. Wilson, K., and Walker, J. 2010. Principles and Techniques of Biochemistry and Molecular Biology. 7th edition. Cambridge University Press.

SEMESTER	II					
YEAR	I					
COURSE CODE	20BC1201					
TITLE OF THE COURSE	BIOANALYTICAL TECHNIQUES					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To create general understanding about theoretical concepts of techniques used to detect and assay biomolecules.
- To familiarize the students with basic concepts and principles of biophysical and biochemical techniques used in biological sciences.
- To give holistic view for understanding the screening, isolation, separation and characterization of molecules.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be scientifically equipped with understanding of the about the different biomolecules and their important functions.	L3
CO2	Student will be aware of the analytical tools and their instrumentation used in biotechnology/biological sciences.	L3
CO3	Students will have a basic understanding of biomedical equipments	L4
CO4	Students will be empowered for better prospects leading to project design and execution.	L3

COURSE CONTENT:	
MODULE 1	
12Hrs	
Spectroscopy: Wave particle duality, the concepts of electromagnetic spectrum, Concepts of Absorbance and Emission Spectroscopy, Beer-Lambert's law, application and its limitations. Extinction coefficient, Concepts of chromophore/auxochrome and Chromic shifts. Principle, schematics and applications of Colourimeter and UV-Vis Spectroscopy. Assay of biomolecules (Carbohydrates and Proteins). Principle, schematics and application of Luminometry, Tubidometry, Klett Photometry, Flame photometry and IR spectroscopy.	
MODULE 2	
12Hrs	
Chromatography History and principle of Chromatography. Distribution/partition coefficient, Absorption and Adsorption phenomenon, Retention factor (R _f & R _t concepts). Types: Planar and columnar, S-L, L-L, G-S, G-L and G-G. Paper and thin layer chromatography, types and their application	

in separation of biomolecules. Plate theory and Rate of theory; resolution, selectivity and effectiveness of columns, Types of matrices used, separation of biomolecules using gel permeation, ion exchange, affinity and adsorption chromatography with applications. Brief idea about High Performance Liquid Chromatography (HPLC) and Gas Chromatography (GC).	
MODULE 3	12Hrs
Electrophoresis: Migration of ions in electric field, Factors affecting electrophoretic mobility. Paper electrophoresis, Cellulose acetate electrophoresis, High voltage electrophoresis and their Applications. Gel electrophoresis - Types of gels, Procedure, for gel making. Detection, Recovery & characterization of macromolecules (molecular weight determination and subunit enumeration). Principle and application of Poly acrylamide Gel Electrophoresis (PAGE), Iso-electric focussing (IEF) and 2D-PAGE, Submerged agarose gel electrophoresis (SAGE). Application of electrophoresis in molecular biology (genomics, transcriptomics and proteomics).	
MODULE 4	12Hrs
Isotopic tracer technique: Radioactive & stable isotopes, Pattern and rate of radioactive decay. Measurement of radioactivity: Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique), Autoradiography their advantages and limitations. Centrifugation: Basic principles, RCF, Svedberg constant and Sedimentation coefficient. Preparative centrifugation: Differential & density gradient centrifugation, Applications. Analytical centrifugation: Determination of molecular weight of biomolecules. Immunological techniques: Immuno-diffusion, immuno-electrophoresis and immuno-fluorescence.	

TEXT BOOKS:

1. Principles and Techniques of Practical Biochemistry – Keith Wilson and John Walker. Cambridge low price edition.
2. Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications.

REFERENCES:

1. Analytical Techniques in Biochemistry and Molecular biology – Katoch. Springer.
2. Fundamentals of Analytical Chemistry - Skoog, Holler and West. Saunders.
3. Handbook of Analytical Techniques – Gunzler and Williams. Wiley & Sons.
4. Immunology – Kuby. Freeman Publishers.
5. A Textbook of Practical Biochemistry- Joshi and Saraswat. Jain Publishers.

SEMESTER	II					
YEAR	I					
COURSE CODE	20GN1201					
TITLE OF THE COURSE	FUNDAMENTALS OF CYTOGENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Understand the characteristics of chromosome and its related anomalies.
- Elucidation on the versatility of the chromosomes and its different interactions.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will learn details on chromosomes, its conformations to bring about genetic variability.	L2
CO2	The students will get insight on chromosome abnormality which leads to cytogenetic aberrations and disease.	L3

COURSE CONTENT:	
MODULE 1 CHROMSOME CHARACTERISTICS	12Hrs
Physical basis of inheritance: chromosome theory of inheritance, Eukaryotic Chromosome- Macro- molecular organization. Primary and Secondary constriction, Sat-bodies, telomeres, chromosome types. Heterochromatin and Euchromatin and its significance. Ultra structure of chromosome, Nucleosome model and Nucleosome Structure. Karyotype and Ideogram. Special types of chromosomes: Polytene chromosome- Salivary gland chromosome in Drosophila, Lamp- brush chromosome in amphibian Oocyte, B Chromosome.	
MODULE 2 LINKAGE	12Hrs
Introduction and definition of Linkage, Discovery of linkage, Coupling and Repulsion hypothesis, Linkage group- Drosophila, maize and man, Types of linkage-complete linkage and incomplete linkage, Factors affecting linkage - distance between genes, age, temperature, radiation, sex, chemicals, nutrition, etc. Sex Linkage: Meiotic behavior of chromosome and non- disjunction. Bridges theories of non-disjunction. Sex linkage in Drosophila.	
MODULE 3 CROSSING OVER	12Hrs
Crossing over- definition and types of crossing over-germinal and somatic crossing over. Cytological basis of crossing over- Sterns experiments in Drosophila. Mechanism of crossing over - chiasma type theory, the breakage first theory, the	

contact first theory, strain or torsion theory. Molecular mechanism of crossing over- Holliday model, single strand breaks.	
MODULE 4 CHROMOSOMAL ABERRATIONS	12Hrs
Numerical- Euploidy (Monoploidy, Haploidy and Polyploidy). Polyploidy- Autopolyploidy and Allopolyploidy. Aneuploidy- Monosomes, Nullisomes and Trisomes. Structural- Deletions, Duplication, Translocation, Inversions, Centric fusion and centric fission. Evolutionary significance of chromosomal aberrations. Genetic diseases and disorders.	

TEXT BOOK:

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Strickberger M. W., Genetics. (1968) Macmillan Publishers.

REFERENCES:

1. Gupta P. K. 2009. Cytology, Genetics and Molecular Biology. Rastogi Publications.
2. Winter P. C., Hickey G. I. & Fletcher H. L. 2003. Instant notes in Genetics. Viva Books Pvt.Ltd.
3. Weaver R. F., Hendrick P. W. and Brown W.C. 1992. Genetics, 2nd Edition.
4. Sinha U., Sunita and Sunita Sinha.1981 Cytogenetics: Plant Breeding and evolution. Vikas publishing House.
5. Snustad D. P. and Simmons M. J. 2009. Principles of Genetics. John Wiley and Sons, INC.
6. Phundan Singh. 2013. Elements of Genetics, Edition 4, Kalyani Publishers.
7. Edgar Altenburg. 1970. Genetics. Oxford & IBH Publications.
8. Gardener E. J., Simmons M. J. and Snustad D. P. 1998. Principles of Genetics J. Wiley and Sons pubs.
9. Obe. G. and Natarajan A.T. 1990 Chromosomal Aberrations: Basic and Applied aspects Springer Verlag, Berlin.

SEMESTER	II					
YEAR	I					
COURSE CODE	20BS1201					
TITLE OF THE COURSE	BIOINFORMATICS AND BIOSTATISTICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To create general interest in applied domain towards using computers for biological applications.
- To familiarize the students with basic concepts and principles statistics and their applications in biological sciences.
- To give holistic view for understanding the scientific validation and biomodelling.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be aware of various applied and allied scientifically domains to innovative and creative think.	L2
CO2	Student will be aware of the computer tools and applications which can be implemented in biological sciences.	L2
CO3	Students will be empowered for better prospects leading to project design and execution.	L3

COURSE CONTENT:

MODULE 1		12Hrs
Introduction to computers: History of Computers, Components of computers (Hardware, Software and accessories). Concepts on Computer software, operating system (Windows), tools and applications of MS Office (notepad, word processor, spread sheet & presentation). Introduction to networks: LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls. Concepts on encryption of data. Relational Databases Management (RDMS): Codd Rules and concepts of databases, Data mining and applications, accessing bibliographic databases and Basics on citation and indexing (Pub Med and Google scholar).		
MODULE 2		12Hrs
Bioinformatics (Genomics): Nucleic acid sequence databank – NCBI, EMBL and DDBJ. Microbial genomic database		

(MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER. Gene Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs.	
MODULE 3	12Hrs
Bioinformatics (Proteomics): Introduction to protein structure – Primary, secondary structure prediction, tertiary structure prediction. Concepts on Protein Data Bank (PDB). Protein Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of proteins, domain and motif and Phylogenetic analysis. Protein sequence databank – NBRF-PIR, SWISSPROT and Swiss ExPASy. Metabolic pathway data bank (KEGG/Pub gene). Protein modeling - principles of homology and comparative modeling phylogenetics. Applications - Molecular docking – Patchdoc /Autodoc.	
MODULE 4	12Hrs
Biostatistics: Introduction to Biostatistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error. Sampling methods and their significance. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Statistical package - Features of statistical software. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases.	

TEXT BOOKS:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Bioinformatics. Keith, J. Humana Press, 2008.
4. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.

REFERENCES:

1. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists.
2. Bazin, M.J. (1983). Mathematics in microbiology Academic press.
3. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
4. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge.
5. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.
6. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
7. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series.
8. Higgins & Taylor (2000). Bioinformatics, OUP.
9. Baxavanis (1998). Bioinformatics.
10. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford

SEMESTER	II					
YEAR	I					
COURSE CODE	20MB1271					
TITLE OF THE COURSE	MICROBIAL PHYSIOLOGY - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	4	-	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To make students learn quantitative and qualitative methods for study of biomolecules in microbiology lab

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be equipped with coloured based changes given out by microbial tests	L2

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Starch hydrolysis
2. Gelatin hydrolysis
3. Catalase test
4. Sugar/Triple fermentation test
5. Nitrate reduction test
6. H ₂ S production test
7. IMViC test
8. Oxidase test
9. Isolation of antibiotics resistant mutant by gradient plate technique
10. Demonstration of replica plating method for selection of antibiotic resistant mutants

REFERENCES:

- Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
- Boyer, R.F. 2003. Modern Experimental Biochemistry. Third Edition. Pearson Education.
- Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
- David, W. 2000. Physiology and Biochemistry of Prokaryotes. Second Edition. Oxford University Press.
- Griffin, D.H. 1993. Fungal Physiology. Second Edition. Wiley Liss- A John Wiley Sons, Inc, Publication. USA. p: 1-458.
- Moat, A.G. and Froster, S.W. 2002. Microbial Physiology. Fourth Edition. John Wiley And Sons, New York.

SEMESTER	II					
YEAR	I					
COURSE CODE	20BC1271					
TITLE OF THE COURSE	BIOANALYTICAL SEPARATIONS -LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
		0	4	0	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To make students learn quantitative and qualitative methods for study of biomolecules.
- To provide hands-on training to physico-chemical methods.
- To give insights on isolation, separation and characterization of biomolecules.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be equipped with methodology to study biomolecules using spectroscopic, electrophoretic and chromatographic techniques.	L2
CO2	Students will have a complete understanding on methods to analyse biomolecules.	L3
CO3	Students will be empowered for better prospects leading to project design and execution.	L4

EXPERIMENTS/PRACTICAL:
1. Determination of extinction coefficient using colorimetry.
2. Determination of lambda maximum of biomolecules using UV spectroscopy.
3. Estimation of protein by Lowry method or Estimation of sugar by Miller method.
4. Estimation of pKa of amino acid (glycine).
5. Determination of density & viscosity of given unknown solution.
6. Circular Paper chromatography for amino acid/ sugars and Rf calculations.
7. Separation of amino acid by Thin Layer Chromatography (TLC).
8. Column chromatography of phyto-pigments on adsorbent (silica/alumina).

TEXT BOOKS:

1. Principles and Techniques of Practical Biochemistry – Keith Wilson and John Walker. Cambridge low price edition.
2. Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications.
3. Analytical Techniques in Biochemistry and Molecular biology – Katoch. Springer.
4. Fundamentals of Analytical Chemistry - Skoog, Holler and West. Saunders.

5. Handbook of Analytical Techniques - Gunzler and Williams. Wiley & Sons.
6. A Textbook of Practical Biochemistry- Joshi and Saraswat. Jain Publishers.

SEMESTER	II					
YEAR	I					
COURSE CODE	20GN1271					
TITLE OF THE COURSE	FUNDAMENTALS OF CYTOGENETICS - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	0	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Identifying chromosome features and their status in animal and plants.
- Analyse linkage and crossing over problems by mapping method.
- Understanding cytogenetics using Drosophila as a model organism

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The student will gain skill to prepare and visualise chromosomal slides from various sources.	L3
CO2	Students can solve genetic linkage analysis by construction of cytogenetic maps on linkage. Gene interactions, predict crosses and understand its role in inheritance.	L4
CO3	Students will become skilled in handling and maintaining Drosophila cultures.	L2

List of Laboratory/Practical Experiments activities to be conducted (if any):
1. Micronuclei from buccal cell (H&E basic staining)
2. Preparation of Metaphase spreads from blood for Karyotyping.
3. Genetic Problems on linkage & crossing over - Drosophila, Maize, Human (Sex Linkage)
4. Study of chromosomal aberration using karyotype information by observation of permanent slides of chromosomal aberrations. Cytogenetics using Drosophila as a model organism.
5. Culturing and Handling of Drosophila - Media preparation, Handling drosophila.
6. Study of different types of Drosophila- Body color mutant- Ebony body and Yellow body, Wing mutant- Curly wing and vestigial wing and Eye color mutant- Bar eye, white eye, sepia eye.
7. Mounting of Sex Comb and Genital plate of Drosophila melanogaster
8. Salivary gland Chromosome - Dissection of Salivary glands and preparation of polytene chromosome.

REFERENCES

1. *Drosophila* Cytogenetics Protocols, Methods in Molecular Biology, Volume 247, Daryl S Henderson, Humana Press.
2. The AGT Cytogenetics Laboratory Manual, Marilyn S Arsham, Margaret J , March , Helen J Lawce, Fourth Edition, Wiley Blackwell.

SEMESTER	II					
YEAR	I					
COURSE CODE	20BS1202					
TITLE OF THE COURSE	COMPUTER APPLICATIONS AND INFORMATION TECHNOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	24	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To create general interest in applied domain towards using computers for biological applications.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be aware of the computer tools and applications which can be implemented in biological sciences.	L2
CO2	Students will be empowered for better prospects leading to project design and execution.	L2

COURSE CONTENT:

MODULE 1 History and Generations of Computers **4Hrs**

Evolution, Generations of computers (I, II, III, IV, V) Classification of computers (mainframes, mini computers, microcomputers, special purpose) Comparison with respect to memory, power, cost and size, Real-Time, Online, Offline, Overview and functions of a computer systems, Input and output devices, Storage devices: Hard disk, Diskette, Magnetic tape, RAID, ZIP, devices, Digital tape, CD-ROM, DVD (capacity and access time), Main Circuit Board of a PC: Chips, Ports, Expansion.

MODULE 2 Categories of Computers and Operating Systems **4Hrs**

The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer & the Super Computer, Operating System concepts, Windows 98/XP and later versions, Windows server NT/2000, Unix/Linux & servers. Introduction to networking: various terminologies, Associated hardware devices, gadgets (Router, Switch) tools, services, and resources, Network Topologies and Protocols, LAN, WAN and MAN World Wide Web (WWW) Network security: fire walls.

MODULE 3 **8Hrs**

Data processing & presentation: Introduction, Office Automation Software (Open Source Software).

Computer viruses and Internet Searches: An overview of Computer viruses, What is a virus? Virus symptoms, How do they get transmitted? What are the dangers? General Precautions, Search engines: Google, Yahoo, Concepts in text-based searching, searching Medline, PubMed, and bibliographic databases.

MODULE 4 Algorithms, Flowcharts, Programming concepts & Bioinformatics	8Hrs

Algorithms: Concepts & definitions, converting algorithms to flowchart; Coding: flowcharts to programs, Comparing algorithms, flowcharts & programs; Introduction & Overview of Biological databases. Introduction to Bio-informatics: Definition, Introduction to data mining, Computational gene finding – multiple alignment and sequence search (BLAST, FASTA, CLUSTALW). Applications of Bioinformatics.

REFERENCES:

1. Computer Fundamentals, 4th edition (2004) P.K. Sinha, BPB publication, India
2. Computer Networks. 4th edition (2008). Tanenbaum. Pearson Education, India
3. Biostatistics: P.N. Arora, P.K. Malha.
4. Introduction to Database Management Systems, 1st edition, (2004), Atul Kahate, Pearson education, India.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MB2301					
TITLE OF THE COURSE	IMMUNOLOGY AND MEDICAL MICROBIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Demonstrate an understanding at an advanced level of microbial virulence mechanisms and host response to infection.
- To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To introduce and describe the classification, structure, classification and physiology of bacteria that infect humans	L3
CO2	To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories. To learn about the use of antibiotics and resistant mechanisms encoded in bacteria to neutralise these chemical agents	L3

COURSE CONTENT:

MODULE 1 : ELEMENTS OF IMMUNE SYSTEM

12Hrs

History and scope of immunology, Definition and types of immunity (innate and adaptive). Structure, Functions and Properties of: Immune Cells (Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell and Dendritic cell) and Immune Organs– Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT and CALT. Immune responses- Primary and Secondary Immune Response, Humoral and cell mediated immunity. Complement system – Components, function and activation pathways, Major Histocompatibility Complex.

MODULE 2 : ANTIGENS AND ANTIBODIES

12Hrs

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity), Types, Haptens, Super antigens, Epitopes (T & B cell epitopes), Structure of T-cell and B-cell receptors. Structures of antigen presenting cell. Cluster of differentiation and Co-stimulatory signals and its role T-dependent and T-independent antigens, Adjuvants. Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic). Hypersensitivity reactions (Definition and types).

Immunoglobulin family and class switch mechanism.

MODULE 3 : IMMUNOLOGICAL DISORDERS AND TECHNIQUES **12Hrs**

Clonal selection theory of antibody production; Production and application of Monoclonal antibodies. Autoimmune disorders (Type-1 diabetics and Myasthenia gravis,) Transplantation immunology – Graft, types and rejection of graft. Brief concept of cancer immunology. **Immunological techniques:** Types and Principles of Ag-Ab reactions - Precipitation, Agglutination, Complement fixation and its applications. Immunodiffusion, Immunoelectrophoresis, ELISA, RIA, Immunofluorescence, Flow cytometry and Immunoelectron microscopy.

MODULE 4 : MEDICAL MICROBIOLOGY **12Hrs**

Normal flora of skin, oral cavity and other body regions. Relationship between normal pathogens and host. Terminologies- Pathogenicity, Virulence, Invasion, Toxins: Exotoxins, Enterotoxins and Endotoxins.

Epidemiology, etiology, pathogenesis and prophylaxis of the following:

Bacteria–*Salmonella typhi* and *Mycobacterium tuberculosis*. **Fungi**–*Tricophyton spp.* And *Candida albicans*. **Viruses** –Hepatitis and HIV. **Protozoa** – *Leishmania donovani* and *Entamoeba histolytica*. Antibiotics and their mode of action – Antibacterial, Antifungal, antiviral and antiprotozoal agents. Mechanism of drug resistance. Methods of testing drug sensitivity (Kirby Bauer method, Minimum Inhibitory Concentration). **Immunoprophylaxis**- Vaccines and its types. Immunization schedule and its significance.

TEXT BOOKS:

1. Anathnarayana and Panikar (2013) Text Book of Microbiology, 9th Edition. University press.
2. Richard A, Goldsby, Thomas J, Kindt, Barbara A and Osborne (2000). Kuby Immunology. 4th Edition. W.H. Freeman and Company, New York.
3. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York.
4. Warren Levinson (2000) Medical Microbiology and Immunology, Examination and Board Review. 8th Edition. McGraw Hill.
5. Tortora, Funke, Case (2009) Microbiology, 9th Edition. Benjamin Cummings.
6. Connie R Mahon (2010) Text book of diagnostic Microbiology. 3rd edition, Pearson.
7. Fritz H Kayser (2005) Medical microbiology. ThiemeVerlag.
8. Mackie and McCarthey (1996) Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchill Livingstone.
9. Frank and Steven A (2002) Immunology and evolution of Infectious Diseases. Princeton University Press.
10. Wadher and Bhoosreddy (2005) Manual of Diagnostic Microbiology. Himalaya Publisher.
11. Kufe (2003) Cancer Medicine. BC Decker Inc.
12. Leslic Collier, John Oxford (2000) Human virology a text book for students of medicine, dentistry and microbiology. 2nd edition. Oxford university press.
13. Jenson, Wright robinson (1997) Microbiology vol 1, Microbial Infection vol 2, Practical Medical Microbiology, Churchill living stone.
14. Credric, A Mims (2004) Medical Microbiology, 3rd Edition. Mohshy Inc.
15. Nester Roberts Pearsall Anderson (1997) Microbiology- a human perspective, 2nd Edition, McGraw-Hill.

SEMESTER	III					
YEAR	II					
COURSE CODE	20BC2301					
TITLE OF THE COURSE	HUMAN PHYSIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I/I	20BC1101	BASIC BIOCHEMISTRY

COURSE OBJECTIVES:

1. To illustrate the general human physiology in terms of nutrition and energy synthesis.
2. To have an insight into the cellular to organ level differentiation and their related biochemical concepts

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The student will understand the mechanism of action of the energy generation machinery and the organs associated with it.	L2 & L3
CO2	The cell to organ system to organism architecture will be better understood.	L4

COURSE CONTENT:

MODULE 1		12Hrs
Nutrition: Basic principles of a balanced diet to provide energy and nutrients. Respiratory quotient, BMR, SDA and factors affecting them. Role of carbohydrates, protein, lipid and as fuel molecules. Hematology: Blood components and their functions, blood groups: the ABO system. role of hemoglobin in oxygen transport. Various buffer systems of the blood, acid base balance, factors affecting acid-base balance. Respiration: Components of respiratory system: nasal cavity, trachea, pharynx, lungs, bronchi, bronchioles and alveoli and their functions.		
MODULE 2		12Hrs
Biochemistry Cardiovascular System: Basic anatomy of the heart, Physiology of heart, blood vessels and circulation. Basic understanding of Cardiac cycle. Blood pressure and its regulation. Brief outline of cardiovascular disorder (hypertension, arteriosclerosis, myocardial infarction and congestive heart failure. Skeletal system: Tissues - introduction. Extracellular matrix and its components, Bone-ultra structure, composition, cells: osteoblasts, osteocytes and osteoclasts. Bone growth, remodeling and regulation by hormones Muscle: Types – smooth, striated and cardiac. Contractile and regulatory proteins of		

muscle structure of actin and myosin. The sarcomere, sliding filament model of skeletal muscle contraction. Brief idea of contraction of smooth muscles.	
MODULE 3	12Hrs
Digestion: Anatomy of GIT and accessory organs, Regulation of GIT movement, Digestion, absorption and transport of carbohydrates, lipids and proteins. Excretion: Structure of nephron in brief, mechanism of urine formation: Glomerular filtration, Tubular re-absorption & Active secretion, Regulation of acid–base balance by the kidney, Acidosis and alkalosis. Reproduction: Brief account of histological structure of ovary & testis. Structure & functions of male & female sex hormones. Menstrual Cycle.	
MODULE 4	12Hrs
Neurobiology: Structure of Neurons, Physiological properties of Nerve fibers, Detailed account of impulse generation, Membrane potential, development, depolarization and repolarization. Transmission of impulse in myelinated and nonmyelinated nerve fibers. Nernst's and Goldman Equation, Nernst's potential. Synapse and mechanism of synaptic transmission: Cholinergic and adrenergic transmission, Functions of acetyl choline, GABA, dopamine and glutamate as neurotransmitters.	

TEXT BOOKS:

1. Textbook of Medical Physiology – Guyton and Hall. Elsevier.
2. Human Physiology – Chatterjee. Sapna Publishers.
3. Fundamentals of Biochemistry - Deb. Central Publishers.
4. Medical Biochemistry – Chatterjee and Shindey.
5. Biochemistry – Das. Central Publishers.
6. Biochemistry –Jain. Himalaya Publications.
7. Principles of Nutrition – Swaminathan. Himalaya Publications.
8. Laboratory Manual for Practical Biochemistry –Hemavathi, Shivraja and Ganesh. Jaypee Publishers.

SEMESTER	III					
YEAR	II					
COURSE CODE	20GN2301					
TITLE OF THE COURSE	BASIC HUMAN GENETICS AND GENETIC ENGINEERING					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To provide students with basic principles of human genetic engineering including the techniques, applications and limitations.
- To demonstrate the ability to design recombinant molecules and apply information extracted from a variety of sources including journal articles, technical bulletins, product manuals, and drug information sheet to solve problems.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will have knowledge of tools and strategies used in genetic engineering.	L3
CO2	Understanding of applications of recombinant DNA technology and genetics	L4

COURSE CONTENT:	
MODULE 1 HUMAN CHROMOSOMES, INHERITANCE	14Hrs
Human Chromosomes: Normal Human Karyotype: Paris Nomenclature, karyotyping (Quantification of DNA of individual chromosomes), Pedigree studies: Symbols used in pedigree studies, Pedigree analysis & construction, Pedigree analysis for the inheritance pattern of genetic diseases.	
MODULE 2 GENETIC DISEASES AND INHERITANCE PATTERN	5Hrs
Autosomal Dominant Inheritance (Ex.- Adult polycystic kidney, Achondroplasia and Neurofibromatosis). Autosomal Recessive Inheritance (Ex.- Albinism, Sickle cell anemia, Phenylketonuria). X-linked Recessive Inheritance (Ex.- Duchenne muscular dystrophy-DMD). X-linked Dominant Inheritance (Ex.- Xg blood group). Y-linked inheritance (Holandric gene Ex.- Testes determining factor - TDF). Multi-factorial inheritance (Ex.-Congenital malformations- Cleft lip and palate, Rheumatoid arthritis and Diabetes). Mitochondrial diseases (Ex.- Leber's hereditary optic neuropathy).	
MODULE 3 INTRODUCTION TO rDNA TECHNOLOGY	14Hrs
History and fundamentals of r-DNA technology, Tools for r-DNA technology. Molecular	

tools for gene cloning: Nucleases -Endo and Exonucleases – Nomenclature, Types and characteristic features. Modification of cut ends. DNA ligases and DNA Recombinases. DNA Modifying Enzymes - Alkaline phosphatase, Polynucleotide kinase, Klenow fragment, terminal nucleotidyl transferase.

MODULE 4 VEHICLES FOR CLONING

15Hrs

Properties of an ideal vector. Types: Cloning and expression vectors. Cloning vectors: Prokaryotic vectors: Plasmids- pBR322; pUC18; Bacteriophages -Lambda phage, Cosmids. Eukaryotic vectors: YAC vectors; Shuttle vectors- Yeast and E. coli. For higher plants: Integrative DNA transfer- Agrobacterium vectors-Ti plasmid-Binary and Co integrated vectors; Non integrative DNA transfer-Plant viral vectors (CaMV).

REFERENCES:

1. Nicholl D. S. T. An introduction to Genetic engineering (2nd ED), Cambridge University Press, 2002.
2. Satyanarayana U. Biotechnology, Books and Allied (P) Ltd., Kolkata, 2008.
3. Purohit S. S. Biotechnology Fundamentals and applications, student Edition, Jodhpur, 2003.
4. Sandhya M. Genetic engineering: Principles and practice, MacMillan. India Ltd. 2008.
5. Channarayappa. Molecular Biotechnology- Principles and practices, University press (India) Private Limited, 2006.

SEMESTER	III					
YEAR	II					
COURSE CODE	20BS2301					
TITLE OF THE COURSE	MOLECULAR BIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Understand the general principles of central dogma, DNA and RNA types structure and their role in cells.
- Explain the mechanisms of DNA replication, RNA synthesis and repair, various levels of gene expression, regulation and protein function.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Know the importance of recent discoveries and the applications and potential of molecular biology with these technologies.	L1
CO2	Student will gain understanding of chemical and molecular processes that occur in and between cell.	L2

COURSE CONTENT:

MODULE 1 THE MOLECULAR BASIS OF LIFE		12Hrs
Central dogma, DNA and RNA as genetic material – experimental proof. Evidences for DNA as the genetic material- Griffith's transformation experiment, Hershey and Chase experiment, evidence for RNA as the genetic material of viruses (TMV, Retroviruses). Nucleic acids: DNA structure and types (A, B and Z model), Denaturation and renaturation kinetics of DNA, Types of RNA – mRNA, tRNA and rRNA, mi RNA and siRNA.		
MODULE 2 DNA REPLICATION AND ITS COMPONENTS		12Hrs
Replication of DNA (Conservative, Dispersive and Semi Conservative DNA replication, Meselson and Stahl experiment), theta and rolling circle model of replication. Prokaryotic and Eukaryotic – Enzymes and proteins involved in replication.		
MODULE 3 DNA TRANSCRIPTION AND ITS COMPONENTS		12Hrs
RNA polymerases, Mechanism of transcription – initiation, elongation and termination in prokaryotes and eukaryotes. Post-transcriptional modifications of Eukaryotic mRNA (Poly A tailing, 5' capping and splicing mechanisms)		
MODULE 4 TRANSLATION AND REGULATION OF GENE EXPRESSION		12Hrs
Genetic code, wobble hypothesis, Mechanism of translation in prokaryotes and eukaryotes,		

Post translational modification of Proteins. Regulation of Gene expression in Prokaryotes – Operon concepts, induction, repression, attenuation, examples of Lac and Trp operons. Regulation of Gene expression in Eukaryotes –galactose metabolism in yeast.

TEXT BOOKS:

1. Cell & Molecular Biology by Gerald Karp, 3rd Edition, John Wiley & Sons (2009)
2. Molecular Biology of the Gene by James Watson et al, Pearson Education (2013)
3. Molecular Biology of the Cell, Bruce Alberts et al, Garland Science Publication (2007)
4. Principles of Biochemistry by Nelson and Cox, WH Freeman Publications (2008)
5. Textbook of Cell and Molecular Biology by Ajoy Paul, Books and Allied Ltd (2011).
6. Molecular Biology and Genetic Engineering by P K Gupta, Deep and Deep Publications (2008).
7. Cell Biology, Genetics, Molecular Biology, evolution and Ecology by PS Verma and VK Agarwal, S. Chand Publications (2006).

SEMESTER	III					
YEAR	II					
COURSE CODE	20MB2371					
TITLE OF THE COURSE	IMMUNOLOGY AND MEDICAL MICROBIOLOGY - LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	4	-	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories.	L3

List of Laboratory/Practical Experiments activities to be conducted (if any) :	
1.	Identification of different types of blood cells
2.	Precipitation reactions: a. Ouchterlony Double Diffusion b. Radial Immune Diffusion
3.	Agglutination Reaction: a. Blood grouping and Rh typing
4.	Isolation of normal microflora from skin and oral cavity
5.	Snyder's test for dental caries detection
6.	Antibiotic sensitivity test
7.	Dot ELISA
8.	Determination of effectiveness of antiseptics by thumb impression method.

REFERENCES:

- Balakrishnan, Senthilkumar & Karthik, Kaliaperumal & Duraisamy, Senbagam. (2015). Practical Immunology- A Laboratory Manual. 10.13140/RG.2.1.4075.4728.
- Hay, F.C., Westwood, O.M.R., 2002. Practical Immunology, 4th edition. ed. Wiley-Blackwell, Malden, MA.
- Lab Manual in Biochemistry, Immunology and Biotechnology by Nigam, Arti - AbeBooks." McGraw-Hill Education (India) (2008)
- Pharmaceutical Biotechnology by S.P.Vyas & V.K.Dixit. CBS Publishers & Distributors, New Delhi.
- Maheshwari, D. K. (2002). *Practical Microbiology*. S. Chand Publishing.

SEMESTER	III					
YEAR	II					
COURSE CODE	20BC2371					
TITLE OF THE COURSE	CLINICAL BIOCHEMISTRY -LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	0	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

1. To provide an advanced understanding and applied knowledge of clinical biochemistry using biological samples (Urine or Blood).

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to perform a range of diagnostic techniques relevant to the field of laboratory medicine.	L3

EXPERIMENTS/PRACTICALS:
1. Qualitative analysis of normal components of urine.
2. Qualitative analysis of abnormal components of urine.
3. Estimation of Glucose estimation by Miller's method /DNS method.
4. Protein/DNA by UV absorption spectroscopy.
5. Estimation of Protein by Folin - Ciocalteu method.
6. Estimation of Iron by Wong's method.
7. Estimation of Phosphate by Fiske – Subbarow's method.
8. Estimation of Creatinine by Jaffe's method.

TEXT BOOKS:

1. Practical Clinical Biochemistry, ed. Harold Varley, 4th edn. CBS Publishers (2088).
2. Practical Clinical Biochemistry: Methods and Interpretation, ed. Ranjna Chawla, Jaypee Brothers Medical Publishers (2096).
3. Practical and Clinical Biochemistry for Medical Students, ed. T.N. Pattabhiraman, Gajanna Publishers (2094).
4. Hawk's Physiological Chemistry, ed. Oser, 14th Edn. (2076), Tata-McGrawHill.
Biochemistry, ed. Plummer Tata-McGraw Hill, (2071).

SEMESTER	III					
YEAR	II					
COURSE CODE	20GN2371					
TITLE OF THE COURSE	BASIC HUMAN GENETICS AND GENETIC ENGINEERING-LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	0	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To prepare students for successful career in industry and research institutes.
- To develop the ability amongst the students to apply modern genetic engineering techniques in industry and research.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Proficient in preparing human chromosomes for karyotyping analysis.	L3
CO2	Describe gene cloning, restriction endonucleases, use modern gene technologies are used to elucidate genetic issues	L4
CO3	Critically analyse, evaluate and compile received results	L3

List of Laboratory/Practical Experiments activities to be conducted (if any):

1. Preparation of Human Metaphase Chromosomes
2. Identification of inactivated X chromosome as Barr body.
3. Resolution and molecular weight estimation of fragmented DNA using agarose gel electrophoresis.
4. Preparation of Pedigree chart of some common phenotypic characters of human.
5. Molecular cloning. Demonstrations: • Plasmid DNA isolation • Restriction Digestion • DNA ligation • Preparation of competent cells and Transformation.

REFERENCES

1. Jocelyn, E. K., Elliot, S. G., Stephen, T. K. (2009), Lewin's Gene X. Jones & Barlett.
2. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. (2014). Lewin's Genes XI. Jones and Bartlet India Pvt. Ltd.
3. Freshney, R.I. (2011). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley online library.
4. Primrose, S. B., and R. M. Twyman. Principles of gene manipulation and Genomics. Blackwell Publishing MA. USA. 2006.
5. Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz. Scientific American books. USA. 1983.

SEMESTER	III					
YEAR	II					
COURSE CODE	20BS2302					
TITLE OF THE COURSE	ENVIRONMENTAL SCIENCE					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	26	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- The course will offer extensive knowledge on environment and the impact it has on life.
- The course equally focusses on the importance of ecological balance.
- The programme is designed to evoke awareness amongst students who seek careers in the environment sector.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	With an understanding of environmental management, students will be able to solve deleterious impacts on the ecosystem.	L2
CO2	With a background on environmental science, graduates have bright career opportunities in wild life conservation, and other environment sectors.	L3

COURSE CONTENT:

MODULE 1 FOUNDATION ON ECOLOGY & ENVIRONMENT		10Hrs
Organizational level of ecological systems, Abiotic and biotic environment, limiting factors, adaptation, habitat and niche, concept of biosphere, population parameters, structure, growth regulation, interactions between populations, life history strategies (r and k species), the concept of carrying capacity. Structure and function of ecosystems, productivity, decomposition, energy flow, ecological efficiencies, global pattern of productivity, nutrient cycling (Carbon, Nitrogen and Phosphorus), major biomes of India and the world.		
MODULE 2 ENVIRONMENTAL BIOGEOCHEMISTRY		6Hrs
Structure and composition of the atmosphere, radiation budgets, general circulation of the atmosphere, prevailing and adiabatic lapse rates, air masses and fronts, monsoon, vertical profiles of major and trace gases, atmospheric photochemistry, reaction of nitrogen, oxygen, ozone, chlorides etc., properties of dust and aerosols in the atmosphere.		
MODULE 3 ENVIRONMENTAL POLLUTION		5Hrs
Types and major sources of air pollutants, effects of air pollutants on physico-chemical and		

biological properties surrounding atmosphere, air borne diseases and their effects on health. Types and major sources of water pollutants, effects of water pollutants on physicochemical and biological properties of water bodies, water borne diseases with special reference to water pollution. Types and major sources of soil pollutants, effects of soil pollutants on physico-chemical and biological properties of soil. Major sources of noise pollution, effects of noise pollution on health, noise level standard in industrial, commercial, residential and silence zones. Radioactive and thermal pollution sources and their effects on surrounding environment.

MODULE 4 ENVIRONMENTAL MANAGEMENT	5Hrs

Introduction and scope of environmental management, basic concepts of sustainable development, industrial ecology and recycling industry. Role of natural products and biodiversity in international trade, fundamentals of fossil fuels use, energy production and trade, energy balance and energy audit. Eco-marketing. Environmental Impact Assessment (EIA), general guidelines for the preparation of environmental impact statement (EIS).

REFERENCES

1. Ramesh Vijaya K. (2005). Environmental Microbiology. MGP Publishers, Chennai.
2. Edward Alcamo I. (2001). Fundamentals of Microbiology, Jones and Bartlett Publishers, INC. VI Edition.
3. Kumar H.D. (1995). General Ecology, I Ed. Vikas Publishing House Pvt. Ltd., NewDelhi.
4. Pepper W. (1995). Environmental Microbiology. A.P. Publishers.
5. William C. Frazier and Dennis C. Westhoff. (1995). Food Microbiology, Tata McGraw-Hill Publishing Company limited, New Delhi, IVth Edition.
6. Odum E.P. (1971). Fundamental Ecology, 5th Ed., Saunders.
7. Kormondy E.J. (1962). Concepts of Ecology, Prentice Hall. 8.Singh H.R. (1989). Animal Ecology and Environmental Biology. Nagin Chand & Co. Shoban Lal (1992). Ecology.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20MB2401					
TITLE OF THE COURSE	INDUSTRIAL, FOOD AND DAIRY MICROBIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To exhibit depth of knowledge by demonstrating microbial sciences in the field of applied fields of industrial, food and dairy microbiology.
- To relate microbes in interdisciplinary connections with other sciences, in particular to industrial productions, food sciences and dairy products.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	It will develop depth of understanding on fermentation technology, modern microbial techniques and analysis relating to industrial, food and dairy microbiology.	L3
CO2	It will develop problem solving capabilities in practical working in teams in laboratory-based virtual experiments to gather and evaluate microbial data using a range of current analysis techniques relating to productions, food sciences and dairy products.	L4

COURSE CONTENT:	
MODULE 1 : INTRODUCTION TO INDUSTRIAL MICROBIOLOGY	12Hrs
Concepts and scope of microbes in industry. Screening, isolation of industrially important microbes. Strain improvement - Mutation, recombination- gene regulation and genetic manipulation. Preservation: Industrially important microbes. Culture collection centers. Basic components and design of Typical fermenter. Types of fermenter-Laboratory, pilot-scale and production fermenters; constantly stirred tank fermenter, fluidized bed bioreactors and air-lift fermenter. Types of fermentation - Batch, Continuous, chemostat, Turbidostat, submerged and solid-state fermentation. Different parameters affecting fermentation.	
MODULE 2 : INDUSTRIAL BIOPROCESSING	12Hrs
Upstream Processing: Nutrients: growth factors, carbon, nitrogen, mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization; inoculum preparation and inoculum development. Downstream processing: Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption,	

Liquid extraction, Solvent recovery, chromatography, Membrane processes, Drying, Crystallization. Productions and Applications: Alcohol production, organic acids (citric acid), enzymes: amylases- (Fungal and Bacterial). Amino acid - L-Glutamic acid. Vaccines (Hepatitis B), hormones (human insulin), antibiotic (Penicillin). Applications of genetic engineering in industrial bioprocessing. Production economics and IPR.	
MODULE 3 : FOOD MICROBIOLOGY	12Hrs
Principles and methods of food preservation by Physical, Chemical and food Additives, Biopreservation. Microbial spoilage of food: Causes and sources of food spoilage. Food borne Infections and Intoxications. Bacteria – Clostridium. Virus- Hepatitis A, Sea toxicants; Mycotoxins (Aflatoxins, Ochratoxins,). Fermented foods (Fermented Vegetables, Beverages, Bread, and Idli). Single cell Protein, Probiotics, Prebiotics and Synbiotics; Nutraceuticals, Quorn). Food control Agencies: HACCP, Employees Health standards, GMP. Industrial effluents treatment, Criteria of microbiological quality control.	
MODULE 4 : DAIRY MICROBIOLOGY	12Hrs
Nutritional level and microbial flora of milk. Sterilization of milk; predominant types of microorganisms in chilled and refrigerated milk and their importance; heat resistant bacteria and their role in milk spoilage. Principles of quality control tests for milk; bacteriological grading. Microbiology of dairy products: Yogurt, acidophilus milk, fat rich products (Cream and butter) and cheese. Biosensors in Food Industry; Food fortification.	

TEXT BOOKS:

1. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
2. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2 nd Edition Aditya Books (P) Ltd, New Delhi.
3. Waites Michael J., Morgan Neil., Rockey John S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
4. McNeil B and Harvey LM. Fermentation. A Practical Approach, IRL press, New York.
5. Robert H (2006) Microbiology and Technology of Fermented Foods. Blackwell Publishers.
6. Matthew Rimmer (2008) Intellectual Property and Biotechnology: Biological Inventions Edward Elgar. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Limited, New Delhi.
7. Frazier and Wasthoff, Food Microbiology, Tata McGraw-Hill Publishing Company Limited.
8. Hammer B.W and Babal, Dairy Bacteriology, Prentice Hall Incorporated, London.
9. James M.J. Modern Food Microbiology, CBS Publishers and Distributors, Delhi. 1996
10. Mary E.T and Richard E. I. Microbial Food Safety Animal Agriculture: Current Topics, Iowa state University Press. 2003
11. Bibek R. Fundamentals of Food Microbiology. Bibek Ray. 2 nd Edition. CRC press. 2001.
12. Adams M.R. and Moss M.O. Food Microbiology. Royal Publishing Corporation. 2000.
13. John G. Essentials of Food Microbiology. Arnold International Students Edition.
14. Frazer W.C. Food Microbiology. McGraw Hill, New York. 1979.
15. Foster E.M. et al., Dairy Microbiology. Prentice Hall Inc., Englewood. 1975.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20BC2401					
TITLE OF THE COURSE	ENZYMOLGY AND PROTEIN CHEMISTRY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I/I	19BS1207	BASIC BIOCHEMISTRY

COURSE OBJECTIVES:

1. To have a comprehensive understanding about the enzymes present in different systems, and their structure and functions.
2. To enhance the knowledge of kinetics, active sites and mechanism of action of different classes of enzymes from different biological systems.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Will be able to understand the biological significance of enzymes, their critical roles in different systems and their efficiency in biological reactions.	L2 & L3
CO1	Will be able to apply skills/knowledge to calculate different kinetic parameter of enzymes and also the will be equipped with information about the enzyme technologies and enzymatic assays and their medicinal/industrial applications.	L4

COURSE CONTENT:	
MODULE 1	
11Hrs	
Introduction, classification & nomenclature of enzymes; Active site, Lock & key model, induced fit model and strain/TS theory-taking lysozyme and chymotrypsin as examples; Enzyme specificity- bond, group, absolute and stereo-chemical specificity; Enzyme catalysis: Proximity & Orientation effect; Regulatory enzymes: - Allosteric (ATCase) and covalently modulated (Glycogen phosphorylase) enzymes, MODULEs-Katal & IU; Effect of physical and chemical parameters on enzyme activity with examples.	
MODULE 2	
11Hrs	
Enzyme Kinetics: Importance of measuring initial velocities, Derivation of Michaelis-Menten equation, Single & double reciprocal plots, Inhibition (Competitive, Noncompetitive & Uncompetitive) on Lineweaver-Burke plots; Importance of Kcat / Km. Bisubstrate reactions – brief introduction.	
Enzyme Assay and Purification: Enzyme assay, Specific activity; Enzyme isolation and purification, criteria for enzyme purity; Isoenzymes; Coenzymes and their significance. Clinical and Industrial applications of enzymes.	

MODULE 3	11Hrs
Classification based on composition, shape and function; Peptide bond; Ramachandran Plot; Structural organization: primary, secondary, tertiary and quaternary structures; Structure of Haemoglobin, Immunoglobulin, Collagen, myosin and Keratin; Denaturation of proteins and melting temperature; Hofmeister series; Protein assays and quantification methods; Peptide synthesis.	
MODULE 4	11Hrs
Protein purification & Proteomics: Vectors and hosts, downstream processing; Protein Expression; Isolation and purification of proteins (non-enzymatic), Characterization through gel permeation, ion exchange and affinity chromatography; Sequence determination by Sanger and Edman degradation methods; Protein fragmentation and Peptide purification; Derivatization of peptides and mass spectroscopy of peptides; mass determination; Applications of proteomics.	

TEXT BOOKS:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed.
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Protein Protocols Handbook – Walker. Humana Press.
7. Protein Purification Applications – Roe. Oxford University Press.
8. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20GN2401					
TITLE OF THE COURSE	APPLIED GENETICS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	0	0	0	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

1. To go through basic and specialized knowledge and understanding the aspects of genetics is essential to applying concepts in Genetics.
2. To take the students through the basics of applied genetics and disease gene mapping.
3. To teach various techniques that students can apply in their future career in biological research as well as in industry.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Applied Genetics deals with the application of Genetics in Molecular Biology, Developmental Biology, Medicine, Pharmaceutical Industries, Medical Sciences, Agriculture and Horticulture based industries etc.	L3
CO2	Students will have a deeper understanding of several facets of applied genetics.	L3
CO3	Students will be equipped to pursue a fitting career in academia or industry.	L4

COURSE CONTENT:

MODULE 1 GENETIC RESOURCES AND BIODIVERSITY	8Hrs
Germplasm, classification, Germplasm activities, and organizations associated with germplasm (NBPGR, IBPGR). Genetic Erosion, biodiversity, centres of Diversity, Vavilovian Centres of Diversity, Law of Parallelism, Gene sanctuaries, Gene bank and Cryopreservation.	
MODULE 2 INTRODUCTION TO TISSUE CULTURE	7Hrs
Types of cell culture media for plants and animals; Preparation and sterilization of cell culture media <i>ANIMAL CELL CULTURES TECHNIQUES:</i> History of animal cell culture; Different tissue culture techniques; Types of primary culture; Chicken embryo, fibroblast culture; Secondary culture; Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organ culture; estimation of cell number; Characterization and maintenance of cell lines, Cryopreservation; Application of animal cell culture for in vitro testing of drugs.	

<i>PLANT CELL CULTURES TECHNIQUES</i> : Embryo, Anther and Ovary cultures, Shoot and Root Meristem cultures, Callus culture from undifferentiated cells, Protoplast culture. Economic benefits of Tissue Culture: Resistance to pests and Pathogens, Improvement in Nutritive value etc.	
MODULE 3 HETEROSIS IN ANIMALS AND PLANTS	15Hrs
Introduction to Heterosis and characteristics. Introduction to animal breeds, inbreeding, grading, cross breeding. Fish breeding: Selection, Induced Polyploidy, Gynogenesis and Androgenesis, Inbreeding. Production of breeds: crossing of inbred lines for commercial production. Breeding strategies for improvement of livestock for milk, meat, wool production. Breeding strategies for improvement of Poultry. Introduction to plants breeding: Estimation of heterosis - Heterobeltosis, Economic heterosis, Standard heterosis. Hybridization techniques- intergeneric and interspecific hybridization. Identification of hybrid plants. Inbreeding depression. Hybrid vigor exploitation in Rice, Tomato.	
MODULE 4 GENETICS IN MEDICAL & INDUSTRIAL BIOTECHNOLOGY	10Hrs
Production of recombinant Insulin, Interferon and Human Growth hormone (HGH). Vaccines-Hepatitis B vaccine. Preparation of DNA probes, Monoclonal antibodies and Diagnostic kits (Typhoid, Syphilis). DNA Fingerprinting: Methodology of DNA fingerprinting. Molecular markers-RFLP & RAPD, Micro satellite, SNPs, STR. Applications with examples in forensic science, medico legal aspects, wild life crying	
MODULE 5 BIOINFORMATICS	10Hrs
Introduction to Bioinformatics Databases, Nucleic acid Sequence databases (NCBI, EBI), Protein Sequence Databases (UNIPROT, SWISS-PROT), Structure Databases (PDB). Applications of bioinformatics.	

REFERENCES:

1. Alcamo I.E. DNA Technology. The Awesome Skill 2nd edition. Harcourt / Academic press. 2000.
2. Gupta P.K. Elements of Biotechnology. Rastogi. 2002-2003.
3. Singh B. D. Biotechnology. Kalyani Publication. 2002.
4. Glide B.R. and Pasternak, J. J. Molecular Biotechnology, 2nd edition. AS press, Washington. 1998.
5. Nicholl D. S. T. An Introduction to Genetic Engineering Second Edition. Cambridge University Press. 2002.
6. Razdan M. K. An Introduction to plant tissue culture. Oxford & IBH, New Delhi. 1993.
7. Lasley. J.E. Genetics of Livestock Improvement. Prentice India.
8. Animal cell culture Techniques by Ian Freshney, Wiley-Liss.
9. Animal Cell Culture – Practical Approach BY Ed. John R.W. Masters, 3rd Edition, Oxford University Press.
10. Animal Cell Culture Techniques BY Ed. Martin Clynes,. Springer

SEMESTER	IV					
YEAR	II					
COURSE CODE	20BS2401					
TITLE OF THE COURSE	GENOMICS AND PROTEOMICS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	48	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To go through basic and specialized knowledge and understanding the aspects of genomics and proteomics is essential to understanding Genetics and its architecture.
- To take the students through foundations in genomics and disease gene mapping.
- To teach various approaches to investigating genomics and proteomics that students can apply in their future career in biological research as well as in industry.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be able to understand how genomes are organised and contemplate on the mapping of monogenic and polygenic traits.	L2
CO2	Students should be endowed with strong theoretical knowledge of genomics.	L3
CO3	In conjunction with the practical in bioinformatics, the students should be able to take up biological research as well as find placement in the relevant biotech industry.	L3

COURSE CONTENT:	
MODULE 1 PROKARYOTIC AND EUKARYOTIC GENOME ORGANIZATION	
8Hrs	
Prokaryotes: Bacteria and Bacteriophages. Eukaryotic nuclear genomes: Arabidopsis, rice, yeast, Drosophila, C. elegans and mouse genome. Eukaryotic organelle genomes - Chloroplast and Mitochondria.	
MODULE 2 GENOME MAPPING TECHNIQUES	
8Hrs	
Genetic mapping: Cross breeding and pedigree analysis, DNA markers – RFLPs, SSLPs, SNPs.	
Physical mapping: Restriction mapping, Fluorescent in situ hybridization.	
MODULE 3 HUMAN GENOME PROJECT	
8Hrs	
History, organization and goals of human genome project. DNA segment nomenclature, Human genome diversity, Organization of human genome, Mitochondrial genome, Gross base composition of nuclear genome, Gene density, CpG islands, RNA-encoding genes,	

Functionally identical genes, Diversity in size and organization of genes.	
MODULE 4 COMPARATIVE GENOMICS	5Hrs
Whole genome analysis, Genome sequence, micro assay, molecular phylogeny, C-value, number of genes and complexity of genomes, Conservation and diversity of genomes, Comparative genomics as an aid to gene mapping and study of human disease genes. Comparative genomics of mitochondria and chloroplast genomes.	
MODULE 5 PROTEIN PROFILING	5Hrs
Prediction of primary, secondary and tertiary structure of proteins- SCOP, DALIDD, CATH classification. Determining protein structure, Homology modelling. Introduction to proteome and proteomics, protein separation and analysis using 2D Gel Electrophoresis, Liquid chromatography, Mass spectrometry, Interacting proteins by phage display and Yeast two hybrid system.	

REFERENCES

1. T.A. Brown, Genomes, Bios, 2002.
2. Coleman and Tsongalis, Molecular Diagnosis, Humana, 1997.
3. Dale and Schartz, From Genes to Genomes, Wiley, 2003.
4. Dunham, I., Genome Mapping and sequencing. Horizon Scientific. 2003.
5. Hawley and Mori, The Human Genome, Academic, 1999.
6. Lewis, Human Genetics, WCB, 1999.
7. Liebler, Introduction to Proteomics, Humana, 2002.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20MB2471					
TITLE OF THE COURSE	INDUSTRIAL, FOOD AND DAIRY MICROBIOLOGY - LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	4	-	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To apply techniques to industrial microbiology; biochemical and fermentation mechanisms.
- To impart basic understanding of principles, and key concepts relevant to industrial microbiology.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To introduce basic fermentation techniques employed in Microbial industries.	L3
CO2	Course will enable the student to apply the knowledge in various aspects of fermentation or industrial microbiology	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :	
1.	Isolation of microorganisms from fruits.
2.	Isolation of microorganisms from vegetables.
3.	Production and determination of amylase activity.
4.	Preparation of wine.
5.	Study of different types of fermenters (Models/ Charts).
6.	Cell immobilization techniques (yeast cells).
7.	Determination of quality of raw milk by methylene blue reduction test.
8.	Estimation of lactic acid from different dairy product.
9.	Production of alcohol from different sources and estimation by specific gravity method.

REFERENCES:

1. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
2. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
3. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
4. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi

5. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
6. Robert Mellor (2009) Entrepreneurship for Everyone: A student Textbook. SAGE Publication.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20BC2471					
TITLE OF THE COURSE	ENZYMOLGY -LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	0	40	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	-	-	-

COURSE OBJECTIVES:

1. To train the students to design the enzymatic assays and learn the calculation of kinetic parameters of the enzymes.
2. To learn isolation, handling and quantification of enzymes from biological samples and to train them to carry out enzymatic assays and interpret the results.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to interpret the kinetic parameters of the enzymes and assay results.	L3
CO2	Students will be able to design and carry out the enzymatic assays and will gain the practical knowledge about the mechanism of action of different enzymes.	L4

EXPERIMENTS/PRACTICALS:

1. Introduction to enzymology Lab and product curve determination
2. Isolation of enzymes (amylase/ phosphatase) from biological source and activity determination through time curve.
3. Determination of kinetic constants through LB plot
4. Effect of pH on enzyme activity
5. Effect of temperature on enzyme activity
6. Determination of Arrhenius constant
7. Effect of enzyme dilution on enzyme activity
8. Effect of activators and inhibitors on enzyme activity
9. Immobilization of enzyme using calcium alginate.

TEXT BOOKS:

1. Practical enzymology – Hans Bisswanger, Wiley-VCH, 2019, 3 rd Ed
2. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house 2001, 1st Ed
3. Principles and Techniques of Practical Biochemistry – Wilson, Wilson and Walker, Cambridge University Press 2000, revised Ed
4. Introduction to practical Biochemistry, Plummer, Tata McGraw-Hill Education 2001, 2nd Ed
5. Basics of Enzyme Immobilization – Alka Dwevedi, Springer International Publishing, 2016, 1 st Ed.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20GN2471					
TITLE OF THE COURSE	APPLIED GENETICS -LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	0	4	0	-	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

1. Experiments will give emphasis on current methods and applications of genetic manipulation in plants and crops.
2. Through the use of transgenics, one can produce plants with desired traits and even increased yields.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	After being introduced to the topics students will cover 'methods available for plant transformation through Agrobacterium mediated.	L3
CO2	Students will also study about the role of precise genome modification in crops, role of vectors and markers in gene expressions.	L3
CO3	The students are expected to read, research and discuss papers related to the topic	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :	
1.	Tissue culture techniques: • Sterilization • Explants preparation • Media Composition and preparation • Culturing of all kinds of explants for callus induction, multiple shoot proliferation.
2.	Synthetic seed preparation
3.	Study of different techniques in plant hybridization
4.	Study of pollen fertility
5.	Study of diagnostic kits - WIDAL & VDRL
6.	Study of hybrid plants - Rice, Cotton, Chilly, and Tomato.
7.	Study of hybrid animals - Poultry, dairy, fishery.
8.	Homology sequence analysis using Blast and Fasta.

REFERENCES

1. Pasternak, An Introduction to Molecular Human Genetics, Fitzgerald, 2000.
2. Primrose and Twyman, Principles of Genome Analysis & Genomics, Blackwell, 2003.
3. Razdan M. K. An Introduction to plant tissue culture. Oxford & IBH, New Delhi. 1993.
4. Ravishanker G.A. and Venkataraman L.V. Biotechnology Application of Plant Tissue and cell culture. BH Publications. 1997.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20BS2402					
TITLE OF THE COURSE	BIOETHICS AND IPR					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	26	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To introduce the students to the concepts of biosafety regulatory frameworks concerning genetically modified organisms at national and International levels
- To give elementary essential concepts of Bioethics, IPR and patent laws.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student should develop basic understanding of the concepts of Biosafety, regulations concerning GMOs IPR and patent laws.	L2
CO2	This course should generate interest for avenues for pursuing higher studies and careers in these areas.	L2
CO3	General knowledge should create awareness necessary for higher studies in biotechnological fields.	L2

COURSE CONTENT:

MODULE 1 : BIOSAFETY-REGULATORY FRAMEWORK FOR GMO's IN INDIA 8Hrs

Regulatory framework in India governing GMOs-Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety Committee (IBC), Review Committee on Genetic Manipulation, Genetic Engineering Approval Committee (GEAC), Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic Plants (1998), Seed Policy (2002), Prevention Food Adulteration Act (1955), The Food Safety and Standards Bill (2005), Regulation for Import of GM Products Under Foreign Trade Policy (2006-2007), National Environment Policy (2006). Rules for the manufacture, use/import/export and storage of hazardous microorganisms/ genetically engineered organisms or cells (Ministry of Environment and Forests Notification,1989).

MODULE 2 BIOSAFETY-REGULATORY FRAMEWORK FOR GMO's AT INTERNATIONAL LEVEL 6Hrs

Convention of Biological Diversity (1992) – Cartagena Protocol on Biosafety – Objectives and salient features of Cartagena Protocol – Advanced Information Agreement (AIA) procedure – procedures for GMOs intended for direct use-risk assessment-risk

management-handling, transport, packaging and identification of GMOs- Biosafety Clearing House-unintentional transboundary movement of GMOs-Benefits of becoming a party to the Cartagena Protocol- status of implementation in India.	
MODULE 3 BIOETHICS	4Hrs
What is bioethics- The legal and socioeconomic impacts of biotechnology - Public education of the process of biotechnology involved in generating new forms of life for informed decision-making – ethical concerns of biotechnology research and innovation.	
MODULE 4 INTELLECTUAL PROPERTY RIGHTS	3Hrs
Intellectual property rights-TRIPS, GATT-International conventions patents and methods of application of patents-Legal Implications-Biodiversity and farmer rights.	
MODULE 5 PATENTS AND PATENT LAWS	5Hrs
Objectives of the patent system - Basic principles and general requirements of patent law-biotechnological inventions and patent law-Legal Development-Patentable subjects and protection in biotechnology-The patenting living organisms.	

REFERENCES

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2. Ganguli Prabuddha Gearing up for Patents.....The Indian Scenario” , Universities Press (1998)
3. Ganguli Prabuddha “Intellectual Property Rights--Unleashing the Knowledge Economy”, Tata McGrawHill (2001)
4. Ganguli Prabuddha and Jabade Siddharth, “Nanotechnology Intellectual Property Rights. Research, Design, and Commercialisation”, CRC Press , Taylor and Francis Group, USA (2012)
5. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local Communities [Paperback], Darrell A. Posey and Graham Dutfield , IDRC Books; annotated edition (June 1996).
6. F. H. Erbis and K. M. Maredia. Intellectual property rights in agricultural Biotechnology, University Press.
7. Sivamiah Shantharam, Jane F. Montgomery. Biotechnology, Biosafety and Biodiversity, Oxford & IBH Publ. New Delhi.
8. Tutelyal, VA. Genetically modified Food Sources, Safety Assessment and Control, Academic Press an Imprint of Elsevier, New Delhi.
9. Jecker Nany S, JohsenAlbert, Perlman, Robert A. Bioethics: An Introduction to the History Methods and Practice, John & Bartlett, New Delhi.
10. Sharma, HC Dhillon, MK, Sahrawat, KN. Environmental Safety of Biotech and Conventional IPM Technology, Stadium Press LLC. USA.
11. Jecker Nany S, Jones & Barlet Bioethics: An Introduction to the History Methods and Practice, New Delhi
12. Sathish MK Bioethics and Biosafety, IK International.

SEMESTER	V					
YEAR	III					
COURSE CODE	20MB3501					
TITLE OF THE COURSE	AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	44	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To observe the importance of various life cycles carried out in the nature, for plants growing, animal husbandry and processing of plant and animal products. - Explains the geochemical and the environmental significant processes carried out by the microbial communities that include the activities of controlled by various environmental factors and limiting microbial activities.

COURSE OUTCOMES:
Fundamental concepts and techniques in soil microbiology, soil microbial diversity, basic and applied concepts environmental problems and available solutions towards them.

TOTAL:44 HRS

PART A: AGRICULTURAL MICROBIOLOGY	
MODULE I: BIOFERTILIZERS AND BIOLOGICAL CONTROL	11 hrs
Types of Biofertilizers, Mass cultivation of biofertilizers- <i>Rhizobium</i> , <i>Azotobacter</i> , VAM and Azolla. Bio-fertilizers: Mode of application of biofertilizers. Advantages and limitations. Bio-inoculants- Mechanisms of biological control, Mass production and field applications of <i>Bacillus thuringiensis</i> , <i>Trichoderma spp.</i> and Nuclear Polyhedrosis Virus. Advantages and limitations. Marketing - Carrier and Legal clearances.	
MODULE II: PLANT PATHOLOGY	
	11 hrs

Host pathogen interaction, disease triangle, disease cycle, classification of plant pathogens and plant diseases.

Defence mechanisms – Concepts of constitutive defense mechanisms in plants, inducible structural defences (histological-cork layer, abscission layer, tyloses, gums), inducible biochemical defences (hypersensitive response (HR), SAR and ISR, phytoalexins, pathogenesis related (PR) proteins, Plantibodies.

Plant disease control- Principles and practices in disease control – Regulatory (quarantine, crop certification), Cultural (host eradication, crop rotation, sanitation), Chemical (Protectants and Systemic fungicides), Biological (Suppressive soil and microbial antagonism).

Study of different plant diseases- Bacteria –Blight of rice, Fungi – Rust of Wheat, Virus – Tobacco Mosaic Virus, Mycoplasma – Sandal Spike, Nematode- Root knot disease.

PART B- ENVIRONMENTAL MICROBIOLOGY

MODULE III: AEROBIOLOGY AND SOIL MICROBIOLOGY

11 hrs

Aerobiology: Significance of microorganisms in air, air borne pathogens and aeroallergens. Techniques in aerobiology: Gravity slide, Plate exposure, Rotorod sampler, Anderson Samplers, Impingers and Filtration. Control of Air borne microorganisms – Dust control, Filtration, Fumigation and UV light exposure.

Soil Microbiology: Soil profile, Soil microorganisms - Bacteria, fungi, actinomycetes, algae, protozoa and viruses. Biogeochemical cycles - Carbon cycle, Nitrogen cycle and Sulphur cycle. Microbial interactions in soil - Neutralism, Positive interactions (mutualism, commensalism, synergism, syntropism, protocoperation), Negative interactions (amensalism, antagonism and parasitism). General account of bioleaching, biodegradation and bioremediation.

MODULE IV: AQUATIC AND WASTE WATER MICROBIOLOGY

11 hrs

Aquatic Microbiology: Zonation of water system (Fresh and Marine), Factors affecting aquatic flora (Oxygen, Temperature, pH, light, hydrostatic pressure, turbidity and nutrients). Water Pollution: Sources and Eutrophication. Water quality analysis: Collection of water samples, Standard plate count, MPN and membrane filter technique. **Municipal treatment of water:** Sedimentation, Filtration and Disinfection.

Waste water Microbiology: Characteristics of sewage (physical, chemical and biological), Concept of BOD and COD. **Sewage Treatment:** Domestic treatment plants (septic tanks), Municipal sewage treatment Primary (coagulation and sedimentation), Secondary (Trickling filter, activated sludge, oxidation pond) and Tertiary treatment (ion exchange, reverse osmosis and dialysis). Brief account on solid waste treatment (Landfills and Composting); Biogas production.

REFERENCES

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.

2. Alexopoulos C.J and Mims C.W., Introductory Mycology, New Age International, New Delhi.
3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. Plant Pathology, Fifth Edition, Elsevier Academic Press, 2005.
5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbarao N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.
7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
7. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
8. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press.
9. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.
10. Jabir Singh. Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
11. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science
12. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
13. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
14. Robert L Tate, Soil Microbiology, 2nd Edition, John Wiley and Sons.
15. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
16. Grant W.D and Long P.E. Environmental Microbiology. Kluwer Academic Publishers, 1981.
17. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
18. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
19. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER	V					
YEAR	III					
COURSE CODE	20BC3501					
TITLE OF THE COURSE	METABOLISM					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	44	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
- To enhance the comprehensive understanding of biochemical processes/metabolic pathways in the living systems, particularly about the human system. - Educate the students about the concepts of nutrition, pathophysiology and inborn errors associated with the metabolism.

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	Student will know how the biomolecules play a role in energy production/storage which is an absolute necessity to sustain life.	L3
CO2	Students will have a greater understanding of how the homeostasis of a body is maintained and a slight change in the system could tip the balance which could lead to disease.	L4
CO3	Students will have an idea as to how hormones control the physiology of an organism via signaling mechanisms.	L4
CO4	The students will be able to comprehend the importance of proper diet and nutrition and diseases/disorders associated with improper diet.	L4

COURSE CONTENT:	
MODULE 1 CARBOHYDRATE METABOLISM	11 Hrs
Introduction to anabolic, catabolic, amphibolic pathways and intermediary metabolism. Glycolytic pathway; energetics and regulation, aerobic and anaerobic fates of pyruvate, entry of sugars other than glucose into metabolism, Gluconeogenesis, Cori cycle, TCA cycle. Degradation, synthesis and regulation of glycogen. Disorders of Carbohydrate Metabolism- Diabetes mellitus, glycogen storage disorders and lactose intolerance.	
MODULE 2 LIPID METABOLISM	11 Hrs
Oxidation of fatty acid – α , β and ω types, β -oxidation of even number saturated fatty acids. Energetics of β -oxidation. Schematic representation of biosynthesis of even number saturated fatty acids and cholesterol biosynthesis. Metabolism of ketone bodies with physiological significance. Fatty acid biosynthesis, chain elongation and desaturation. Biosynthesis of triacylglycerol, phospholipids and sphingolipids, sphingolipid storage disorders. Regulation of cholesterol metabolism; Biochemistry of obesity, atherosclerosis and hypercholesterolemia; synthesis of prostaglandins and related compounds.	
MODULE 3 METABOLISM OF AMINO ACIDS AND PEPTIDES	11 Hrs

Biosynthesis of physiologically active amines; serotonin, histamine, dopamine, norepinephrine and epinephrine. General mechanisms of amino acid metabolism and regulations: Role of cofactors; PLP and THF in amino acid metabolism. Deamination, transamination, decarboxylation de-sulphuration process. Urea Cycle and its regulation; Synthesis and degradation of Basic and Aromatic amino acids and their Regulation. In born errors of amino acid degradation; Phenyl Ketonuria, alkaptonuria, maple syrup urine. Introduction to bioactive peptides; Structure, localization and mechanism of action of- leptin, ghrelin, neuropeptides, enkephalin, angiotensin, defensin, vasopressin and oxytocin and associated disorders.

MODULE 4 METABOLISM OF NUCLEIC ACIDS

11 Hrs

Synthesis of purine and pyrimidine nucleotides – the de novo and the salvage pathway and their regulation. Degradation of purine and pyrimidines and disorders associated with degradation: Lesch-Nyhan syndrome, Gout, SCID, adenosine deaminase deficiency.

TEXT BOOKS/REFERANCES:

1. Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3rdEd. John Wiley and Sons(2009).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012).
3. Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and LubertStryer, W H Freeman and Co. (2006).
4. Textbook of Biochemistry with Clinical Correations – Thomas M. Devlin, John Wiley & Sons; 7th edition (22 January 2010)
5. Biochemistry of Foods, Eskin, Elsevier (2012).
6. Biochemistry and Molecular Biology; 5thEd. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University Press (2014).
7. Harpers Illustrated Biochemistry; 30th Ed. V.W. Rodwell , D. Bender , K.M. Botham , P. J. Kennelly, P. A. Weil (2015)

SEMESTER	V					
YEAR	III					
COURSE CODE	20GN3501					
TITLE OF THE COURSE	POPULATION AND EVOLUTIONARY GENETICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	-	-	-	44	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:	
- To make student understand the forces that have an impact on levels of genetic variations in natural and/or experimental populations for both qualitative and quantitative traits. - To make the students familiar with different types of DNA markers and the range of tools for their detection to enable advanced studies on molecular population genetics.	

COURSE OUTCOMES:		
CO No.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO1	This course will give students exposure towards understanding population health and disease susceptibility.	L3
CO2	This course will be helpful to the students to conceptualize the existence of genetic variation and speciation.	L4

COURSE CONTENT:	
MODULE 1 INTRODUCTION TO POPULATION GENETICS	11 Hrs
Mendelian Population and scope of population genetics. Gene and genotype frequencies, mating patterns, Hardy-Weinberg principle, heterozygotes, extension of H-W principle to multiple alleles, sex-linked alleles. Non-random mating, inbreeding and assortative mating, inbreeding coefficient. Factors that change allelic frequencies.	
MODULE 2 GENETIC VARIATION AND INHERITANCE OF COMPLEX TRAITS	11 Hrs
Testing gene mutations for alleles: complementation test, intragenic complementation Genotypes & phenotypes: Effect of the environment on phenotype development, Penetrance and expressivity, Visible, sterile and lethal mutations, Gene interactions and modifying genes, Pleiotropy.	
MODULE 3 GENETIC POLYMORPHISMS AMONG POPULATIONS	11 Hrs

Genetic polymorphism, transient and stable and factors responsible for stable polymorphism. DNA markers and populations differences. Application of population genetics. Role of population genetics in genetic counselling. Genetic origin and evolution of human races. Genetic Demography, age and gender specific death and birth rates, intrinsic rate of natural increase. Index of opportunity for natural selection.

MODULE 4 EVOLUTIONARY GENETICS
11 Hrs

Darwinism, Neo Darwinism and Synthetic Theory. Evolution of Sexual Reproduction. Sex Ratio and Sex Determination. Chromosomal evolution, genome evolution, selfish DNA. Competition Among Levels of Organization. Speciation and Phylogeny. Coalescent Theory. Drift versus selection in population. Kin and group Selection. Cancer as an evolutionary process.

REFERANCES:

1. Hamilton M.B. (2009). Population Genetics. Wiley-Blackwell, UK.
2. Hedrick P.W.(2011). Genetics of Populations. Jones and Bartlett Publishers, Massachusetts.
3. Jobling, M., Hollox, E., Hurles, M., Kivisild, T. and Tyler-Smith, C. (2013). Human Evolutionary Genetics. Garland Science.
4. Nielsen, R. and Slatkin, M. (2013). An Introduction to Population Genetics: Theory and Applications. Sinauer Associates, Inc.
5. Relethford, J.H. (2012). Human Population Genetics. John Wiley & Sons.
6. Snusted, D.P., Simmons, M. J. (2010). Principles of Genetics. John Wiley & Sons, New York.
7. Knight, J.C. (2009). Human Genetic Diversity –Functional consequences for Health and Disease. Oxford University Press, USA.

YEAR	III					
COURSE CODE	20BS3571					
TITLE OF THE COURSE	ESTIMATION OF BIOMOLECULES- LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	4	-	-	2
Perquisite Courses (if any)						
#	Sem/Year	Course Code	Title of the Course			
-	-	-	-			

COURSE OBJECTIVES:

- To make students learn Qualitative analysis of biomolecules
- To make students learn Quantitative methods of study of biomolecules

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to learn the procedures and safety precautions while handling the biomolecules	L2 and L3
CO2	Students will be able to learn quantitate biomolecules and estimate using standard graphs	L3

List of Laboratory/Practical Experiments activities to be conducted (if any):
1. Qualitative analysis of Monosaccharides and disaccharides (Glucose, Fructose, Lactose, Sucrose)
2. Estimation of Glucose estimation by Miller's method
3. Qualitative Analysis of amino acids (Tryptophan, Tyrosine, Cystiene, Proline, Arginine, Histidine)
4. Estimation of Protein by Folin - Ciocalteu method/Estimation of aminoacids by Ninhydrin method
5. Lipids (Solubility, acrolein test)
6. Determination of Iodine Number of a fat sample
7. Estimation of DNA by DPA method
8. Estimation of RNA by Orcinol method

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house 2012, 7th edition
2. An Introduction to Practical Biochemistry: Plummer D.T, Tata Mc Graw Hill.
3. Biochemistry – Harper, Lange Publications, 2nd edition
4. Biochemistry- Voet and Voet. Wiley and Sons. 4th edition

SEMESTER	V					
YEAR	III					
COURSE CODE	20BS3574					
TITLE OF THE COURSE	APPLIED MICROBIOLOGY AND POPULATION GENETICS-LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	4	-	-	2
Perquisite Courses (if any)						
#	Sem/Year	Course Code	Title of the Course			
-	-	-	-			

COURSE OBJECTIVES:

- To understand the fundamental concepts and techniques in soil microbiology, soil microbial diversity, basic and applied concepts environmental problems.
- To make the students to learn about various inorganic experiments.
- To make the students to learn about estimation of different elements present in various compounds.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To enable us to know how microorganisms may be utilized in agricultural microbiology.	L2
CO2	Students will get to know about the estimation of different elements like iron, calcium, nickel etc.	
CO3	The students will learn the synthesis of coordination compounds.	

List of Laboratory/Practical Experiments activities to be conducted (if any):
1. Isolation and enumeration of bacteria, fungi and Actinomycetes from rhizosphere soil.
2. Examination of Bacteroides from legume root nodules.
3. Demonstration of fungal contaminants in ground nut by standard blotter method.
4. Isolation and enumeration of air borne microbes by Petri plate exposure method.
5. Estimation of Biological Oxygen Demand (BOD).
6. Genetic problems on polygenic variance, Heritability.
7. Disease-risk prediction in population using Hardy-Weinberg equations
8. Study of phylogenetic trees
9. Study on finger and Palmer dermatoglyphic patterns
10. Pedigree analysis and construction

SEMESTER	V					
YEAR	III					
COURSE CODE	20AU0003					
TITLE OF THE COURSE	CONSTITUTION OF INDIA AND HUMAN RIGHTS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	0	0	0	22	0

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Define a constitution
- Describe the salient features of the Indian Constitution
- Explain different ways of acquiring Indian Citizenship
- List the Fundamental Rights and Fundamental Duties of Indian citizens
- Describe the Directive Principles of State Policy and their significance

COURSE OUTCOMES:

appreciate the fundamental law of the land

be aware of what kind of government the country will have.

understanding what lays down the rules to govern the country

about the rights and also the duties of its citizens

COURSE CONTENT:	
MODULE 1	4Hrs
Framing of the Indian Constitution: Role of the Constituent Assembly. Philosophy of the Constitution: Objectives, resolution, preamble, fundamental Rights and Duties. Human rights and Environmental protection.	
MODULE 2	4Hrs
Special Rights created in the Constitution of Dalits, Backward Classes, Women and Children, and religious and linguistic minorities. Directive Principles of State policy: The need to balance fundamental rights with directive principles.	
MODULE 3	5Hrs

Union Executive: President, Prime Minister and Council of Ministers; powers and functions, coalition Government, problems in their working. Union Legislature: Lok Sabha and Rajya Sabha, powers and functions. Recent trends in their functioning.	
MODULE 4	4Hrs
State Government: Governor, Chief Minister and Council of ministers, Legislature. Centre – State relations: Political, financial, administrative: Recent Trends.	
MODULE 5	5Hrs
Judiciary: Supreme Court, Judicial Review, Writs, Public interest litigations. Enforcing rights through writs. Emergency provisions (Article 356)	

TEXT BOOK:

- 1 D.D. Basu – Introduction to the Indian Constitution.
- 2 A.S. Narang – Indian Constitution, Government and Politics.
- 3 Nani Palkhivala – We, the People, UBS Publishers, New Delhi, 1999.
- 4 A.G. Noorani – Indian Government and Politics
- 5 J.C. Johari – Indian Government and Politics Vol. I & II, Vishal, New Delhi
- 6 Gran Ville Austin – The Indian Constitution – Corner stone of a Nation, Oxford, New Delhi, 2000.
- 7 M.U. Pylee, Constitutional Government in India.
- 8 K.K. Ghai, Indian Constitution.

SEMESTER	V					
YEAR	III					
COURSE CODE	20AU0020					
TITLE OF THE COURSE	KANNADA KALI – I					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	0	0	0	-	0

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To enable students read and write in Kannada
- To make students to communicate in Kannada helping them to interact with local people for their daily needs

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students should be able to read, write and communicate in Kannada	L3

COURSE CONTENT:

1. ALPHABETS – AKSHARAMAALE - ಅಕ್ಷರಮಾಲೆ
2. SIGNS OF VOWELS AND CONJUNCT CONSONANTS –
KAAGMODULEHA MATTHU OTTHAKSHARAGALU
ಕಾಗುಣಿತ ಮತ್ತು ಒತ್ತಕ್ಷರಗಳು
3. DAILY USING WORDS PART – 1
DINANITHYADA PADAGALU BHAAGA – 1
ದಿನನಿತ್ಯದ ಪದಗಳು ಭಾಗ – 1
4. WEEKDAY AND MONTH NAMES –
VAARADA MATTHU THINGALA HESARUGALU
ವಾರದ ಮತ್ತು ತಿಂಗಳ ಹೆಸರುಗಳು
5. TASTE – RUCHI – ರುಚಿ
6. COLOURS – BANNAGALU – ಬಣ್ಣಗಳು
7. NUMBERS – SANKYEGALU - ಸಂಖ್ಯೆಗಳು
8. DAILY USING WORDS PART – 2
DINANITHYADA PADAGALU BHAAGA – 2
ದಿನನಿತ್ಯದ ಪದಗಳು ಭಾಗ – 2
9. QUESTION PATTERNS – PRASHNEYA VIDHAANAGALU
ಪ್ರಶ್ನೆಯ ವಿಧಾನಗಳು
10. MEASUREMENTS – ALATHEGALU - ಅಳತೆಗಳು
11. EDUCATION WORDS – SHAIKSHANIKA PADAGALU
ಶೈಕ್ಷಣಿಕ ಪದಗಳು
12. LIQUID ITEMS – NEERINAAMSHADA PADAGALU
ನೀರಿನಾಂಶದ ಪದಗಳು
13. FRUITS – HANNUGALU – ಹಣ್ಣುಗಳು
14. VEGETABLES – THARAKAARIGALU – ತರಕಾರಿಗಳು

15. FOOD ITEMS – AAHAARA PADAARTHAGALU
ಆಹಾರ ಪದಾರ್ಥಗಳು
16. DAILY USING WORDS PART -3 –
DINANITHYADA PADAGALU BHAAGA -3
ದಿನನಿತ್ಯದ ಪದಗಳು ಭಾಗ -3
17. METALS – LOHAGALU – ಲೋಹಗಳು
18. RELATIVES – SAMBANDHIKARU – ಸಂಬಂಧಿಕರು
19. SEASONS AND CLOTHES –
KAALAGALU MATTHU BATTEGALU
ಕಾಲಗಳು ಮತ್ತು ಬಟ್ಟೆಗಳು
20. HOUSE AND FURNITURE –
MANE MATTHU PEETOPAKARANAGALU
ಮನೆ ಮತ್ತು ಪೀಠೋಪಕರಣಗಳು
21. OPPOSITE WORDS – VIRUDDHA PADAGALU
ವಿರುದ್ಧ ಪದಗಳು
22. VERBS - KRIYAA PADAGALU – ಕ್ರಿಯಾ ಪದಗಳು
23. ANIMALS – PRAANIGALU – ಪ್ರಾಣಿಗಳು
24. INSECTS – KRIMIKEETAGALU – ಕ್ರಿಮಿಕೀಟಗಳು
25. BIRDS – PAKSHIGALU – ಪಕ್ಷಿಗಳು
26. FEELINGS – BHAAVANEGALU – ಭಾವನೆಗಳು
27. TENSES – KAALASOOCHAKAGALU – ಕಾಲಸೂಚಕಗಳು
28. COMMUNICATION WORDS – SAMBHAASHANEYA PADAGALU-
ಸಂಭಾಷಣೆಯ ಪದಗಳು

List of Laboratory/Practical Experiments activities to be conducted (if any) :

- 1.
- 2.

SEMESTER	V					
YEAR	III					
COURSE CODE	20AU0022					
TITLE OF THE COURSE	KANNADA MANASU-I					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	0	0	0	-	0

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To equip the native Kannada speaking students with advanced skills in Kannada
- communication and understanding.
- To enrich the students with creative writing.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will have better speaking and writing communication skills in Kannada	L3

COURSE CONTENT:

ಕನ್ನಡ ಪಠ್ಯಕ್ರಮ

1. ಕನ್ನಡ ಭಾಷಾ ವಿಜ್ಞಾನದ ಸ್ವರೂಪಗಳು
2. ಭಾಷಾ ಕಲಿಕೆಯ ವಿವಿಧ ನೆಲೆಗಳು
3. ವ್ಯವಹಾರಿಕ ಭಾಷೆಯಲ್ಲಿ ಕನ್ನಡ
4. ಕಂಪ್ಯೂಟರ್ ಕಲಿಕೆಯಲ್ಲಿ (ಗಣಕಯಂತ್ರ) ಕನ್ನಡ ಬಳಕೆ
5. ಪತ್ರ ಲೇಖನ
 1. ವೈಯಕ್ತಿಕ ಪತ್ರಗಳು
 2. ವ್ಯವಹಾರಿಕ ಪತ್ರಗಳು
6. ಪ್ರಬಂಧ ರಚನೆ
 1. ಸಾಮಾಜಿಕ ಕ್ಷೇತ್ರ
 2. ಶೈಕ್ಷಣಿಕ ಕ್ಷೇತ್ರ
7. ಗಾದೆಗಳ ಬಳಕೆ
 1. ಜನಪದದ ಶೈಲಿ
 2. ಅನುಭವದ ಶೈಲಿ
8. ವಾಕ್ಯ ಸಂಯೋಜನೆ
 1. ಸರಳ ವಾಕ್ಯ
 2. ಮಿಶ್ರವಾಕ್ಯ
 3. ಸಂಯೋಜಿತ ವಾಕ್ಯ
9. ವ್ಯಾಕರಣ ಭಾಗ
 1. ಅನುಕರಣವಾಚಿ ಪದಗಳು
 2. ವಿರುದ್ಧ ಪದಗಳು, ನುಡಿಗಟ್ಟುಗಳು
 3. ವಿದ್ಯರ್ಥಕ ಪದಗಳು
 4. ಅರ್ಥ, ಸಮಾನಾರ್ಥ, ನಾನಾರ್ಥ ಪದಗಳು
 5. ನಿಷೇಧಾರ್ಥಕ ಪದಗಳು
 6. ಸಂಖ್ಯಾವಾಚಕ, ನಾಮವಾಚಕಗಳು
 7. ವಿಭಕ್ತಿ ಪ್ರತ್ಯಯಗಳು
 8. ಕ್ರಿಯಾಪದಗಳು, ಧಾತುರೂಪ
 9. ಪದ ವಿಂಗಡಣೆ
 10. ದ್ವಿರುಕ್ತಿ, ಜೋಡುನುಡಿ, ಇತ್ಯಾದಿ

10. ಸೃಜನಾತ್ಮಕ ಬರವಣಿಗೆ
 1. ವಿಷಯದ ಆಯ್ಕೆ
 2. ಅನಿಸಿಕೆಯ ಭಾಗ
 3. ವಿಶ್ಲೇಷಣೆ
 4. ಉಪಸಂಹಾರ
11. ವಿಷಯದ ಚರ್ಚೆ, ಪ್ರಬಂಧ ಮಂಡನೆ
12. ಸಮೂಹ ಚರ್ಚೆ, ಪಠ್ಯ - ಪದ್ಯ - ನಾಟಕ ಭಾಗ
13. ವಿಷಯ ಸಂಗ್ರಹಣೆ, ವರದಿ, ಲೇಖನ ಕಲೆ
14. ಸಂಪರ್ಕ ಮಾಧ್ಯಮಗಳು - ಅದರ ಬಳಕೆ
15. ಸ್ವತಂತ್ರ ಕಥೆ, ವರ್ಣನೆ, ಪ್ರವಾಸಕಥನ ಮತ್ತು ಅನುಭವಗಳ ನಿರೂಪಣೆ

SEMESTER	V					
YEAR	III					
COURSE CODE	20BS3601					
TITLE OF THE COURSE	RESEARCH METHODOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2		-	-	22	2

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	-	-	-

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	-	-	-

COURSE OBJECTIVES :

1. Students understand research terminology one that can be used to carry out different approaches to research
2. To be aware of the ethical principles of research, challenge and approval processes

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Demonstrate knowledge of research processes (reading, evaluating and developing)	L2
CO2	Compare and contrast qualitative and quantitative research	L4

COURSE CONTENT:	
MODULE I	
Meaning, Objectives and Characteristics of research. Research Methods Vs Methodology. Types of research. Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical. Research process. Criteria of good research. Developing a research plan. Defining the research problem. Techniques involved in defining the problem Survey of literature. Primary and secondary sources. Reviews, treatise, monographs patents. Identifying gap areas from literature review. Development of working hypothesis.	
MODULE II:	

Research design and methods - Basic Principle. Features of good design. Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan. Exploration, Description, Diagnosis, and Experimentation. Determining experimental and sample designs. Sampling design - Steps and types in sampling design. Measurement and scaling techniques. Methods of data collection. Testing of hypotheses. Procedure for hypotheses testing flow diagram for hypotheses testing. Data analysis with Statistical Packages. Correlation and Regression. Important parametric test. Chi-square test. Analysis of variance and Covariance.

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1.NO

2. NO

TEXT BOOKS :

REFERENCES

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
6. Day, R.A., 1992. How to Write and Publish a Scientific Paper, Cambridge University Press.
7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications

SEMESTER	V					
YEAR	III					
COURSE CODE	20BS3602					
TITLE OF THE COURSE	PROJECT					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	-	12	-	6

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	-	-	-

COURSE OBJECTIVES:

1. Construct a project from Plan, schedule, monitor and control students' own work and to exhibit ideas in discussions and presentations
2. Apply tools and techniques to the applied courses taught and to communicate their findings through a written report and poster presentation

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To provide a postgraduate level knowledge in Microbiology, including understanding, analysis, management, and handling of real-life information technology problems in workplace.	L4
CO2	To provide graduate education that will prepare students to become thoughtful, productive members of the competing profession and community.	L4
CO3	To provide a high-quality post graduate education and training in microbiology which prepares students for productive careers and lifelong learning.	L5