

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		

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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		

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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		

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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		

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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
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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-Ponndorff-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, Immuno-electrophoresis, 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>Trichophyton 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. Thieme Verlag.
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
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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	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 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	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 pK_a 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. 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.
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 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. 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