DAYANANDA SAGAR UNIVERSITY

SHAVIGE MALLESHWARA HILLS, KUMARASWAMY LAYOUT
BENGALURU–560 111, KARNATAKA.

SCHOOL OF BASIC & APPLIED SCIENCES

SCHEME & SYLLABUS
FOR
MASTER OF SCIENCE (M.Sc.) – 2020

SPECIALIZATION: HUMAN GENETICS

(With effect from 2020-21)

(Update From I to IV Semesters)

SCHEME – M.Sc. – HUMAN GENETICS – 2020-21 ONWARDS

I SEM M.Sc. – HUMAN GENETICS

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	222	20MSC5101	FUNDAMENTALS OF CHEMISTRY	CR	4	-	-	-	4	60	40
2	222	20MSC5102	BIOMOLECULES	CR	4	-	-	-	4	60	40
3	222	20MSC5103	MOLECULAR GENETICS	CR	4	-	-	-	4	60	40
4	222	20MSC5104	GENERAL MICROBIOLOGY	CR	4	-	-	-	4	60	40
5	222	20MSC5105	BIOINFORMATICS – I (PROTEOMICS)	CR	2	-	-	-	2	60	40
6	222	20MSC5106	BIOSTATISTICS	CR	2	-	-	-	2	60	40
7	222	20MSC5171	ANALYSIS OF BIOMOLECULES – LAB	CR	-	-	6	-	3	100	0
8	222	20MSC5172	TECHNIQUES IN MICROBIOLOGY AND GENETICS – LAB	CR	-	-	6	-	3	100	0
GRAND TOTAL = 800					**20**	**-**	**12**	**-**	**26**	**560**	**240**

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits, CIA – Continuous Internal Assessment

SCHEME – M.Sc. – HUMAN GENETICS – 2020-21 ONWARDS

II SEM M.Sc. – HUMAN GENETICS

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	222	20MHG5201	FUNDAMENTALS OF HUMAN GENETICS	CR	4	-	-	-	4	60	40
2	222	20MHG5202	HUMAN BIOCHEMICAL AND IMMUNOGENETICS	CR	4	-	-	-	4	60	40
3	222	20MSC5201	MOLECULAR BIOLOGY	CR	4	-	-	-	4	60	40
4	222	20MSC5202	ANALYTICAL TECHNIQUES	CR	4	-	-	-	4	60	40
5	222	20MSC5203	BIOINFORMATICS – II (GENOMICS)	CR	2	-	-	-	2	60	40
6	222	20MSC5204	EVOLUTION AND DEVELOPMENTAL BIOLOGY	CR	2	-	-	-	2	60	40
7	222	20MHG5271	PRACTICALS IN HUMAN CYTOGENETICS, BIOCHEMICAL AND IMMUNOGENETICS	CR	-	-	6	-	3	100	0
8	222	20MSC5271	BIO-ANALYTICAL TECHNIQUES – LAB	CR	-	-	6	-	3	100	0
GRAND TOTAL = 800					**20**	**-**	**12**	**-**	**26**	**560**	**240**

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits,
CIA – Continuous Internal Assessment

SCHEME – M.Sc. – HUMAN GENETICS – 2020-21 ONWARDS

III SEM M.Sc. – HUMAN GENETICS

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	222	20MHG5301	MEDICAL AND CANCER GENETICS	CR	4	-	-	-	4	60	40
2	222	20MHG5302	GENETIC SCREENING, COUNSELING AND DISEASE MANAGEMENT	CR	4	-	-	-	4	60	40
3	222	20MHG53XX	ELECTIVE – 1	CR	3	-	-	-	3	60	40
4	222	20MHG53XX	ELECTIVE – 2	CR	3	-	-	-	3	60	40
5	222	20MHG53XX	ELECTIVE – 3	CR	3	-	-	-	3	60	40
6	222	20MSC5301	CLINICAL RESEARCH	CR	2	-	-	-	2	60	40
7	222	20MSC5302	SCIENTIFIC WRITING AND IPR	CR	2	-	-	-	2	60	40
8	222	20MSC5303	RESEARCH METHODOLOGY	CR	2	-	-	-	2	60	40
9	222	20MHG5371	LABORATORY EXERCISES IN MEDICAL AND CANCER GENETICS	CR	-	-	6	-	3	100	0
10	222	20MHG5372	LABORATORY EXERCISES IN GENETIC SCREENING AND ANALYSIS	CR	-	-	6	-	3	100	0
GRAND TOTAL = 1000					**23**	**-**	**12**	**-**	**29**	**680**	**320**

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits,
CIA – Continuous Internal Assessment

LIST OF ELECTIVE COURSES FOR THE PROGRAMME- HUMAN GENETICS

S. No.	Course Code	Course
1	20MHG5321	Human Population Genetics
2	20MHG5322	Developmental and Reproductive Genetics
3	20MHG5323	Clinical Genetics
4	20MHG5324	Applied Human Genetics
5	20MHG5325	Genetics in toxicology and Forensic science

SCHEME – M.Sc. – HUMAN GENETICS – 2020-21 ONWARDS

IV SEM M.Sc. – HUMAN GENETICS

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	222	20MSC5401	PROJECT WORK	CR	-	-	36	-	18	240	160
GRAND TOTAL = 400					-	-	36	-	18	240	160

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits,
CIA – Continuous Internal Assessment

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

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

COURSE OBJECTIVES :

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

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Student will acquire a foundation of chemistry of sufficient breadth and depth to enable them to understand and critically interpret the primary concepts in chemistry.	L2
CO2	Students will familiarize with the basic concepts related to chemical bonding, electrochemistry, thermodynamics, chemical kinetics, stereochemistry, reaction mechanism and their interdisciplinary role in thorough understanding of higher biological courses	L3

COURSE CONTENT:	
MODULE 1 General Chemistry	**13 Hrs**
Types of chemical bonds in biological molecules, Hydrogen bonding & its relevance in biological systems, importance of water in biological systems, pH, pKa, pKb, pOH, preparation of buffers, Henderson-Hasselbalch equation and numerical problems associated with buffer preparation VSEPR, Crystal field theory, Ligand field theory – explanation of coordination bonds in biomolecules - bonding of iron in haemoglobin & cytochromes, cobalt in vitamin B12, magnesium in chlorophyll.	
MODULE 2 Physical Chemistry	**13 Hrs**
Electrochemistry: Electrode potential, standard & reference electrode, calculation of biological standard potential & biological equilibrium constant, Nernst's' equation. Thermodynamics: First & second laws of thermodynamics, enthalpy, entropy, free energy,	

free energy change & its applications in biology, activity, chemical potential. Chemical Kinetics: Rate of reaction, order& molecularity of reactions, effect of temperature on reaction rates, Arrhenius equation, activated complex theory, catalysis.	
MODULE 3 Organic Chemistry - I	**13 Hrs**
Stereochemistry: Geometric & Optical Isomerism, Symmetry elements, R/S notation, chirality & optical activity, Stereochemistry of glucose & amino acids. Reactive intermediates: Reactive intermediates, Ionic, radical & concerted reactions, transition state theory, kinetically & thermodynamically controlled reactions.	
MODULE 4 Organic Chemistry - II	**13 Hrs**
Reaction mechanism: S_N1, S_N2 E1 & E2 reactions, aromatic electrophilic and aromatic nucleophilic reactions, mechanistic study of reactions important for biology, metabolic reactions, aldol condensation – collagen and elastin, esterification of acids, oxidation and reduction. Heterocyclic compounds: aromaticity, Chemistry & biological relevance of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole, chemistry of porphyrins.	

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

TEXT BOOKS :

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

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

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

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

COURSE CONTENT:

MODULE 1 CARBOHYDRATES **13 Hrs**

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

Complex Carbohydrates: Homopolysachharides and heteropolysachharides - starch, glycogen, cellulose chitin, glycosaminoglycans and proteoglycans; Glycoproteins and Glycolipids - O and N linked oligosaccharides, Blood group determinants, Lectins, lipo-polysaccharides.

MODULE 2 AMINO ACID AND PROTEINS **13 Hrs**

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

Secondary structure: α-, PP-, 310 and π-helix, β pleated sheet, β and □bend, Peptide bond geometry and conformational map, Chou and Fasman algorithm; Super secondary

structures: motifs and domains	
MODULE 3 PROTEIN CONFORMATION AND FOLDING	**13 Hrs**
Tertiary structure: interactions stabilizing tertiary structure; denaturation of proteins, secondary and tertiary structure of fibrous proteins: α-keratin, silk fibroin and collagen. **Quaternary structure:**Hemoglobin Structure and mechanism of co-operativity, molecular basis of Sickle-cell anemia; Cross linking agents to determine subunit composition. **Protein folding:** Protein renaturation, significance of Anfinson's experiment, Classical model of folding, Levinthol paradox, Landscape model of folding, accessory proteins-protein disulfide isomerases and molecular chaperones; conformational diseases: Alzheimer's and Prion diseases.	
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MODULE 4 LIPIDS AND NUCLEIC ACID	**13 Hr**
Lipids: Classification and biological importance of lipids. Structure, nomenclature, properties and functions of Simple lipids - free fatty acids, acyl glycerols& wax; Complex lipids - phospholipids, ether lipids, sphingolipids, galactolipids and Derived lipids – sterols and icosanoids including prostaglandins, thromboxanes and leukotrienes. Lipid peroxidation. **Nucleic acids:** Nucleosides, nucleotides and polynucleotides; Specialized sequences: stem-loops, G-quadruplexes, palindromic and mirror repeats; denaturation and renaturation curves of nucleic acids; Oligonucleotide synthesis by phosphoramidite method.	

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

TEXT BOOKS:

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

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5103**					
TITLE OF THE COURSE	**MOLECULAR GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**52**	**4**

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

COURSE OBJECTIVES :

- To understand the functions and structures of nucleic acids and proteins.
- To understand the concepts of transcription, translation, control of gene expression, mutations, DNA repair and DNA recombination

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	In-depth knowledge of biological and/or medicinal processes through the investigation of the underlying molecular mechanisms	L3
CO2	At the end student will gain an understanding of chemical and molecular processes that occur in and between cells	L3
CO3	Discuss the molecular mechanisms by which DNA controls development, growth or morphological characteristics of organisms	L4
CO4	Explain the principles of cloning and genetic manipulation and their application in genetic analysis	L3
CO5	Discuss the molecular mechanisms by which DNA controls development, growth or morphological characteristics of organisms	L2

COURSE CONTENT:	
MODULE 1	**13Hrs**
Mendelian genetics: Concepts and theories, gene interactions, Morgan's linkage analysis, chromosome theory of inheritance. Features of *E. coli.* and Human genome, C-value paradox, Fine structure of gene, Split genes and overlapping genes. Concept of Epigenetics and Genomic imprinting. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance. **Organization of Chromosomes:** Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains andscaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes.	

MODULE 2	**13Hrs**
Bacterial Recombination: plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of *E. coli*. **Mechanism of Recombination:** Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in *E. coli*; role of Rec A in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein in Meiotic recombination; Gene Conversion. Site-specific recombination: integration of lambda genome in *E. coli*. Topological manipulation of DNA	
MODULE 3	**13Hrs**
Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation: Ames test, Mutations in mitochondrial genome and related disorders. Karyotype - normal and abnormal karyotype analysis for genetic disorders. **Transposons and Molecular mechanism of transposition:**Transposable elements in prokaryotes and eukaryotes – IS elements, CompositeTransposons, Tn3 elements, *Ac* and *Ds* elements, P elements, Retrotransposon and theirsignificance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesis	
MODULE 4	**13Hrs**
Sex Determination: Factors affecting sex determination, Mechanism of sex determination in *Drosophila* (role of *sxl* gene) and mammals (role of *sry* gene). Secondary sex determination in mammals.Mechanism of dosage compensation in *Drosophila* (role of MSL genes) and mammals (X-chromosome inactivation, role of Xist RNA). **Medical Molecular Genetics:** Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzheimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)	

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

TEXT BOOKS :

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

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

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

COURSE OBJECTIVES :

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

COURSE OUTCOMES :

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

COURSE CONTENT:

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

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

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

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

MODULE 2: Microbial Techniques	13Hrs
Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM). Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective, enriched, enrichment and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic). Microbial Nutrition and kinetics: Growth curve, Macro and Micronutrients, Factors influencing the growth of microbes.	
MODULE 3: Applied Microbiology-I	**13Hrs**
Agriculture Microbiology- Biofertilizer: Biological Nitrogen fixation- symbiotic and asymbiotic, Phosphate solubilizing microbes, Microbial antagonism in soil, PGPR, Biological control of plant diseases (*Trichoderma*, *Pseudomonas* and AM fungi). Biopesticides: *Bacillus thuringiensis* and *Beauveria bassiana*. Medical Microbiology: pathogens, host-pathogens interaction, infection and its types. Bacterial diseases: *Staphylococcus* and *Salmonella.* Fungal diseases: Candidiasis, and Aspergillosis. Viral Diseases- Pox virus and Hepatitis viruses. Protozoan and Helminthic diseases: Malaria and Filaria.	
MODULE 4: Applied Microbiology-II	**13Hrs**
Environmental Microbiology: Microbes in biogeochemical cycle, biodegradation of pesticides (2,4D and DDT), crude oil, oil spillage in ocean, Xenobiotic (PET), biosorption of heavy metals. **Industrial Microbiology**: Fermentation, types, fermentor design, fermentation products- organic acids, vitamins, antibiotics and enzymes, fermented food- bread, cheese, Alcoholic products- wine and beer.	

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

TEXT BOOKS :

1. Ananthanarayanan, R. and Jayaram Panicker C.K. (2004) Text book of Microbiology. Orient Longman, Hyderabad.
2 Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
3 Dubey, R.C. Microbiology 1st Edition. Chand and company.
4 Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1998.
5 Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.

REFERENCES :

1 Edward Alcamo. Microbiology. Cliffs Notes 1996.
2 Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
3 Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.

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

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

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

COURSE CONTENT:	
MODULE 1	**13 Hrs**
History, scope, definitions and basic concepts in bioinformatics and its relation with molecular biology. Basic concepts in computer and its organization. Software & operating system - Windows, UNIX, Linux, Java, PERL and python. Application software- word processor, spread sheet. Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls. **Data management** - Relational Databases Management (RDMS) - Database generation. Data mining and applications, accessing bibliographic databases-Pubmed, Google Scholar, NCBI, EMBL and DDBJ. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB) &UniProt, Metabolic pathway data bank (KEGG)	
MODULE 2	**13 Hrs**

Introduction to protein structure. Data generation; Generation of large scale molecular biology data (Through, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction and protein biochips). Tools in proteomics: databases (GENBANK, Pubmed, PDB),Sequence analysis (FASTA, BLAST, BLAT), Structure viewer (RASMOL, PyMOL). Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and analysis tools. Secondary structure prediction (GOR), tertiary structure prediction, protein modelling-principles of homology and comparative modelling phylogenetics; Structure prediction methods – high accuracy and template based, free modelling (new folds); Pattern recognition – PSSMs, weight matrices; hidden Markov models. Threading, structure evaluation and validation and *ab intio*Modelling, Applications - Molecular docking – Autodoc.

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

TEXT BOOKS:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (2098). Bioinformatics.

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

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

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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

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

TEXT BOOKS:

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

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

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

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

List of Laboratory/Practical Experiments activities to be conducted (if any) :
5. Estimation of lactose in milk by Miller's method
6. Estimation of amino acids by Ninhydrin method
7. Estimation of Iodine number of fats
8. Estimation of nucleic acids by Orcinol and DPA method
9. Potentiometric titration of amino acids
10. The study of kinetics of potassium persulphate and potassium iodide via calorimetry
11. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation
12. Estimation of percentage of iron in hematite ore using barium diphenylamine sulphonate as an internal indicator
13. Estimation of calcium in lime stone by titrimetric method
14. Determination of the percentage of available chlorine in the given sample of bleaching powder

TEXT BOOKS:

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

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5172**					
TITLE OF THE COURSE	**TECHNIQUES IN MICROBIOLOGY AND GENETICS - LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**-**	**6**	**-**	**-**	**3**

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

COURSE OBJECTIVES :

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

COURSE OUTCOMES :

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

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

10.	Preparation of buccal smear to study Barr bodies.
11.	Concept of Multiple Alleles in Humans (Blood group).
12.	Genetics problems (Mendelian Genetics, epistasis, Sex-linked inheritance, Lethal Gene inheritance).

TEXT BOOKS :

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

REFERENCES :

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

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MHG5201**					
TITLE OF THE COURSE	**FUNDAMENTALS OF HUMAN GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**52**	**4**

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

COURSE OBJECTIVES :

- To be updated with the knowledge on the basics of human genetics and genetic causes for human diseases.
- To study the genetic techniques as to gain the knowledge in the field of basic human genetics.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	The fundamentals of human genetics will help to students in obtaining basic knowledge of human genetics and its importance.	L3
CO2	Students will have an idea on identifying the pattern of inheritance and genetic cause for the disease	L3

COURSE CONTENT:	
MODULE 1	**13Hrs**
Introduction to Genetics: Mendel and his experiments, Law of segregation and independent assortment; Chromosomal basis of segregation and independent assortment. Allelic variation and gene function, Dominance relationships, basis of dominant and recessive mutations; Multiple allelism, allelic series.	
MODULE 2	**13Hrs**
History and Scope of Human Genetics: Origin of Human Genetics, Present and future prospectus of Human Genetics, Pedigrees-gathering family history, pedigree symbols, construction of pedigrees; Monogenic traits-Autosomal inheritance-dominant and recessive; Sex-linked inheritance-dominant and recessive; Sex-limited and sex-influenced traits; Y-linked; Mitochondrial inheritance, Errors in transmission (Mutation), Classification of Genetic Disorders, Medical Applications of Chromosomes, Drawing of a pedigree, Consanguinity.	

MODULE 3	**13Hrs**
Human Cytogenetics: Review of cellular division mitosis and meiosis, Human Chromosomes, Chromosomal aberrations, Techniques in human chromosome analysis, Human karyotype: banding, nomenclature of banding, Pathology of human chromosomes, Nomenclature of aberrant karyotypes, Common chromosomal disorders and Mendelian disorders: Down syndrome, Edwards syndrome, Patau's syndrome and other trisomies, disorders of structural aberrations.	
MODULE 4	**13Hrs**
Complex traits: Characteristics and structure of genes, Single gene disorders, Multifactorial disorders. Polygenic inheritance of continuous (quantitative) traits, Dysmorphology, Polygenic inheritance of discontinuous (dichotomous) traits-threshold model, liability and recurrence risk, Genetic susceptibility in multifactorial disorders (alcoholism, diabetes mellitus, obesity), Estimation of genetic components of multifactorial traits: empiric risk, heritability, coefficient of relationship.	

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

TEXT BOOKS :

1. Principle of Genetics, 8th Edition, Gardner, Simmons, Snustad.
2. Human Molecular Genetics, 2nd edition, Tom Strachan and Andrew P. Read.
3. Human Genetics, Lewis, 1999.
4. Basic human Genetics, Mange and Mange, 1999.
5. Human Molecular genetics, Strachan and Read, 2003.
6. Cummings, M.R. 1997. Human Heredity: Principles and Issues. International Thomson Publishing Co., New York.
7. Mckinlay Gardner, R.J. 2000. Chromosome Abnormalities and Genetic Counseling. Oxford University Press, Oxford.
8. Ricki Lewis. 2009. Human Genetics-Concepts and Application. Ninth Edition. McGraw-Hill Collge Publishers.
9. Stern. C. 1973. Principles of Human Genetics, 3rd ed. W.H. Freeman and Company, San Francisco.
10. Turpin, R. and Lejeune, J. 1969. Human Afflictions and Chromosomal Aberrations. Pergamon Press, Oxford.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MHG5202**					
TITLE OF THE COURSE	**HUMAN BIOCHEMICAL AND IMMUNOGENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**52**	**4**

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

COURSE OBJECTIVES :

- To understand the genetics of biochemical disorders especially inborn errors of metabolism.
- To study the genetics of immune system and immunodeficiency diseases.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will get an idea of how genetically inherited diseases are associated with biochemical pathways.	L3
CO2	This course will help to understand the importance of genes in gaining immunity	L3

COURSE CONTENT:	
MODULE 1	**13Hrs**
The concept of Biochemical Polymorphism: Concept of enzyme and protein polymorphism; Effects of multiple gene loci on protein structure; Molecular structure, biosynthesis and genetics of the ABH antigens, Rh antigens and MN antigens. Quantitative and qualitative variation of enzymes; Haemoglobin variants; Hemoglobin and Hemoglobinopathies, Effects of Single Amino Acid Substitutions: Sickle cell Anaemia, Genetics of steroid and insulin receptors.	
MODULE 2	**13Hrs**
Inborn errors of metabolism: Disorders of aminoacid metabolism (Alkaptonuria, Phenylketonuria, Maple Syrup Urine Disease), Disorders of Carbohydrate Metabolism (Galactosemia, Hereditary Fructose Intolerance), Glycogen storage diseases (affecting liver and muscle), Lysosomal Storage Disorders (Tay-Sachs Disease), Disorders of Lipoprotein and lipid metabolism-Hyper Lipoproteinemia, FH; Disorders of Purine metabolism Lesch	

Nyhan syndrome; Disorders of Pyrmidine metabolism-Orotic Aciduria, Disorders of copper metabolism (Menkes and Wilson diseases).
MODULE 3 **13Hrs**
Introduction to immune system: Innate and adaptive immunity, Phagocytes, the complement system, natural killer cells; The adaptive immune system: Cellular immune system, humoral immune system; Genetic basis of structure and diversity; Immunoglobulin molecules and genetic basis of antibody diversity. Organization of immunoglobulin genes, mechanism of gene rearrangements, class switching, regulation of immunoglobulin genes.
MODULE 4 **13Hrs**
Regulatory mechanisms of immune system: The Major Histocompatability complex (MHC), Organization of HLA complex, Structure of class I and II HLA molecules, Expression of HLA genes, HLA polymorphism. Immunodeficiency diseases-Agamma-globulinemia, Severe combined immuno-deficiency, Ataxia telangiectasia, Wiskott-Aldrich syndrome. Hypersensitive reactions, Cytokine-related diseases, Immune system in human health, Immune response to infectious diseases and malignancy, Concept of immunotherapy, Vaccines, Transplantation immunology.

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

TEXT BOOKS :

1. Principle of Genetics, 8th Edition, Gardner, Simmons, Snustad.
2. Human Molecular Genetics, 2nd edition, Tom Strachan and Andrew P. Read.
3. Human Genetics, Lewis, 1999.
4. Basic human Genetics, Mange and Mange, 1999.
5. Human Molecular genetics, Strachan and Read, 2003.
6. Cummings, M.R. 1997. Human Heredity: Principles and Issues. International Thomson Publishing Co., New York.
7. Mckinlay Gardner, R.J. 2000. Chromosome Abnormalities and Genetic Counseling. Oxford University Press, Oxford.
8. Ricki Lewis. 2009. Human Genetics-Concepts and Application. Ninth Edition. McGraw-Hill Collge Publishers.
9. Stern. C. 1973. Principles of Human Genetics, 3rd ed. W.H. Freeman and Company, San Francisco.
10. Turpin, R. and Lejeune, J. 1969. Human Afflictions and Chromosomal Aberrations. Pergamon Press, Oxford.

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

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

COURSE OBJECTIVES :

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

COURSE OUTCOMES :

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

COURSE CONTENT:

MODULE 1: DNA replication and repair	**13Hrs**

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

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson & Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.

Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomere synthesis- telomerases regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.

Mechanism of DNA Repair: DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.
MODULE 2: Gene expression – Transcription **13Hrs**
Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination- Rho dependent and Rho independent. **Eukaryotic Transcription**: Composition of eukaryotic RNA polymerases, Role of enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, elongation and termination. Post transcriptional modifications of mRNA (5' cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.
MODULE 3: Gene expression- Translation **13Hrs**
Protein synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of amino acids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Co and post translational modifications of proteins, translation control in eukaryotes. **Protein targeting and localization**: Export of secretory proteins- signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxisomes and membrane.
MODULE 4: Regulation of gene expression in prokaryotes and eukaryotes. **13Hrs**
Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP in the expression of lac genes and catabolite repression Regulation of tryptophan operon by attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage. **Regulation of eukaryotic gene expression**: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs of transcription factors, post-transcriptional control. **Gene Silencing:** transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

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

TEXT BOOKS :

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

REFERENCES :

1 Pukkila P J., 2001. Molecular Biology: The Central Dogma.(https://doi.org/10.1038/npg.els.0000812)

2 Mejía-Almonte, C., Busby, S. J. W., Wade, J. T., van Helden, J., Arkin, A. P., Stormo, G. D., … Collado-Vides, J. (2020). Redefining fundamental concepts of transcription initiation in bacteria. Nature Reviews Genetics. (doi:10.1038/s41576-020-0254-8)

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

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

COURSE OBJECTIVES :

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

COURSE OUTCOMES:

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

COURSE CONTENT:	
MODULE 1	**13 Hrs**
Spectroscopy: Electromagnetic radiation & its interaction with matter, Lambert- Beer's law, extinction coefficient & its importance, design of colorimeter & spectrophotometer, chemiluminescence, thermoflourescence, principles & biological applications of UV& visible spectroscopy, Principles & applications of fluorescence, nephelometry, AAS. **Structural elucidation:** CD, IR, NMR, ESR, Raman spectroscopy & their applications in biology, x-ray Diffraction & their application in structural analysis of macro molecules.	
MODULE 2	**13 Hrs**
Electrophoresis: Moving boundary & zonal electrophoresis, paper & agarose gel electrophoresis, native and SDS PAGE, isoelectric focusing, 2D gel electrophoresis. Concepts and instrumentation of pulse field electrophoresis and capillary electrophoresis, Western, Northern and Southern blotting techniques. **Mass spectrometry:** principles, ionization mechanisms, mass analysis TOF, ion trap quadrapole, Ionization methods: electron impact, chemical ionization, fast atom bombardment, field desorption, electron spray ionization, MALDI, protein identification	

using MS. Microarrays, protein biochips.	
MODULE 3	**13 Hrs**
Chromatography: partition coefficient, paper& thin layer chromatography, adsorption chromatography, gel permeation & affinity chromatography, ion exchange chromatography, amino acid analyzer, gas chromatography, GCMS, HPLC, hydrophobic interaction chromatography, covalent, metal chelate & hydroxyapatite chromatography, special chromatographic techniques for nucleic acids, FPLC **Radioactivity:** Disintegration of radionuclides, half-life, detection & measurement, liquid scintillation counter, isotopic tracer techniques, preparation of labeled compounds & their use in biology, autoradiography.	
	13 Hrs
MODULE 4	
Centrifugation: principle, Svedberg's constant, types of centrifuges, differential & density gradient centrifugation, preparative & analytical centrifuges, sedimentation velocity, equilibrium analysis & its applications. **Techniques in drug discovery:** General protocol of classical drug discovery and clinical trials, In-Silico Drug Designing, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, QSAR, Database generation and Chemical libraries, ADMET property.	

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

TEXT BOOKS :

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

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

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

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

COURSE CONTENT:

MODULE 1 **13 Hrs**

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

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

MODULE 2 **13 Hrs**

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

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

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

TEXT BOOKS:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Baxavanis (2098). Bioinformatics.
7. Fry, J.C. (2093). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MSC5204**					
TITLE OF THE COURSE	**EVOLUTION AND DEVELOPMENTAL BIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**0**	**-**	**-**	**26**	**2**

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

COURSE OBJECTIVES :

- To provide students with a deeper insight into the evolutionary processes, both selective and random.
- To provide a comprehensive understanding of the concepts of early animal development.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Describe evolutionary history of complex multicellular life forms	L3
CO2	Explain the molecular and genetic background of animal and plant development	L3
CO3	Describe evolutionary history of complex multicellular life forms	L4
CO4	Interpret, analyse and present experimental results and conclusions in a scientific manner.	L3
CO5	Learning comparative anatomy, developmental mechanisms of organs, and methodologies to integrate genetics	L2

COURSE CONTENT:	
MODULE 1	**13Hrs**
Ecology and Evolution **Ecology and Evolution** **Ecology:** Introduction, biotic and abiotic factors, Biomes **Population ecology:** Dynamics of population, Population growth-Exponential model Logistic growth model **Community ecology**: Interactions, Biogeography, Speciation, Ecological succession, Disturbances Structure- Contrasting views **Ecosystems:** Energy flow and trophic levels, Biological and geochemical processes (BC cycles, B Pyramids etc) Human impacts on ecosystems **Evolution:** Introduction, Early ideas of evolution, Darwinian view of life. **Speciation and Evolutionary Rates:** The nature of evolutionary units; the modern	

synthesis and biological speciation, rates of evolutionary change. **Natural selection:** Stabilizing, directional, and disruptive selection. **Microevolutionary and Macroevolutionary phenomena:** insights into genetic drift, mutation and gene flow, Ontogeny and phylogeny
MODULE 2 **13Hrs**
Developmental Biology **Basic concepts of development:** Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; **Gametogenesis, fertilization and early development:** Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination **Morphogenesis and organogenesis in plants:** Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum **Morphogenesis and organogenesis in animals:** Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in *Drosophila*.

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

TEXT BOOKS :

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

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MHG5271**					
TITLE OF THE COURSE	**PRACTICALS IN HUMAN CYTOGENETICS, BIOCHEMICAL AND IMMUNOGENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**6**	**-**	**42**	**3**

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

COURSE OBJECTIVES :

- To increase students learning ability by conducting praticals of human cytogenetics, on biochemical genetics including errors in metabolism.
- To familiarize students with the various immunological techniques including antigen-antibody interactions, quantitation of antigens or antibody, agglutination reactions etc.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	After this course students would have practical knowledge of various human cytogenetic, biochemical and immunological techniques.	L4
CO2	Completion of this practical course, student will have the hands on training experience, which will help to carry out such practical experiments as well as research in future	L2

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1**.** Barr body identification from buccal cells
2. Karyotyping: a) Setting up of Human leukocyte culture b) Harvesting and metaphase plate preparations c) Preparation of G-banded chromosomes and observation
3. Problems on patterns of Inheritance in Human: Pedigree analysis; Autosomal patterns, X

and Y linked patterns.
4. Glucose estimation from Blood/Urine.
5. Sickling test to identify sickle shaped RBC's.
6. Determination of Red Blood Cell (RBC) and White Blood Cell (WBC) count by using hemocytometer.
7. Blood smear preparation and differential leukocyte count.
8. ABO-Blood grouping and Rh typing.
9. Single/Double Immunodiffussion assay for quantitation of antigens/antibody.
10. Determination of lymphocyte viability by Trypan blue dye exclusion test.

TEXT BOOKS :

1. 1 Wilson & Walker (2000). Practical biochemistry. Principle and techniques, Cambridge.
2. Grifith's et al. (2004). An introduction to genetic analysis, Freeman
3. Rooney, D.E. and Czepulkowski, B.H. (1992). Human Cytogenetics: A Practical Approach. IRL Press, Vol. 1&2, 2nded.
4. Stoddart, M.J. (2011). Mammalian Cell Viability: Methods and Protocols. Humana Press, New York.
5. Gersen, S.L. and Keagle, M.B. (2005). The Principles of Clinical Cytogenetics. Humana Press, 2nded.
6. Freshney, R.I. (2010). Animal Cell Culture: A Practical Approach. IRL Press, Oxford,
   2nded.
7. Hay FC and Westwood OMR (2003) Practical Immunology, 4th Ed., Blackwell Publishing.

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

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

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Isolation of plant genomic DNA using SDS/CTAB method and its analysis.
2. Isolation of genomic DNA from bacteria/animal tissue and its analysis.
3. Isolation of total RNA from biological source and its analysis
4. Study of conjugation in *E. coli.*
5. Study of mutation in *E. coli* by Physical method (UV).
6. Determination of extinction coefficient of biomolecules using UV spectroscopy (Protein/DNA/RNA)
7. Separation of biomolecules (amino acids/carbohydrates) using TLC.
8. Separation of phytomolecules (secondary metabolites) using silica column chromatography
9. Separation of proteins using SDS-PAGE and molecular weight determination.
10. Separation of cell organelles using density gradient centrifugation.

TEXT BOOKS:

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

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5301**					
TITLE OF THE COURSE	**MEDICAL AND CANCER GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**52**	**4**

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

COURSE OBJECTIVES :

- This course will provide up-to-date information about various applications of genetics to human health.
- The objective of the course is to understand how genetics contributes to predisposition and progression of cancer.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will have an idea on different types of genetic disorders, mapping of disease genes to specific locations on chromosomes, analyses of the molecular mechanisms through which genes cause disease.	L1
CO2	This course will familiarize the students with current concepts in cancer genetics and genomics.	L3

COURSE CONTENT:	
MODULE 1	**13Hrs**
INTRODUCTION TO MEDICAL GENETICS Scope of Medical Genetics: Practical applications of medical genetics, Impact of genetics condition on families, Types of human genetic diseases. Nomenclature of mutations, from genotype to phenotype: loss of function mutations, gain of function mutations. Identifying Human Disease Genes, monogenic and polygenic disorders.	
MODULE 2	**13Hrs**
GENETIC DISORDERS OF HUMAN Genetic disorders of Skin: Psoriasis, hereditary hemorrhagic telenglectsia, multiple neurofibromatosis, blooms syndrome. Skeletal system: Marfan's syndrome, brachydactyly, syndactyly, polydachyly, spina bifida and anencephaly, Rheumatoid arthritis, Osteogenesis imperfecta. Muscle: muscular dystrophies, Myotonia. Eye: Glaucoma, retinoblastoma. Jaws: Hare lip and palate. Ears: Deafness. Alimentary system: Hypertrophic pyloric	

stenosis. Respiratory system: Cystic fibrosis. Cardio vascular system: congenital heart disease, coronary heart diseases and Hypertension. Central nervous system: The ataxias and familial spastic paraplegia. Kidney and urinogenital tract: Cystinosis, polycystic kidney disease. Endocrine system: diabetes.
MODULE 3 **13Hrs**
AN OVERVIEW OF CANCER GENETICS The genetic basis of cancer, Characteristics of cancer cells, Difference between normal and cancer cells, Contact inhibition, Malignancy as a loss of normal cellular affinities, Differential gene expression in normal vs transformed cells, Molecular changes in proto-oncogenes, tumor suppressor genes-Knudson's Hypothesis.
MODULE 4 **13Hrs**
TYPES OF HUMAN CANCER Inherited versus sporadic cancers. Retinoblastoma, Lung cancer, Colon cancer, Brain cancer, Breast cancer, Prostrate cancer, cervical and esophageal cancers. Epstein Barr virus and its relationship to Burkett's lymphoma, Papilloma virus and cervical carcinoma. Genetic predisposition to sporadic cancer. Cancer prevention, diagnosis and treatment.

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

TEXT BOOKS :

1. 1. Peter Turnpenny and Sian Ellard (Eds) (2012) Emery's Elements of Medical Genetics, Elsevier, 14th Edition.
2. RA Weinberg (2012) Biology of Cancer, Garland, Taylor and Francis Group Publication, 2nd Edition.
3. Peter Turnpenny and Sian Ellard (Eds) (2012) Emery's Elements of Medical Genetics, Elsevier, 14th Edition.
4. LB Jorde, JC Carey and MJ Bamshad (2009) Medical Genetics, Elsevier Publication.
5. S Heim, F Mitelman (2011) Cancer Cytogenetics: Chromosomal and Molecular Genetic Aberrations of Tumor Cells, John Willey and Sons Publications.
6. Gardner, A. and Davies, T. (2009) Human Genetics-Scion Publishing, 2nd edition.
7. Tobias, E.S. , Connor, J.M. and Ferguson-Smith, M. (2011) Essential Medical Genetics, Wiley-Blackwell publications, 6th edition.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5302**					
TITLE OF THE COURSE	**GENETIC SCREENING, COUNSELING AND DISEASE MANAGEMENT**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**52**	**4**

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

COURSE OBJECTIVES :

- The primary objective of the course is to educate students in the fundamental concepts of medical genetics and counselling in order to become competent, insightful, knowledgeable, sensitive and passionate genetic counsellors.
- To provide intensive practical knowledge of Genetic Counseling, screening and disease management.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	This course will prepare the student with in-depth knowledge of genetic counseling, diverse fieldwork and innovative learning experiences to develop motivated genetic counselors to meet the needs of an expanding landscape in genetics and genomics.	L2
CO2	Student will understand the genetic mechanisms play a fundamental role in the pathogenesis and treatment of diseases and in the maintenance of health.	L3

COURSE CONTENT:	
MODULE 1	**13Hrs**
INTRODUCTION TO GENETIC COUNSELING Scope of genetic counseling, methods of genetic counseling, educating the counselee, presenting the risks and options and guiding. Information gathering and construction of pedigrees; Medical Genetic evaluation (Basic components of Medical History, Past medical history, social & family history). Components of Genetic Counselling: Physical examination (General and dysmorphology examination, Documentation), Legal and ethical considerations; Patterns of inheritance, risk assessment and counselling in common Mendelian and multifactor syndromes. Reproductive failures, consanguinity.	
MODULE 2	**13Hrs**

METHODS IN GENETIC SCREENING Scope of genetic screening, Prenatal and Post natal screening. Population screening for genetic diseases, family screening. Prenatal screening methods-Noninvasive methods (Ultrasound, Endoscopy, MRI, Maternal Serum Screening for Down's syndrome & Neural tube defect, Fetal Blood Sampling, etc.) Invasive methods; Amniocentesis, Chorionic Villi Sampling. Ethical issues in prenatal screening & diagnosis. Post-natal screening-chromosomal abnormalities, cytogenetic and molecular methods.

MODULE 3	**13Hrs**
POPULATION SCREENING Newborn screening: PKU, Galactosemia, SCA & Congenital Hypothyroidism. Population carrier screening: Alzheimer's, HD & FHCL, Disease susceptibility for complex diseases – CAD & T2DM, Thalassemia's, Cystic Fibrosis, DMD, Fragile– X syndrome, Hemophilia. Presymptomatic and predispositional testing. Markers for disease diagnosis and prognosis: Genetic markers; Protein/enzyme markers and antibodies	
MODULE 4	**13Hrs**
MANAGEMENT OF GENETIC DISORDERS 13 HRS Conventional methods for treatment of genetic diseases: Diet replacement, dietary avoidance, protein/enzyme substitution- Enzyme replacement therapy; substrate reduction therapy, Recombinant gene products for therapy. Gene therapy; Somatic cell gene therapy vs Germ line gene therapy; Gene transfer methods for therapy, Viral vectors, physical and chemical methods; Limitations of gene therapy Surgical interventions- Organ transplantation, bone marrow transplant. Immunotherapy: Approaches in immune therapy - use of Monoclonal antibodies, NK cells, Dendritic cells, B-lymphocytes and vaccines. Genomic medicine: Pharmacogenetics: G6PD & CYP2D6, benefits of Pharmacogenomics-personalized medicine.	

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

TEXT BOOKS :

1. Snustad, D P., and Michael J. Simmons. (2012) Principles of genetics. Hoboken, NJ: Wiley.
2. K Park (2011) Park's Textbook of Preventive and Social Medicine, Banarsidas Bhanot Publication, 21st Edition.
3. Peter Turnpenny and Sian Ellard (Eds) (2012) Emery's Elements of Medical Genetics, Elsevier, 14th Edition.
4. R.J. McKinlay Gardner, Grant R Sutherland, and Lisa G. Shaffer (2011), Chromosome abnormalities and Genetic counselling, Oxford University Press, 4th Edition.
5. Jean-Marie Saudubray, Georges van den Berghe, John H. Walter, (Eds.) (2012), Inborn Metabolic Diseases: Diagnosis and Treatment, Springer, 5th Edition.
6. DL Rimoin, RE Pyeritz, B Korf (2013), Emery and Rimoin's Principles and Practice of

Medical Genetics, Elsevier Science Publication, 6th Edition.
7. P George, GP Patrinos and WJ Ansorge (2010) Molecular Diagnostics, Academic Press, Elsevier Publication, 2nd Edition.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MSC5301**					
TITLE OF THE COURSE	**CLINICAL RESEARCH**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2		**-**	**-**	**26**	**2**

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

COURSE OBJECTIVES :

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

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will acquire sufficient knowledge on the process and regulatory perspectives of preclinical evaluation studies.	L3
CO2	Students will gain the concepts of designing and monitoring of clinical research studies.	L4

COURSE CONTENT:	
MODULE I: Concepts of Clinical Research	**13Hrs**
General introduction, routes of drugs administration, Dose, threshold dose, no observed effect level (NOEL), measurement of cumulative effects- time relationship. The area under the curve (AUC) of the concentration-time profiles, absolute bioavailability, Volume of Distribution (Vd). maximum tolerated dose (MTD). Basics of pharmacokinetics, calculation of pharmacokinetic estimates. Outline of drug metabolism and elimination. Organ toxicity. Scheme of preclinical evaluation of toxicity study. Calculation of LD50 & ED50. Acute, subacute and chronic toxicity studies. Irwin profile test. Lipinski's rule for drug like molecule.	
MODULE II: Regulatory Perspectives of Clinical Research	**13Hrs**

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

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

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

TEXT BOOKS :

REFERENCES

1. Central Drugs Standard Control Organization- Good Clinical Practices, Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health;2001.
2. International Conference on Harmonization of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonized Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 2096.
3. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi.
4. Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
5. Clinical Data Management edited by R K Rondels, S A Varley, C F Webbs. Second Edition, Jan 2000, Wiley Publications.
6. Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes.
7. Essentials of medical pharmacology. TRIPATHI (K D). 6th edition, 2009, Jaypee Brothers Publihsers.
8. Textbook of modern toxicology. HODGSON (Ernest), 4th Ed. 2010, John Wiley.
9. Foyes principles of medicinal chemistry, WILLIAMS (David A); 5th edition, 2002, Wolter Klu Publishers.
10. Introduction to biochemical toxicology, HODGSON (Ernest); 3rd edition, 2001, Wiley Publishers.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MSC5302**					
TITLE OF THE COURSE	**SCIENTIFIC WRITING AND IPR**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2		**-**	**-**	**26**	**2**

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

COURSE OBJECTIVES :

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

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	After completion of the course students will able to understand the concept and scientific writing. They will be able to draft suitable and effective reports and scientific journal papers.	L3
CO2	They will also get an idea about patent laws and will know how to file a patent	L4

COURSE CONTENT:	
MODULE I: Scientific writing	**13Hrs**
Introduction and overview: Types of projects (Hypothesis- driven projects, Discovery-driven projects, Technology- driven projects) Outlining the proposal, Project Summary, background, Specific aims, Hypothesis, Research strategy: Significance, Innovation and Approach, Bibliography and Reference writing. Ethics in proposal writing- Plagiarism. Writing Reports and Proposal: Objectives, Concept of report writing; Elements of report; types of reports; Dos and Don'ts of report writing; Formats for report. Concepts of Proposal writing, Characteristics of proposal, Types of proposal, Elements of proposal writing; Purpose of a research proposal.	
MODULE II: Intellectual Property Rights	**13Hrs**
Intellectual property rights-TRIPS, GATT-International conventions patents and	

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

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

TEXT BOOKS :

REFERENCES

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

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MSC5303**					
TITLE OF THE COURSE	**RESEARCH METHODOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**40**	**3**

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

COURSE OBJECTIVES :

1. Students understand research terminology one that can be used to carry out different approaches to research

2. To be aware of the ethical principles of research, challenge and approval processes

COURSE OUTCOMES :

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

COURSE CONTENT:	
MODULE I	**10Hrs**
Meaning, Objectives and Characteristics of research. Research Methods Vs Methodology. Types of research. Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical. Research process. Criteria of good research. Developing a research plan.	
MODULE II:	**10Hrs**
Defining the research problem. Techniques involved in defining the problem Survey of literature. Primary and secondary sources. Reviews, treatise, monographs patents. Identifying gap areas from literature review. Development of working hypothesis.	
MODULE III:	**10Hrs**
Research design and methods - Basic Principle. Features of good design. Prediction and	

explanation, Induction, Deduction, Development of Models. Developing a research plan. Exploration, Description, Diagnosis, and Experimentation. Determining experimental and sample designs.

MODULE IV:	**10Hrs**
Sampling design - Steps and types in sampling design. Measurement and scaling techniques. Methods of data collection. Testing of hypotheses. Procedure for hypotheses testing flow diagram for hypotheses testing. Data analysis with Statistical Packages. Correlation and Regression. Important parametric test. Chi-square test. Analysis of variance and Covariance.	

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

TEXT BOOKS :

REFERENCES

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

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5321**					
TITLE OF THE COURSE	**HUMAN POPULATION GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**40**	**3**

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

COURSE OBJECTIVES :

- To make student understand the forces that have an impact on levels of genetic variations in natural and/or experimental populations for both qualitative and quantitative traits.
- To make the students familiar with different types of DNA markers and the range of tools for their detection to enable advanced studies on molecular population genetics.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	This course will give students exposure towards understanding population health and disease susceptibility.	L3
CO2	This course will be helpful to the students to conceptualize the existence of genetic variation and speciation.	L2

COURSE CONTENT:	
MODULE 1	**10Hrs**
INTRODUCTION TO POPULATION GENETICS Mendelian Population and scope of population genetics. Gene and genotype frequencies, mating patterns, Hardy-Weinberg principle, heterozygotes, extension of H-W principle to multiple alleles, sex-linked alleles. Non-random matings, inbreeding and assortative matings, inbreeding coefficient. Factors that change allelic frequencies.	
MODULE 2	**10Hrs**
GENETIC MAPPING OF MENDELIAN TRAITS Identifying recombinants and non-recombinants in pedigrees. Genetic and physical map	

distances, Basics of genetic variation, Genetic markers-SNP, CNV, Indels, VNTR, STR, Microsatellite, Two-point mapping- LOD score analysis, Multipoint mapping, Homozygosity map.
MODULE 3 **10Hrs**
GENETIC VARIATION AND INHERITANCE OF COMPLEX TRAITS:
Tag markers and Haplotypes, Linkage disequilibrium, Fixation index; Quantitative Genetic analysis; Broad-Sense Heritability and Narrow-Sense Heritability. Testing gene mutations for alleles: complementation test, intragenic complementation Genotypes & phenotypes: Effect of the environment on phenotype development, Penetrance and expressivity, Visible, sterile and lethal mutations, Gene interactions and modifying genes, Pleiotropy.
MODULE 4 **10Hrs**
GENETIC POLYMORPHISMS AMONG POPULATIONS
Genetic polymorphism, transient and stable and factors responsible for stable polymorphism. DNA markers and populations differences. Application of population genetics. Role of population genetics in genetic counselling. Genetic origin and evolution of human races. Genetic Demography, age and gender specific death and birth rates, intrinsic rate of natural increase. Index of opportunity for natural selection.

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

TEXT BOOKS :

1. Hamilton M.B. (2009). Population Genetics. Wiley-Blackwell, UK.
2. Hedrick P.W.(2011). Genetics of Populations. Jones and Bartlett Publishers, Massachusetts.
3. Jobling, M., Hollox, E., Hurles, M., Kivisild, T. and Tyler-Smith, C. (2013). Human Evolutionary Genetics. Garland Science.
4. Nielsen, R. and Slatkin, M. (2013). An Introduction to Population Genetics: Theory and Applications. Sinauer Associates, Inc.
5. Relethford, J.H. (2012). Human Population Genetics. John Wiley & Sons.
6. Snusted, D.P., Simmons, M. J. (2010). Principles of Genetics. John Wiley & Sons, New York.
7. Knight, J.C. (2009). Human Genetic Diversity –Functional consequences for Health and Disease. Oxford University Press, USA.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5322**					
TITLE OF THE COURSE	**DEVELOPMENTAL AND REPRODUCTIVE GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**40**	**3**

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

COURSE OBJECTIVES :

- The goal of the course is to explore how genetic differences between individuals lead to behavioral differences between individuals.
- Provide an overview of reproductive disorders, types of infertility, and genetic causes for infertility.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	After completing the course students will be able to develop knowledge on hereditary mechanisms and processes relevant for the nervous system and behavior.	L3
CO2	Students will learn about genetic causes behind infertility, methods available for genetic testing, diagnosis, and reproductive options.	L2

COURSE CONTENT:

MODULE 1	**10Hrs**

EARLY DEVELOPMENT

Gametogenesis and differentiation: Oogenesis and spermatogenesis, Hormonal regulations. Fertilization and development: Molecular events of fertilization, activation of sperm motility, gamete fusion, Role of calcium during egg activation, Genetics of multicellularity cleavage, Molecular events.

MODULE 2	**10Hrs**

BASIC CONCEPTS OF DEVELOPMENT

Potency, commitment, specification, induction, competence, determination and differentiation; Morphogenetic gradients, pattern formation, cell fate and cell lineages; Mosaic versus regulative development; Genomic imprinting. Genomic imprinting; later phases of embryonic development; phenocopies and malformations; the development of structure and birth defects in humans; sex differentiation and its errors.

MODULE 3	**10Hrs**
REPRODUCTIVE SYSTEMS AND DISORDERS Male and female reproductive systems: Gonads and differentiation of sexual characters; hormonal regulation of sexual differentiation; Reproductive Disorders: Genetic and environmental susceptibility for reproductive disorders, endometriosis, polycystic ovarian disorder, pseudohermaphroditism; true hermaphroditism; gonadal disgenesis, testicular feminization.	
MODULE 4	**10Hrs**
GENETICS OF INFERTILITY AND ASSISTED REPRODUCTIVE TECHNIQUES Genetic basis of male infertility, genetic basis of female infertility; Abnormal gametes and infertility, Spontaneous abortions and still birth (etiology, pathogenesis, genetic characteristics, diagnosis and management), Reproductive technologies; Assisted reproductive techniques (ARTs), IVF, artificial insemination, cryo-preservation of oocyte, sperm & embryo, in vitro fertilization, embryo transfer, intra-cytoplasm sperm injection, ethical issues, prenatal diagnosis, pre-implantation genetic diagnosis (PGD), Genetic technologies used in PGD,	

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

TEXT BOOKS :

1. Plomin, R., DeFries, J.C., McClearn, G.E. & McGuffin, P. (2008). Behavioral Genetics (5th Ed.). Worth Publishers, NY.
2. Knopik, Neiderhiser,DeFries and Plomin. Behavioral Genetics. Worth, 2017, 7th Ed.
3. Mazzocco, M.M. & Ross, J.L (2007; Eds). Neurogenetic Developmental Disorders. MIT Press, Boston, MA.
4. Kim, YK (2009; Ed). Handbook of Behavioral Genetics. Springer, NY, NY.
5. Anholt, R. & MacKay, T. (2010). Principles of Behavioral Genetics. Elsevier Press, San Diego, CA.
6. Moody (2007). Principles of developmental biology, Elsevier.
7. Singh and Pal (2007). Human Embryology, 8th Edition, McMillan.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5323**					
TITLE OF THE COURSE	**CLINICAL GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**40**	**3**

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

COURSE OBJECTIVES :

- To provide students with increased knowledge about the genetic causes and inheritance of genetic disorders.
- This course is designed to provide an overview of human genetic diseases associated with blood, muscle, brain and Eye.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	After completing the course students will have acquired knowledge about the cause and inheritance of genetic disorders in humans.	L1
CO2	Students will have knowledge of genetic disorders, congenital anomalies and malformations and molecular mechanisms underlying these diseases.	L4

COURSE CONTENT:	
MODULE 1	**10Hrs**
GENETIC BASIS OF SYNDROMES AND DISORDERS Monogenic diseases: Cystic fibrosis, Tay-Sachs syndrome, Marfan syndrome. Polygenic diseases: Hyperlipidemia, Atherosclerosis, Diabetes mellitus. Genomic syndrome: Neurofibromatosis I syndrome. Genomic imprinting Syndromes: Prader-Willi & Angelman syndromes, Beckwith-Wiedeman Syndrome	
MODULE 2	**10Hrs**
CONGENITAL ABNORMALITIES AND DYSMORPHIC SYNDROMES Numerical (Down's Syndrome, Fragile-X syndrome, Edward's syndrome), Microdeletions (DiGeorge Syndrome, Prader Willi and Angelman Syndrome, Retinoblastoma), Breakage syndromes (Ataxia Telengiectasia, Fanconi Anemia)	

MODULE 3	**10Hrs**
DISORDERS OF BLOOD, MUSCLE AND EYE Disorders of Haemopoitic systems. Overview of Blood cell types and haemoglobin. Hemoglobinopathies, Thalassemias, Hemophilias. Disorders of muscle: Dystrophies (Duchenne Muscular dytstrophy and Becker Muscular Dystrophy), Myotonias, Myopathies. Disorders of eye: Retinitis pigmentosa, Cataracts, Colour blindness.	
MODULE 4	**10Hrs**
MITOCHONDRIAL AND NEUROGENETIC DISORDERS Mitochondrial disorders: Kearns-Sayre syndrome, Pearson's syndrome, and progressive external ophthalmoplegia, MELAS syndrome, Leber's hereditary optic neuropathy, Defects in nuclear genes leading to dysfunction of mitochondrial proteins (Friedreich's ataxia). Neurogenetic disorders:Charcot-Marie tooth syndrome, Spino-muscular atrophy, Alzheimer's disease.	

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

TEXT BOOKS :

1. Cassidy, S.B. and Allanson, J.E. (2010). Management of Genetic Syndromes. Wiley-Blackwell, 3rd ed.
2. Gardner, R.J.M., Sutherland, G.R. and Shaffer, L.G. (2011). Chromosome Abnormalities and Genetic Counselling. Oxford University Press, 4th ed.
3. Gunder, L.M.and Sudbury, S.A.M. (2011). Essentials of Medical Genetics for Health Professionals. Jones and Bartlett Learning.
4. Hudgins, L., Toriello, H.V. Enns, G.M. and Hoyme, H.E. (Eds.) (2014). Signs and Symptons of Genetic Conditions: A Handbook. Oxford University Press, London, 1st ed., p.560.
5. Jorde, L.B., Carey, J.C. and Bamshad, M.J. (2010). Medical Genetics. Mosby, 4th ed.
6. Korf, B.R. and Irons, H.B. (2013). Human Genetics and Genomics. John Wiley and Sons, Hoboken, 4th ed.
7. Roderick R. McInnes and Huntington F. Willard (2007).Thompson& Thompson Genetics in Medicine

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5324**					
TITLE OF THE COURSE	**APPLIED HUMAN GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**40**	**3**

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

COURSE OBJECTIVES :

- To understand applications of human genetics in drug therapy optimization and patient care.
- To enrich the current knowledge with nutritional genomics and genomic medicine.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Student will have the knowledge of recent trends in human genetics and its applications.	L1
CO2	This course will enhance the in-depth understanding of genomic medicine and Nutrigenomics concepts and cultivating empathy towards patients with genetic conditions	L4

COURSE CONTENT:

MODULE 1 **10Hrs**

APPLICATIONS OF HUMAN GENETICS

Production of recombinant Insulin, Interferon and Human Growth hormone (HGH). Vaccines-Hepatitis B vaccine. Preparation of DNA probes, Monoclonal antibodies and Diagnostic kits (Typhoid, Syphilis). DNA Fingerprinting: Methodology of DNA fingerprinting. Molecular markers-RFLP & RAPD, Micro satellite, SNPs, STR. Applications with examples in forensic science, medico legal aspects.

MODULE 2 **10Hrs**

PHARMACOGENOMICS

Introduction to pharmacogenomics. Genetic polymorphism of CYP isoenzymes and drug transporters. New pharmacological classes of drugs (antibodies, antisense RNAs, siRNAs, aptamers). Personalized medicine and drug prescription. Development of new innovative molecularly-targeted cancer therapeutics; Examples of drugs related to the pharmacogenomics application in clinical practice: a) Pharmacodynamics- and

pharmacogenomics-guided warfarin dosing in individual patients; b) Pharmacological assessment of tamoxifen-paroxetine interaction and pharmacogenomics of tamoxifen in oncology; c) Thiopurine drugs and pharmacogenomics of TPMT enzyme in guiding dosage schemes; d) Pharmacogenomics of antidepressant and psychotropic drugs.

MODULE 3	**10Hrs**

NEUTRIGENOMICS

Introduction to nutrigenomics and personalized nutrition. 'Omics' technologies used in nutrition. Nutritional Epidemiology and Study Design. Genetic variation and nutrient response. Food Intolerances. Consumer genetics and personalized nutrition- Keeping genetic information safe. Genetic determinants of eating behaviours. Functional food, functional food science, food technology and its impact on functional food development; markers for development of functional foods; key issues in Indian functional food industry and nutraceutical. Relation of functional foods and nutraceutical (FFN) to foods and drugs.

MODULE 4	**10Hrs**

CHARACTERIZATION OF COMPLEX DISEASE TRAITS

Scaling the human genome: UCSC genome browser, RegulomeDB database, ENCODE-ChIA-PET database, Dual Luciferase Reporter (DLR) assay. Estimating DNA-protein interactions: Chromatin Immunoprecipitation (ChIP) assay, Electrophoretic mobility Shift Assay (EMSA) and affinity pull down assays, 3D view of the Genome: Chromatin Conformation Capture (3C) and Hi-ChIP assays.

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

TEXT BOOKS :

1. QI L.Gene-Diet Interactions in Complex Disease (2012): Current Findings and Relevance for Public Health, Curr Nutr Rep: 1: 222-227
2. TUCKER K.L.,SMITH C.E.,LAI C.Q.,ORDOVAS J.M (2013).Quantifying diet for nutrigenomic studies, Annual review of nutrition: 33: 349-371.
3. PETERS L.L.,ROBLEDO R.F.,BULT C.J.,CHURCHILL G.A.,PAIGEN B.J.,SVENSON K.L.(2007). The mouse as a model for human biology: a resource guide for complex trait analysis, Nature reviews Genetics 8: 58-69.
4. FRAZER K.A.,MURRAY S.S.,SCHORK N.J.,TOPOL E.J.(2009). Human genetic variation and its contribution to complex traits, Nature reviews Genetics: 10: 241-251.
5. DAVID L.A.,MAURICE C.F.,CARMODY R.N.,GOOTENBERG D.B.,BUTTON J.E.,WOLFE B.E.et al. (2013) Diet rapidly and reproducibly alters the human gut microbiome, Nature

6. LUCA F.,PERRY G.H.,DI RIENZO A. (2010) Evolutionary adaptations to dietary changes, Annual review of nutrition: 30: 291-314.
7. Raffaele DE Caterina, J. Alfredo Martinez and Martin Kohlmeier (2020). Principles of Nutrigenetics and Nutrigenomics, Elsevier.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5325**					
TITLE OF THE COURSE	**GENETICS IN TOXICOLOGY AND FORENSIC SCIENCE**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**40**	**3**

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

COURSE OBJECTIVES :

- To Lay foundation in forensic genetics that can be applied to assess problems concerning various types of DNA markers and analyses.
- Study and understand different experiments employed in forensic genetics and Toxicology.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	At the end of the course student will able to understand genetic toxicology and methods applied in forensic genetics.	L1
CO2	Student will have the current knowledge of genetics in forensic applications.	L4

COURSE CONTENT:	
MODULE 1	**10Hrs**
INTRODUCTION TO GENETIC TOXICOLOGY Origin of genetic toxicology; historical prospective of genetic toxicology; fundamentals of genetic toxicity; mechanism of induction of chromosomal alterations and sister chromatid exchanges; mutagens-chemical, physical, biological, environmental and food; antimutagens. Mechanisms of gene mutations; germinal mutations and human genetic diseases; mutations and cancers; genetic toxicology and congenital malformations; consequences of genotoxic effects in humans.	
MODULE 2	**10Hrs**
EVALUATION OF GENO TOXICITY **10 HRS** Functional genomics: cDNA/gene, cloning; site-directed mutagenesis; Mammalian tissue culture, Methods for generation of transgenic animals/ knock-in, knockout models (microinjection, ES cell transformation); E Numutagenesis; PFGE, Automated DNA sequencing. In vitro gene mutation – bacterial reverse mutation assay (Ames test),	

mammalian cell Hprt mutation; In vivo gene mutation - Rodent lymphocyte Hprt mutation assay.
MODULE 3 **10Hrs**
INTRODUCTION TO FORENSIC GENETICS
Forensic Biology: Definition and scope Importance, nature, location, collection and preservation of biological exhibits and crime scene investigation of biological evidence. DNA Profiling: Introduction, History of DNA Typing, DNA variations, DNA typing systems- RFLP analysis, PCR amplifications, sequence polymorphism. Analysis of SNP, Y-STR, Mitochondrial DNA, Ancient DNA typing. DNA Statistics: frequency estimate calculations, interpretations, allele frequency determination, Paternity/Maternity index, Sibling index, Probability of match. Human Genome Project, DNA Forensic Databases.
MODULE 4 **10Hrs**
FORENSIC SIGNIFICANCE OF DNA PROFILING
Applications in disputed paternity cases, child swapping, missing person's identity- civil immigration, legal perspectives- legal standards for admissibility of DNA profiling, procedural and ethical concerns, status of development of DNA profiling in India and abroad. New and future technologies: DNA chips, SNPs and limitations of DNA profiling.

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

TEXT BOOKS :

1. Goodwin, Linacre, and Hadi (2010) An Introduction to Forensic Genetics, 2nd Edition, Wiley [Paperback]
2. Butler, J.M. (2005) Forensic DNA Typing, 2nd Edition, Elsevier.
3. Baird, M.L. Analysis of Forensic DNA Samples by Single Locus VNTR ProbesForensic DNA TechnologyMark Farley, James Harrington, editorsLewis, 1991.
4. Principles of Genetic Toxicology (2013) by D. Brusick Second Edition, Springer2. Genetic Toxicology Testing - A Laboratory Manual edited (2016) by Ray Proudlock Elsevier-Academic Press3. Genetic Toxicology: An Agricultural Perspective edited by Raymond F. Fleck, Plenum Press4.
5. Transgenic plants as sensors of environmental pollution genotoxicity (2008) Kovachuk and Kovalchuk. Sensors 8(3), 1539-15585.
6. Toxicology of Herbal Products edited by Olavi Pelkonen, Pierre Duez, Pia Maarit Vuorela, Heikki Vuorela.
7. Rudin N, Inman K (2001). An Introduction to Forensic DNA Analysis, CRC Press.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5371**					
TITLE OF THE COURSE	**LABORATORY EXERCISE IN MEDICAL AND CANCER GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**6**	**-**	**42**	**3**

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

COURSE OBJECTIVES :

- To increase students learning ability by conducting practical's including isolation of DNA/RNA from blood sample, amplification of gene through PCR, Sequencing of PCR products and analysis.
- To familiarize students with the various methods involved in mutation analysis, genotype-phenotype correlation and disease pathway analysis.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	After this course students would have practical knowledge of genotyping/genome analysis methods.	L4
CO2	On completion of this practical course, student will have the hands on training experience in the field of Molecular genetic testing.	L2

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1**.** Isolation of DNA from peripheral Blood.
2. Isolation of RNA from whole blood.
3. Quantity and Quality check for Genomic DNA and RNA by using agarose gel electrophoresis and spectrophotometric method.
4. Applications and usage of databases like, OMIM, NCBI, Ensemble, UCSC Genome browser, Emboss, PDB.
5. Primer designing by using bioinformatics tools for genes to be amplified through PCR.
6. PCR amplification of gene fragments by using specific primers.
7. Agarose gel electrophoresis to resolve PCR products and purification of PCR products.
8. Demonstration of sanger method of sequencing and analysis of mutations by using exon sequences of the gene.
9. Use of databases and bioinformatics tools for protein-structures, gene ontologies, protein-interactions and disease pathway analysis.

TEXT BOOKS :

1. Kary B Mullis, Francois Ferre (1994), PCR-The Polymerase Chain Reaction, Birkhauser Boston Edn.
2. LB Jorde, JC Carey and MJ Bamshad (2009) Medical Genetics, Elsevier Publication
3. R. Durbin (1998) Biological sequence analysis; Cambridge University Press, 1998.
4. T Strachan and AP Read (2011), Human Molecular Genetics, Garland Science/Taylor and Francis Group Publication, 4th Edition.
5. P George, GP Patrinos and WJ Ansorge (2010) Molecular Diagnostics, Academic Press, Elsevier Publication, 2nd Edition.
6. L Buckingham (2011) Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, FA Davis Company Publication, 2nd Edition.
7. P George, GP Patrinos and WJ Ansorge (2010) Molecular Diagnostics, Academic Press, Elsevier Publication, 2nd Edition.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5372**					
TITLE OF THE COURSE	**LABORATORY EXERCISES IN GENETIC SCREENING AND ANALYSIS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**6**	**-**	**42**	**3**

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

COURSE OBJECTIVES :

- Students will Explore knowledge in genetic counseling, screening and genetic testing methods by having case studies.
- Train the student to understand how to gather family history by pedigree construction, analysis and prediction of genetic risk.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	At the end of the course Students will be able to perform genetic counseling effectively.	L4
CO2	Students will get case based practical knowledge to understand genetic counseling screening and genome analysis methods.	L2

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Preparation of pedigree on case based study.
2. Case based genetic counseling, problems on Genetic counseling and risk assessment
3. Demonstration of comet Assay to detect DNA damage.
4. Applications and usage of databases like, OMIM, NCBI, Ensemble, UCSC Genome browser, Emboss, PDB.
4. Genotyping by using RFLP markers.
5. Genotyping using VNTR markers.
6. Quantitative PCR (qPCR) for estimation of gene copy or transcript expression level.
7. Demonstration of data analysis in genomics, transcriptomics (mRNA and miRNA analysis), and metagenomics.
8. Case studies in clinically relevant databases and SNP databases.
9. Maternal serum testing for prenatal diagnosis.
10. Identification of chromosomal abnormalities in relation to cancers using banding technique.

TEXT BOOKS :

1. Peter S Harper (2010), Practical Genetic Counselling Elsevier, 7th Edition.
2. R.J. McKinlay Gardner, Grant R Sutherland, and Lisa G. Shaffer (2011), Chromosome abnormalities and Genetic counselling, Oxford University Press, 4th Edition.
3. Jones KL and Smith DW : Smith's Recognizable patterns of Human malformations (7th Edition, 2013): Elsevier Health Sciences
4. Young I: Introduction to Risk Calculation in Genetic Counseling (3rd Edition,2006) Oxford University Press.
5. Knowles, Richard V. (2001) Solving problems in genetics, New York: Springer
6. S Heim, F Mitelman (2011) Cancer Cytogenetics: Chromosomal and Molecular Genetic Aberrations of Tumor Cells, John Willey and Sons Publications.
7. Griffiths, Anthony J., et al. (2015) Introduction to genetic analysis, New York, NY: W.H. Freeman & Company.

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

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

COURSE OBJECTIVES :

1. Construct a project from Plan, schedule, monitor and control students' own work and to exhibit ideas in discussions and presentations

2. Apply tools and techniques to the applied courses taught and to communicate their findings through a written report and poster presentation

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	To provide a postgraduate level knowledge in Human Genetics, 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 Human Genetics which prepares students for productive careers and lifelong learning.	L5