THIRUVALLUVARUNIVERSITY

MASTER OF SCIENCE

M.Sc. BIO TECHNOLOGY DEGREE COURSE

CBCS PATTERN

(With effect from 2017-2018)

The Course of Study and the Scheme of Examinations

S. No.	Part	Study Course Title		Ins. hrs /week	Credit	Title of the Paper	Maximum Marks		
SEMESTER I							**CIA**	**Uni. Exam**	**Total**
1		MAIN	Paper-1	6	4	Cell and Molecular Biology	25	75	100
2		MAIN	Paper-2	6	4	Molecular Genetics	25	75	100
3		MAIN	Paper-3	5	4	Biochemistry	25	75	100
4		MAIN	Practical	10	0	Core Practical 1.Labin Cell and Molecular Biology, Molecular Genetics and Biochemistry	0	0	0
5		Elective I	Paper-1	3	3	A. Molecular Interactions in Biology B. Bio processing Technology C. Aquaculture Bio technology	25	75	100
				30	**15**		**100**	**300**	**400**
SEMESTER II							**CIA**	**Uni. Exam**	**Total**
6		MAIN	Paper-4	5	4	Genetic Engineering	25	75	100
7		MAIN	Paper-5	5	4	Industrial Microbiology	25	75	100
8		MAIN	Paper-6	5	4	Immunology	25	75	100

9		MAIN	Practical-1	0	4	**Core Practical–1** Lab in Cell and Molecular Biology, Molecular Genetics and Biochemistry	25	75	100
10		MAIN	Practical-2	10	4	**CorePractical–2** Lab in Genetic Engineering, Industrial Microbiology and Immunology	25	75	100
11		Elective II	Paper-2	3	3	A. Proteomics and Genomics B. Pharmaceutical Biotechnology C. Virology	25	75	100
12		Compulsory paper		2	4	Human Rights	25	75	100
				30	**28**		**175**	**525**	**700**
SEMESTER III							**CIA**	**Uni. Exam**	**Total**
13		MAIN	Paper-7	5	4	DNA bar coding technology	25	75	100
14		MAIN	Paper-8	5	4	Animal Cell Biotechnology	25	75	100
15		MAIN	Paper-9	4	4	Industrial Biotechnology	25	75	100
16		MAIN	Practical-3	5	0	**Core Practical 3** 1.Lab in DNA bar coding technology and Animal Cell Biotechnology	0	0	0
17		MAIN	Practical-4	5	0	**Core Practical 4** 1. Lab in Industrial Biotechnology	0	0	0
18		Elective III	Paper-3	3	3	A. Nano biotechnology B. Bacteriology C. Medical Microbiology	25	75	100
19		Elective IV	Paper-4	3	3	A. Applied Biotechnology B. Human Diseases C. Systems Biology	25	75	100
				30	**18**		**125**	**375**	**500**

SEMESTER IV							CIA	Uni. Exam	Total
20		MAIN	Paper-10	5	4	Research Methodology	25	75	100
21		MAIN	Practical-3	0	4	**Core practical 3** Lab in DNA bar coding technology and Animal Cell Biotechnology	25	75	100
22		MAIN	Practical-4	0	4	**CorePractical4** Lab in Industrial Microbiology	25	75	100
23		MAIN	Paper-1	22	15	Project/Dissertation with Viva Voce	50	150	200
24		Elective V	Paper-5	3	3	A. Bio safety, Bioethics and IPR B. Biostatistics C. Stem cell biology	25	75	100
				30	**30**		**150**	**450**	**600**

NOTE: College can choose any one of the elective papers given A or B or C, as Elective for a particular Semester

Subject	Papers	Credit	Total Credit	Marks	Total marks
MAIN	10	4	40	100	1000
MAIN PRACTICAL	4	4	16	100	400
ELECTIVE	5	3	15	100	500
MAIN PROJECT	1	15	15	200	200
COMPULSORY PAPER	1	4	4	100	100
Total	**21**		**90**		**2200**

MAIN PAPER – 1

CELL AND MOLECULAR BIOLOGY

Objective: To understand better the cell and intracellular organelles and their vital functions

UNIT – I

Structural organization and function of intracellular organelles - Cell wall, Nucleus, Mitochondria, Golgi bodies, lysosomes, Endoplasmic reticulum, Peroxisomes, Plastids, Vacuoles, Chloroplast, structure & function of cytoskeleton and its role in motility.

UNIT – II

Membrane structure and functions: structure and chemical composition of model membrane. Functions - Membrane protein diffusion, Osmosis, Ion channels, Active transport, Membrane pumps, Mechanism of sorting and regulation of intracellular transport, Electrical properties of membranes.

UNIT – III

Cell signalling: Hormones and their receptors, Cell surface receptors, signaling through G – Protein, Coupled receptors, Signal transduction pathways, Second messengers, regulation of signaling pathways, Light signaling in plants. Ion Channel – Leaked receptors, Enzyme linked receptors, Cytoplasmic and Nuclear receptors.

UNIT – IV

DNA Replication: Unit of replication, Enzymes involved, Replication origin and replication fork, Fidelity of replication, extra-chromosomal replicons. Repair and Recombination: DNA damage and repair mechanisms.

RNA synthesis and processing – Transcription mechanism - Factors - Formation of initiation complex, Transcription activator and repressor, RNA polymerases, Capping, Elongation.

RNA processing - RNA editing, Splicing and polyadenylation, structure and function of different types of RNA, RNA transport.

UNIT – V

Protein synthesis and processing – Genetic code, Ribosome, Formation of initiation complex, Initiation factors and their regulation complex, Elongation and elongation factors, Termination, Amino acylation of tRNA, tRNA idendity, tRNA synthetase, Proof reading, Translational inhibitors, Post-translational modification of proteins.

SUGGESTED BOOKS:

1. Cell Biology – Channarayappa University Press India (P) Limited.
2. Text Book of Biochemistry for Medical students – 2nd edition – Rafi MD. University Press India (P) Limited.
3. Molecular Biology – 2nd edition – David Freifelder, Narosa Publishing House
4. Molecular Biology - Channarayappa University Press India (P) Limited.
5. Molecular Biology – Labfax, T.A. Brown, Bioscientific publishers Ltd, Oxford.
6. Molecular Biology and Biotechnology - J.M. Walker and R. Rapley, 2005
7. Genomes – T.S. Brown
8. Molecular Biology of the Cell – Alberts, B et al.
9. Cell and Molecular Biology - De Roberties and DeRoberties
10. Cell and Molecular Biology - P.K. Gupta

MAIN PAPER – 2 MOLECULAR GENETICS

Objective: To make the students familiar with the activity of the cell components, mutation at the molecular level.

Unit – I

DNA as the genetic material: Griffith's experiment, Hershey-Chase experiment, Experimental proof by Avery, McLeod and McCarty. Molecular nature of the gene - Organisation of Prokaryotic and Eukaryotic genome, Colinearity of Genes and Proteins.

Unit – II

DNA Replication: Conservative, Semi conservative, Rolling circle, Cairn s model of replication. Mechanism of replication - Okazaki fragments, role of different enzymes and accessory proteins. Specific examples of replication single stranded phage, double stranded, SV40, ØX174.

Unit – III

Mutation: Spontaneous, Induced mutation, Radiation induced Mutation – (Ionizing and UV radiation), Chemically induced mutation – Base analogs, Nitrous acid, Acridines, Alkylating and hydroxylating agents. Molecular basis of Mutation – tautomeric shifts, point mutation, transition, transversion, frameshift. DNA repair mechanism - photo reactivation, excision, SOS, recombination and heat shock responses. Chromosomal Abnormalities.

Unit – IV

Genetics of Bacteria and viruses: Transformation, Conjugation, F+, Hfr, Transduction- generalized and specialized. Gene Expression - DNA transcription in prokaryotic and eukaryotic systems.

Unit – V

Regulation of gene expression: Operon concept - lac and trp operons - inducible and repressible operons, effect of glucose, CAP, cAMP. Transposable genetic elements – IS elements, composite transposons, Tn3, Tn5, Tn10, medical significance. Eukaryotes – Ac and Ds elements in maize, elements in drosophila. Retro transposons. Genetic and evolutionary significance of transposable elements. Genetic basis of cancer – benign, malignant and metastatic cancer, Transfection test, Oncogenes and tumor suppressor genes, Ras protein signaling and cancer. Apoptosis.

SUGGESTED BOOKS:

1. The Cell – A molecular approach. 3rd edition by Geoffrey M. Cooper, Robert E. Hausman..
2. Principles of Genetics. 8th edition by Gardner, Simmons and Snustad.
3. Molecular Biology of Genes. 4th edition by Watson, Hopkins, Roberts, Steitz, Weiner.
4. Biochemistry. 4th edition by Geoffret L. Zubay.
5. Genetics Schaum's outline series. 4th edition by Susan Elrod – Tata McGraw Hill.
6. Human Genetics – Concepts and applications by Lewis, R.
7. Microbial Genetics by S.R. Maloy, J.E. Cronan, D. Freifelder, Jones and Barlett Publishers.
8. Molecular genetics of bacteria by J.W.Dale. Wiley and Son.
9. Basic genetics by D.L.G. Hartl, Jones and Publishers.
10. Freidfelder, D. Molecular Biology. Jones & Bartlett Pub, Second Edition.
11. Strickberger, MW.Genetics, 3rd edition, Macmillan Publishing Company.
12. Gene XI - Benjamin Lewin. Oxford University Press, UK.

MAIN PAPER – 3
BIOCHEMISTRY

Objective: To understand the energy background of the cell and energy derivation.

UNIT - I

Biomolecules – Introduction, Significance - Carbohydrates, proteins, lipids, nucleic acids, inorganic minerals. Chemistry of Carbohydrates - Structure and function of Monosaccharides, Oligosaccharides and Polysaccharides; Metabolism of carbohydrates - Glycolysis, Citric acid cycle, HMP pathway, Gluconeogenesis and Glycogenolysis. Electron Transport chain - oxidative and substrate level phosphorylation, Electron carriers of ETC.

UNIT - II

Lipids – Classification- Structure and functions of triglycerides, phospholipids, glycolipids, Significance of PUFA, Cholesterol and its derivatives. Metabolism of fatty acids - β-oxidation. Fatty acid biosynthesis - endogenous synthesis of triacylglycerols, phospholipids cerebrosides, gangliosides, cholesterol. Energitics of lipid metabolism.

UNIT - III

Proteins - Classification – Structure and functions of essential and nonessential aminoacids, Properties of amino acids. General degradation of amino acids - transamination, oxidative deamination, decarboxylation, disposal of ammonia, Urea cycle. Structure of protein - primary secondary, tertiary and quaternary. Conformation of protein (Ramachandran plot, secondary structure, domains, motif and folds).

UNIT - IV

Nucleic acids - Structure and function of DNA and RNA, Purine and Pyrimidine base structure, degradation and synthesis. Inborn errors of nucleotide metabolism. Vitamins - Structure, functions. Deficiency syndrome of vitamins (A, D, E, K, B12 & C).

UNIT - V

Biocatalyst - Enzymes classification, Mechanism of action - allosteric enzymes, isoenzymes, coenzymes and cofactors. Michaelis – Menton equation. Bioenergetics - Concept of free energy,Entropy, Enthalpy & Redox Potential. Determination of ΔG^0 for a reaction, High energy phosphate compounds - ATP, Phosphenol pyruvate, Creatine phosphate, phosphate potential. ATP-ADP Cycle, Energy charge - Phosphate potential & relation to metabolic regulation.

SUGGESTED BOOKS:

1. Lehninger AL, Nelson DL and Cox MM (2002), Principles of Biochemistry. Mac Millan Worth Publishers Inc. (CBS Pub. & Distributors, New Delhi)
2. Martin DW, Jr., Mayer, PA and Rodwell, VW (2002). Harper's Review of Biochemistry 25th Edition, Maruzen Asian Ed: Lange Med. Pub.
3. Stryer L (2002). Biochemistry, Freeman & Co.
4. Zubay, G. Biochemistry. Mac Millan Publication co. New York
5. Sunjay Jain, J L Jain & Nitin Jain, Fundamentals of Biochemistry, Chand Publications, New Delhi.
6. Corn and Stump. Outline of Biochemistry.
7. Deb, A.C. Fundamentals of Biochemistry, New Central Book Agency-Kolkata

MAIN PRACTICAL – 1

LAB IN CELL AND MOLECULAR BIOLOGY, MOLECULAR GENETICS AND BIOCHEMISTRY

LAB IN CELL AND MOLECULAR BIOLOGY

1. Isolation of plant DNA by CTAB method
2. Isolation of DNA from animal tissue
3. Isolation of DNA from the buccal cells
4. Estimation of DNA by diphenylamine method
5. Isolation of total RNA
6. Restriction digestion of plasmid DNA

LAB IN MOLECULAR GENETICS

1. Scoring for Mutants through Physical and Chemical agents
2. Development of auxotrophic mutants employing EMS
3. Screening of multiple antibiotic resistant mutants of E. coli
4. Replica plating technique
5. Bacterial conjugation
6. Bacterial transformation

LAB IN BIOCHEMISTRY

1. Estimation of protein by – Lowry method, Bradford method
2. Estimation of glucose by Ortho-toluidine method,
3. Total sugars by Anthrone method
4. Determination of glycine (Sorensen formal titration),
5. Separation of Amino acids by TLC method
6. Determination of physical factors (temperature and pH) affecting enzyme activity
7. Immobilization of enzyme

Industrial visit: Submission of Report of Molecular Lab visit

ELECTIVE – 1

PAPER - 1

A. MOLECULAR INTERACTIONS IN BIOLOGY

Objective: To make students understanding better about the cell by studying lipid dynamics and thermodynamics.

UNIT - I

Molecular constituents of cells: Standard unit of measurements - Properties and behavior – water, salts, ions and gases. Acids, bases, pH and buffers. Chemical bonds - ionic bond, covalent bond and secondary bond - hydrogen bonds and Vander Waal's bond. Coordination compound - ligands and chelates.

UNIT - II

Thermodynamics of Ligand binding and ligand-linked oligomerization (clustering) of proteins in model lipid bilayers and membranes. Structural principles, physical chemistry and allostery of ABC (ATP-binding cassette) transporters and voltage-gated K+ and Cl- channels.

UNIT - III

Chromosomes and chromatin - Histones and chromatin – centromeres and telomeres – Interactions of DNA and Protein

UNIT - IV

Recognition of DNA & RNA - DNA Binding Proteins, Nuclear Receptors, Antisense & small molecule ligand. Special properties of nucleic acids - Counterion condensation theory; effect of salt concentration and type on nucleic acid structure and nucleic acid-protein interactions. RNA structure and folding. Single-molecule nucleic acid biophysics.

UNIT - V

Protein-ligand - Mechanisms of protein ligand - Nucleic acid and protein-protein interactions. Dynamics of intramolecular structural changes - single-molecule FRET, single-molecule force spectroscopy monitored by laser optical tweezers and atomic force microscopy.

SUGGESTED BOOKS:

1. Alberts B. et al (2008) Molecular Biology of the cell. 5thedition. Garland Science.
2. Weaver, Robert Franklin (2012) Molecular biology. 5thedition. McGraw Hill, New York.
3. David Freifelder (2007). Molecular Biology.16th edition. N.K. Mehra for Narosa Publishing House, New Delhi.
4. Molecular Interactions at the Chemistry-Biology Interface, Parise, James, VDM Verlag publishers.

ELECTIVE – 1

B. BIOPROSPECTING TECHNOLOGY

Objective: To impart the knowledge of a drug production and characterization from various biosources.

UNIT - I

Bioprospecting – Definition, Secondary metabolites - nitrogenous and non-nitrogenous compounds, phenols, terpenoids, alkaloids.

Classification of crude drugs – Schemes for pharmacognostic studies of a crude drug, commercial significance of herbal products – current trend in market.

UNIT - II

Plant based pharmaceuticals – carbohydrates and derived products – drugs containing glycosides, tannins, lipids - fixed oils, fats and waxes, volatile oils, terpenoids, enzymes, proteins, alkaloids. Biological testing of herbal drugs – phytochemicals and their functions.

UNIT - III

Microbial bioprospecting - bioprospecting of microbes for new therapeutics - immunosuppressive, anti-tumor and anti-fungal drugs. Industrial enzymes, novel antifoulants and anti-biofilm agents. Biodiversity of marine microbial strains.

UNIT- IV

Process of bioprospecting – Collection and preparation of samples - microbes, plants, animals. Isolation, characterization and synthesis of specific compounds - aqueous and solvent extraction, distillation process - TLC, GLC, HPLC.

Screening of compound and usage - pharmaceutical (antimicrobial, anticancer, antimitotic, antitumour, antiviral and antifouling) and other uses (antioxidant, deterrent, plant growth regulation). Product development and commercialization - patenting and marketing.

UNIT - V

Marine bioprospecting for pharmaceuticals: Drugs from the marine organisms - sponges, bryozoan, microbes, tunicates, molluscans, sea weeds. Chemical diversity of marine organisms - nitrogenous metabolites, non – nitrogenous metabolites, phytochemicals. Blue gold - the oceans' genetic wealth. Legal aspects of bioprospecting - Patent law and Convention on Biological Diversity (CBD).

SUGGESTED BOOKS:

1. Marine Pharmacognosy: Trends and Applications, Su – Kim, Taylor and Francis Publisher,
2. A Lexicon of medicals plants in India, D.N. Guhabakshi, P.Sensarma and D.C.Pal, 1999. Naya prokash – publications.
3. Ethanobotany The Renaissance of Traditional Herbal Medicine, Rajiv K.Sinha, 1996.INA SHREE publishers.
4. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984 International Book Distributors.
5. Herbal plants and Drugs, Agnes Arber, 1999. Mangal Deep Publications.
6. Contribution to India Ethnobotany by Editor S.K.Jain, 1991 Scientific Publishers.
7. New Natural products and Plants drugs with Pharmacological, Biological (or) Therapeutical activity, H.Wagner and P. Wolff, 1979. Springer, New Delhi.
8. Ayurvedic drugs and their plant source, V.V.Sivarajan and Balachandran India 1994. Oxford IBH publishing Co.
9. Ayurveda and Aromatherapy, Miller, Light and Miller, Bryan, 1988. Banarsidass Delhi.
10. Principles of Ayurveda, Anne Green, 2000. Thorsons, London.
11. Pharmacognosy, Dr.C.K.Kokate et al.1999. Nirali Prakashan.
12. Biotechnoiogy and Patent protection, Beier, F.K., Crespi, R.S.and Straus, 1980.Oxford and IBH Publishing Co, New Delhi.

ELECTIVE – 1

C. AQUACULTURE BIOTECHNOLOGY

Objective: To understand the application of biotechnology in different aspects of aquaculture Feed, environmental management, diagnostic and pharmaceuticals.

UNIT - I

Introduction - Scope of biotechnology in fisheries and aquaculture research. Transgenics - Principles of transgenic technology and its application in fisheries, Synthetic hormones for induced breeding.

UNIT - II

Feed biotechnology: Probiotics, single cell proteins, nutraceuticals. Commercial Recombinant protein - enzymes, hormones, bioactive compounds, therapeutic proteins. Antimicrobial peptides and their applications. Marine toxins.

UNIT - III

Biotechnological approaches in environmental management: Bioremediation, biosensors, biofouling, treatment of waste water. Vaccination in fishes- DNA vaccines, sub UNIT vaccines and Biofilm Vaccines.

UNIT - IV

Applications of biotechnological tools - Recombinant DNA, Monoclonal antibodies, Cell lines , Stem cell culture, DNA markers and MAS. Application of tissue culture in sea weed and pearl production.

UNIT - V

Molecular diagnostic technology in aquaculture: PCR protocol for white spot syndrome virus WSSV, Infectious hypodermal and hematopoietic necrosis virus IHHNV, Yellowhead disease YHD, Taura syndrome virus TSV. Electron microscopy in advanced fisheries research. Cryomicroscopy in aquaculture research.

SUGGESTED BOOKS:

1. Felix S. 2007. Molecular Diagnostic Biotechnology in Aquaculture. Daya Publ. House.
2. Fingerman M, Nagabhushanam R & Thompson MF. 1997. Recent Advances in Marine Biotechnology. Vols. I-III. Oxford & IBH.
3. Glick BR & Pasternak JJ. 1999. Molecular Biotechnology: Principles and Applications of Recombinant DNA Technology. ASM Press.
4. Nagabhushanam R, Diwan AD, Zahurnec BJ & Sarojini R. 2004.Bi otechnology of Aquatic Animals. Science Publ.
5. Felix S 2007. Molecular diagnostic technology in aquaculture, Nare ndra Publishing House, Delhi, India
6. Nair PR. 2008. Biotechnology and Genetics in Fisheries and Aquaculture. Dominant Publ.
7. Pandian TJ, Strüssmann CA & Marian MP. 2005. Fish Genetics an d Aquaculture Biotechnology. Science Publ. Primrose SB. 1989. Modern Biotechnology. Blackwell.
8. Ramesh RC. (Ed.). 2007. Microbial Biotechnology in Agriculture and Aquaculture. Vol.II. Science Publ.
9. Reddy PVGK, Ayyappan S, Thampy DM & Gopalakrishna. 2005. Text Book of Fish Genetics and Biotechnology. ICAR.
10. Singh B. 2006. Marine Biotechnology and Aquculture Development. Daya Publ. House.
11. Zhanjiang JL. 2007. Aquaculture Genome Technologies. Blackwell.

MAIN PAPER – 4
GENETIC ENGINEERING

Objective: To impart knowledge of various aspects of gene cloning and applica tions of recombinant DNA technology.

UNIT - I

Gene Cloning – Introduction, Basic tools - restriction enzymes, modifying enzymes, linker, Adaptor, Homopolymor tailing, DNA ligase, Polymerase enzyme – types, functions, applications. Core techniques in gene manipulation - Cutting and joining of DNA, Itroduction of DNA into cells

UNIT - II

Cloning vectors - Bacteriophage vectors - pBr 322, PUC 18, M13. Bacterial vector - Cosmids, Phagemids, Phasmids, Bacterial Artificial Vector (BAC). Animal viral vectors - SV40. Plant vectors – CaMV, Ti-plasmid. Yeast vector - Yeast Artificial Chromosome. Gene transfer method - Transformation, Transduction, Particle bombardment, Electroporation, Liposome mediated gene transfer, Microinjection. Agrobacterium mediated gene transfer.

UNIT - III

Cloning strategies - Construction – Genomic, rDNA libraries, Probe construction, methods of labeling gene probes - recombinant selection and screening, Molecular cloning. Strategies for identifying recombinant clones – gene mapping technique

UNIT - IV

Analysis of cloned genes - Restriction enzyme analyses, Southern blotting, Northern blotting, Western blotting, colony & plague hybridization. Factors affecting expression of cloned genes, Reporter genes, Fusion proteins. Cloning and expression of commercially useful proteins.

UNIT - V

Application of r-DNA technology - production of recombinant proteins - insulin, Human growth hormone HGH, DNA vaccines. Transgenic plants - insect resistance, disease resistance. Transgenic animals – molecular pharming.

SUGGESTED BOOKS:

1. Principles of gene manipulation by RN old & S.B. Primrose (1996) Blackwell Scientific Publications
2. DNA cloning I & II by DM Glover & BD. Hames (1995) IRL, Press
3. PCR strategies by MA. Innis, DH, Gelfand & JJ Sninskey (((%), Academic press
4. Diagnostic Molecular Microbiology by D.H. Persing, K T.F. Smith, F.c. Teower and T.J. While. ASM Press 1993
5. Recombinant DNA by Watson JD, Gilman M. Witkowski, Zoller M. (1992), Scientific American Books
6. Recombinant gene expression protocols by Tvan RS (1997) Humana Press.

MAIN PAPER – 5
INDUSTRIAL MICROBIOLOGY

Objective: To provide the students the knowledge of scientific and industrial principles for the bioconversion of raw materials into value added products using microorganisms.

UNIT - I

Industrial microbiology – definition, scope and history. Isolating and screening of industrially useful microorganisms. Sterilization and disinfectant methods. Culture methods of microorganisms, culture maintenance

UNIT - II

Types of fermentation - Batch, continuous, semisolid and solid state etc. Fermentation medium

- components of media, types of fermentation process. Bioreactors - Types of Bioreactors - packed bed, bubble column, air lift, fluidized bed bioreactor, membrane/hollow fiber, photobioreactor etc.

UNIT - III

Industrial production by microorganism - Alcohol, glycerol, solvents - acetone, butenol, isopropyl alcohol. Vinegar, acids - lactic, citric, gluconic acid. Vitamins - Riboflavin, B12. Antibiotic - penicillin, streptomycin, tetracycline. Enzymes - alpha amylases, proteases, lipases. Growth factors - gibberellic acid. Hormones - humulin.

UNIT - IV

Microbial production of beverages - beer, wine, rum and whiskey. Food products - SCP, mycoprotein, bread, baker's yeast, cheese, and Yogurt. Fertilizers - rhizobium, azatobactor, azolla.

UNIT - V

Microbes in industry: Sewage treatment using microbial systems - biosorption and bioremediation. Biotechnology in paper industry. biohydrometallurgy and biominerlization (bioleaching). Post production technology - Downstream processing.

SUGGESTED BOOKS:

1. Elmer W. Koneman, Stepahen D Allen, William M Janda, Paul C Schreckenberger, Washington C Winn, Jr. Introduction to diagnostic Microbiology, J. B Lippincott Company, 1994.
2. P K Sivakuamr, M M Joe and K Sukesh, An introduction to Industrial Microbiology, S Chand Publication, 2010.
3. Bushell, M E. Principles of biotechnology. 1988.
4. Casida, L. E. Industrial Microbiology, Wiley Eastern Ltd. 1989.
5. Han, G A. Fermentation and fermentation systes . University of Tromso. 2009.
6. Lechevalier, H A and Morris S. Three centuries of Microbiology, Mc Graw Hill, New York 1965.
7. Stanbury, PF, A Whitaker and S J Hall. Principles of fermentation technology (II Edn). Butterworth Heinemann: Burlington, MA USA 1995.
8. Industrial Microbiology, L. E. J. R. Casida, New Age International Publisher, 2016
9. Prescott & Dunn's Industrial Microbiology, G. Reed, CBS Publishers & Distributors; 4th edition (1 December 2004)
10. Industrial Microbiology, Patel A H, LAXMI PUBLICATIONS-NEW DELHI (2015)
11. An Introduction to Industrial Microbiology, Sivakumaar P.K, S Chand & Company (1 December 2010).
12. Biotechnology: Industrial Microbiology A Textbook, Clarke W., CBS; 1 edition (2016).
13. Modern Industrial Microbiology and Biotechnology, Nduka Okafor, Science Publisher, Taylor and Francis Group, 2007.

MAIN PAPER – 6
IMMNUNOLOGY

Objective: To give an overview the basic concepts and principles of immune system and the techniques for developing diagnostics.

UNIT – I

Introduction to Immunology - Historical perspectives in immunology. Innate Immunity – Barriers and cells, Adaptive immunity – T cells & B cells. Maturation, APCs. Lymphoid organs – structure and functions of primary and secondary lymphoid organs. Molecules of Immune system - MHC, Membrane bound activation receptors and cell to cell interactions. Cytokines receptors - Chemokines and receptors.

UNIT – II

Monoclonal and polyclonal antibodies - production and application. Techniques to make human antibodies. Disease caused by disorders of the immune systems – Autoimmune diseases, Hypersensitivity, Immunodeficiency disease.

UNIT – III

Principles and Applications of immunotechniques - Immunization of rabbits for polyclonal antibodies. Purification of antibodies – Precipitation, Gel filtration, Ion exchange chromatography, Affinity chromatography.

Antibody assay – Double Immuno Diffusion, Radial Immuno Diffusion, Immuno electrophoresis, Rocket Immuno electrophoresis. Radio Immuno Assay (RIA), ELISA, Immunofluorescence, Western blotting, Immuno Electron Microscopy.

UNIT – IV

Transplantation immunology – Historical perspectives. Types of transplantation, Types of grafts, Histocompatibility antigens. Graft rejection – Mechanism of rejection, sanitization stage – Direct recognition, Indirect recognition. Effector stage – Immune destruction of grafts, Participation of antibodies, Role of cytokines and chemokines, Role of innate immunity. Clinical presentation of graft rejection - Hyperacute rejection, Acute rejection, Chronic rejection. Immune suppression - Immuno suppressive drugs, Biologics in immune suppression, Foetus as an allograft.

UNIT – V

Vaccines – Introduction, Modes of requiring immunity to infectious diseases – Passive immunization, Active immunization. Types of vaccines – Live vaccines, Live attenuated vaccines, Inactivated killed vaccines, Subunit vaccines, Conjugate vaccines, multivalent subunit vaccines, DNA vaccines, Recombinant vector vaccines, Edible vaccines. Vaccines delivering systems – Liposomes, Immunostimulation complexes, Virosomes. Some challenging diseases for vaccines – Vaccine against HIV, Retrovirus, Malaria.

SUGGESTED BOOKS:

1. Immunotechnology – Ashim K. Chakravarthy
2. Text Book of Basic and clinical immunology – Sudha Gangal, Shubhangi Sontakke Universities press
3. Immunology – Riott, Brostoff, Male, Mosby.
4. Biotechnology – U. Satyanarayana. Books and Allied (P) Ltd. Kolkatta.
5. Immunological techniques, D.M. Weir.
6. Monoclonal Antibodies: Principles and Practice, J.W. Goding, Academic Press.
7. Hybridoma Technology in Bioscience and Medicine, T.A. Springer, Plenum Press.
8. Basic and Clinical Immunology, D. P. Stities and J. D. Stobo.

MAIN PRACTICAL – 2

LAB IN GENETIC ENGINEERING, INDUSTRIAL MICROBIOLOGY AND IMMUNOLOGY

LAB IN GENETIC ENGINEERING

1. Plasmid DNA extraction from *E. coli*
2. Restriction mapping of genomic and plasmid DNA
3. Preparation of competent cells
4. SDS-PAGE analysis
5. Southern Blot analysis

LAB IN INDUSTRIAL MICROBIOLOGY

1. Isolation and purification of important bacteria
2. Isolation of yeast from rotten fruit juice and rice flour.
3. Quantitative estimation of ethanol produced during yeast fermentation.
4. Production of wine from grapes by using yeast.
5. Immobilization of microbes (bacteria and yeast) on sodium alginate gel.

LAB IN IMMUNOLOGY

1. Agglutination Technique: Blood group identification
2. Bacterial Agglutination Technique-Widal test (Tube / slide agglutination)
3. Ouchterlony Double Diffusion (ODD) and Radial Immunodiffusion (RID)
4. ELISA- Microtitre plate
5. Rocket immunoelectrophoresis (RIEP)
6. SDS PAGE and Western blot

Industrial visit: Submission of Report of Microbiology and Immunology Lab visit

ELECTIVE – II
Paper – 2
A. PROTEOMICS AND GENOMICS

Objective: To understand protein and gene sequences and their databases

UNIT - I

Proteomics - Strategies for design of novel proteins - structure and function. Computer methods in protein modeling, Protein structure - Ramachandran plot. Tools - Isoelectric focusing, PAGE, 2D PAGE, X-ray crystallography, Mass spectrometry, Maldi-Tof, Protein Microarray.

UNIT - II

Functional Proteomics - protein sequence and structural data, protein information resources and secondary data bases. Mining proteomes, protein expression profiling. Identifying protein – protein interactions and protein complexes. Mapping- protein identification, new directions in proteomics.

UNIT - III

Genomics - DNA sequencing method - Maxam Gilbert's method, Sanger's Method. NGS (next generation sequencing - Pyro sequencing, Big dye terminator, Solid, Illumina. Ion Torrent - Directed evolution and Error prone PCR, Applications of RDT

UNIT IV

Bioinformatics – Introduction. Biological databases – Primary, Composite. Secondary databases- Composite protein pattern databases, structure classification databases.

UNIT - V

Genome Information Resources - DNA sequence databases - Nucleic acid databases. Sequence homology, Gene finding. Protein databases - Protein modeling and structure prediction. Sequence alignment & homology searching - BLAST, ClustalW. Alignment - Pairwise alignment technique. Database searching - algorithms and programs, comparing two sequences, identity and similarity, global and local alignment, pairwise database searching. Multiple sequence alignment - Goal of multiple sequence alignment.

SUGGESTED BOOKS:

1. Bioinformatics: Basic algorithm and application, Ruchi Singh and Ruchi Sharma, Universities Press, Hydrabad.
2. Bioinformatics Sequence and Genome analysis; Mount DW, Cold Spring Harbor, Laboratory Press.
3. Bioinformatics : A practical guide to the analysis of Genes and Proteins; Baxevanis, AD and Ouellette BFF, Wiley-Liss
4. Molecular modeling: Principles and applications Prentice; Leach AR, Hall Publications.
5. Molecular Modelling and Drug design; Solomon A, MJP Publishers.
6. Microbial Proteomics: Functional Biology of Whole Organisms, Wiley-Interscience.
7. Microbial Genomics and Drug Discovery; Smith H and Hecker M, Publisher.
8. Genomics, Proteomics and Vaccines. Grandi et al., Wiley publication, 2003
9. Bioinformatics: A practical guide to the analysis of genes and Proteins. Baxevanis and Quellette. Wiley publication, 2002

ELECTIVE - II

B. PHARMACEUTICAL BIOTECHNOLOGY

Objective: To understand pharmaceutical products through biotechnology To inculcate gene therapy techniques

Unit – I

Pharmaceutical Biotechnology –Introduction, concepts, technologies and applications – pharmaceutical industries in India.

Unit – II

Biopharmaceuticals - Expression in plants. Industrial development and production process - scientific, technical. Economic aspects of vaccine research and development.

Unit – III

DNA vaccines – Vaccine from mice to humans. Characterization and bioanalytical aspects of recombinant proteins as pharmaceutical drugs. Biogeneric drugs.

Unit – IV

Therapeutic proteins – Special pharmaceutical aspects. Pharmaceutical and pharmacodynamics of biotech drugs, Formulation of biotech products – Rituximab. Clinical development of the first therapeutic antibody for cancer.

Unit – V

Gene therapy – Somatic, Nonviral gene transfer systems in somatic gene therapy. Advanced biotechnology products in clinical development. Xenotransplantation in pharmaceutical biotechnology, Pharmaceutical enzymes.

SUGGESTED BOOKS:

1. Daniel Figeys (Ed.). 2005. Industrial Proteomics: Applications for Biotechnology and Pharmaceuticals. Wiley, John & Sons, Incorporated.
2. Kayser, O and Muller R.H.. 2004. Pharmaceutical Biotechnology-Drug Discovery and Clinical Applications. WILEY-VCH
3. Heinrich Klefenz. 2002. Industrial pharmaceutical biotechnology.
4. Leon Shargel, Andrew B. C. Yu, Susanna Wu-Pong, and Yu Andrew B. C. 2004. Applied Biopharmaceutics & Pharmacokinetics. McGraw-Hill Companies
5. Stefania Spada, Garywalsh. 2004. Directory of approved biopharmaceutical
6. Gary Walsh. 2003. Biopharmaceutical, Biochemistry & Biotechnology.
7. Thomas Lengauer (Ed.). 2002. Bioinformatics – from Genomes to Drugs. Volume I& II. Wiley-VCH.
8. John F. Corpenter (editor), Mark C. Manning. 2002. Rational Design of stable formulation Theory and Practice (Pharmaceutical Biotechnology). Plenum, US. Ist edition.
9. D.I.A. Crommelin, et al., 2002. Pharmaceutical Biology. Amazon prime publications.
10. Werner Kalow, Urs A Meyer and Rachel F Tyndale .2001. Pharmacogenomics. CPL press.

ELECTIVE - II

C. VIROLOGY

Objective: To impart the knowledge on classification and mechanistic features of virus

UNIT – I

General properties of virus – Introduction, Characteristics, Morphology – Structure, Shape. Chemical properties, Viral haemagglutination, Viral multiplication.

UNIT – II

Cultivation of Virus – Animal inoculation, Embryonated eggs, Tissue culture. Viral Assay, Assay of infection. Viral genetics - Mutataion, Recombination.

UNIT – III

Classification and Nomenclature of Viruses - DNA viruses, RNA viruses, Viriods, Prion. Pathogenetics of viral infection – Routes of entry, spread of virus in the body, significance of the incubation period. Host response to virus infections – Immunological response, Non – Immunological response.

UNIT – IV

Laboratory diagnostics of viral diseases - Specimens, Microscopy, Demonstration of virus antigen, Isolation of virus, Molecular diagnosis. Immunoprophylaxis of viral diseases – Live vaccines, Killed vaccines, Passive immunization.

UNIT – V

Infective Virus: Viruses and cancer, Viruses of Fungi, Virusoids. Bacteriophages, Pox viruses, Herpes viruses, Adeno viruses, Hepatitis viruses, Oncogenic Viruses. Human Immunodeficiency Virus.

SUGGESTED BOOKS:

1. Microbiology by Presscott, Harley and Klein's – Joanne M. Willey, Linde M. Sherwood, Christoper J. Wool Verton – McGraw Hill – Higher Education
2. Cell Biology – Channarayappa, University Press India (P) Limited.
3. Ananthanarayana and Paniker's Text book of Microbiology, Arti Kabil, Universities Press, Hyderabad.
4. Microbiology: Fundamentals and Applications, Roanld M. Atlas, Prentice Hall.
5. General Microbiology, Stainer, Mc Millan Publishing co.

MAIN PAPER – 7

DNA BARCODING TECHNOLOGY

Objective: To make good understanding to the students of emerging technology to establish taxonomy of plants, animals and microbes at molecular level and other applications.

UNIT - I

Introduction to DNA barcoding – Historical perspective of molecular taxonomy, limitations in traditional taxonomy, Birth of DNA barcoding, DNA barcode regions for bacteria, fungi, plants and animals - Nuclear Markers (RAPDs, AFLPs, VNTRs, SNPs, ITS, ESTs and Microsatellites)
- Mitochondrial DNA markers (16S rRNA, 18S rRNA, CO1, COII, COIII, Cyt – b). Structure of mt DNA.

UNIT - II

Components of DNA barcoding - Collection and storage of samples - Selection of tissues for molecular studies (animal parts and plant parts) - Storage and medium of storage – Principles and protocols for DNA isolation - Purification of DNA - DNA precipitation - Factors affecting DNA isolation.

UNIT - III

Components of DNA barcoding: Principle of Quantification of DNA – Purity of DNA - RNA contamination – principle and mechanisms of AGE - Gel concentration - EtBr staining – PAGE
- Gel concentration - Silver staining. General consideration for electrophoresis - Buffer, gel loading dye and voltage.

UNIT - IV

PCR and Primers – Principle and application of PCR in DNA barcoding. Principle of various types of PCR - Gradient PCR, Non – gradient PCR, Nested PCR, RT PCR, qPCR and Touch down PCR - Optimization of PCR - Primers – Definition – specificity, stability and compatibility - Primer designing.

UNIT - V

DNA sequencing technology: DNA sequencing – Types - principle of Maxam – Gilbert sequencing, Sangar chain termination method, Next generation sequencing.

Molecular phylogeny – Phylogeny - Phylogenetic trees - homology - Molecular phylogenetic analysis - Neighbour joining - maximum parsimony and maximum likelihood - Genetic distance and variations. Uses of Sequence scanner, Bioedit, MEGA, Sequin, PHYLIP – NCBI, GenBank and BOLD.

SUGGESTED BOOKS:

1. DNA Barcoding: Methods and Protocols, H. Abdul Jaffar Ali, Vijay Nicole Imprints, Chennai. 2016.
2. A text book on DNA barcoding technology, H. Abdul Jaffar Ali, Vijay Nicole Imprints, Chennai. 2017.
3. Plant DNA Fingerprinting and Barcoding: Methods and Protocols, Sucher, Nikolaus J., Hennell, James R., Carles, Maria C. (Eds.), Humana Press, 2012.
4. DNA-Based Markers in Plants, Phillips, R.L., Vasil, Indra K. (Eds.), Springer Netherlands, 2001.
5. Species Diagnostics Protocols: PCR and Other Nucleic Acid Methods, Clapp, Justin P. Humana Press, 1996.
6. Nucleic Acid Electrophoresis, Tietz, Dietmar (Ed.), Springer-Verlag Berlin Heidelberg, 1998.
7. Molecular Systematics, David M. Hillis , Craig Moritz, Barbara K. Mable, Second Edition 2nd Edition, Sinauer Associates, Inc.; 2nd edition (January 18, 1996)

MAIN PAPER – 8
ANIMAL CELL BIOTECHNOLOGY

Objective: To gain a spectrum of understanding of various aspects of animal cell culture and gene transfer technology.

UNIT - I

Animal Cell Culture lab– Introduction. Lab design and equipments - Sterile area, Laminar flow hood, CO2 incubator, Cryostorage (liquid Nitrogen flask), Refrigerated centrifuges freezers (- 80^0C), Inverted microscope, Hemocytometer, pH meter, Magnetic stirrer, Micropipettes and pipette aid.

UNIT – II

Animal cell culture: Fundamentals, facilities and applications. Media for Animal cells. Types of cell culture - Primary, secondary. Cell transformation, cell lines, Insect cell lines, stem cell cultures, cell viability and cytotoxicity. Biology of cultured cells, measurement of growth, cell synchronization, senescence and apoptosis organ culture. Cryopreservation.

UNIT – III

Genetic engineering in animals - methods of DNA transfer into animal cells - calciumphosphate co precipitation, micro-injection, electroporation, liposome encapsulation. Biological vectors. Hybridoma technology, Vaccine production.

UNIT - IV

Gene therapy - Mapping of human genome. RFLP and applications. DNA finger printing and Forensic science. Molecular diagnosis of Genetic disorders.

Transgenic: Transgenic animals - Merits and demerits - Ethical issues in animal biotechnology. Production and recovery of products from animal tissue.

UNIT -V

Cytotoxicity - Estimation of viability by Dye exclusion, cell proliferation assays, MTT-based cytotoxicity assay.

Cultures - Cytokines, Plasminogen activators, Blood clotting factors, Growth hormones.

SUGGESTED BOOKS:

1. Culture of Animal cells: A Manual of Basic Techniques (2004) R. Ian Freshney.
2. Animal cell culture methods Jennie P. Mattar and David Barnes.
3. Animal Cell Biotechnology: Methods and Protocols (Methods in Biotechnology) 1st Edition, Nigel Jenkins.
4. Animal Cell Biotechnology: Methods and Protocols, Pörtner, Ralf (Ed.), 2014.
5. Animal Cell Culture: Concept and Application, Sheelendra M. Bhatt, 2013
6. Animal Cell Biotechnology, Vol. 1, by R. E. Spier (Author), J. B. Griffiths (Editor).
7. Textbook of animal biotechnology, B Singh, S K Gautam and M S Chauhan, Teri Press,

MAIN PAPER – 9
INDUSTRIAL BIOTECHNOLOGY

Objective: To gain relevant information regarding industrial production of volumes of products of microbial derivation.

UNIT – I

Industrial Biotechnology – Introduction **-** General information on microbes based industries – Major classes of commercial products using microbes – Enzymes, Amino acids, Vitamins, Antibiotics, Food and Beverages.

UNIT – II

Industrial use of microorganisms – isolation, preservation and maintenance of microorganisms. Selection of natural variants – important characteristics, screening methods. Strain improvement – Random mutagenesis and site directed mutagenesis. Isolation of induced mutants synthesizing improved levels of primary and secondary metabolites. Microbes exploited commercially – Saccharomyces, Lactobacillus, Penicillium, Acetobacter, Bifidobacterium, lactococcus, Streptococcus.

UNIT – III

Medium requirement for fermentation process – Carbon, Nitrogen, Minerals, Vitamins and other nutrients. Addition of precursors and metabolic regulators to media and medium optimization. Fermenter – Design, Functions and Types. Quorum sensing in Bioprocess.

UNIT – IV

Microbial enzymes in food processing – Industrial production of enzymes – proteases, amylase, invertase, pectinase and cellulase. High Fructose Corn Syrup (HFCS). Food products – cheese, yoghurt, jelly. Beverages – Alcoholic and Non – alcoholic beverages. Food additives and supplements – Probiotics, Healthcare products, Neutraceuticals, Vitamins and Anitbiotics.

UNIT – V

Mass cultivation of Spirulina, Single Cell Proteins (SCP), Petrocrops. Improvement of nutritional value of seed storage proteins. Biofertilizers – *Azospirillum, Azolla, Rhizobium, Frankia*, VAM. Mass production of phosphate solubilizing bacteria. Natural Biopreservatives. Biopolymers.

Biopesticides – genetic engineering of plants for pest and herbicide resistance. Current status of industrial biotechnology in India.

SUGGESTED BOOKS:

1. Stanbury P. F and Whittaker H., (1997) Principles of Fermentation Technology, Aditya Books (Pvt) Ltd, New Delhi.
2. Purohit and Mathur (1993) Basic and Agricultural Biotechnology.
3. Prescott and Dunn., Industrial Microbiology.
4. Gutierrez Lopez G. f., et. al., (2003) Food Science and Food Biotechnology, CRC Publishers, Washington.
5. Waites M. J., et. al., (2007) Industrial Biotechnology – An Introduction, Blackwell Publishers, UK.
6. Casida L. E., (2007) Industrial Microbiology, Wiley Publishers.
7. Cruegar F and Anne Liese Cruegar (2001) Industrial Microbiology.

MAIN PRACTICAL – 3

LAB IN DNA BARCODING TECHNOLOGY AND ANIMAL CELL BIOTECHNOLOGY

LAB IN DNA BARCODING TECHNOLOGY

1. Isolation of whole genomic DNA from animal tissue by Phenol – Choloroform method
2. Isolation of whole genomic DNA from Bacterial culture
3. DNA amplification by specific primer
4. Quantification of DNA by 260/280 ratio method
5. Determination of molecular weight of amplified DNA in Gel Doc system
6. Separation of PCR product in AGE
7. Pair wise alignment of DNA sequences using Bio edit
8. Submission of DNA sequences in Gen Bank, NCBI
9.

LAB IN ANIMAL CELL BIOTECHNOLOGY

1. Sterilization techniques
2. Animal Cell Culture Media preparation
3. Isolation of whole genomic DNA from animal tissue by Salting out method
4. MTT assay

Industrial visit: Submission of Report of Animal Tissue Culture Lab visit

MAIN PRACTICAL – 4

LAB IN INDUSTRIAL BIOTECHNOLOGY

1. Microbial Production of Ethanol.
2. Isolation of industrially important microbes.
3. Microbial production of citric acid using *Aspergillus niger*.
4. Microbial production of Antibiotics.
5. Isolation of Rhizobium form root nodules of higher plants
6. Testing purity of milk by assessing microbial presence.
7. Instrumentation of Fermentor (demo)

Industrial visit: Submission of Report of Biotech Industry visit

ELECTIVE – III
Paper – 3
A. NANOBIOTECHNOLOGY

Objective: To bring out the knowledge of nanomaterial and its tremendous application in various fields of biology.

UNIT – I

Introduction – Nanoscale, Types of nanomaterial, Physical and chemical properties. Biosynthesis of nanomaterials - Bacteria, Fungi, Algae, Plants, Gold, Silver, Cadmium, Copper. **UNIT – II**

Nanomaterial fabrication: DNA based artificial nanostructure, fabrication, properties and application. Nucleic acid engineered nanomaterial and their application. Protein patterning for application in biomaterials. DNA lipoplexes – Lipofection efficiency in In-vitro and In-vivo, Polymer controlled deliver of therapeutic nucleic acid.

UNIT – III

Instruments: X-ray diffraction (XRD), UV-Visible Spectroscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Tunneling Microscope (STM), Atomic Force Microscope (AFM).

UNIT – IV

Chemical fixation technique - Cryofixation technique, Dehydration, Embedding biological samples section, Sectioning, Staining, Mechanical milling, Chemical etching, Ion etching, Conductive coating.

UNIT – V

Applications: Medicine – Diagnosis, Therapeutic agents - Gene therapy, Antimicrobial activity and wound healing, Tissue engineering, Cosmetics. Communication in Bacteria - Satellite Communication. Environment – Nano material for Pollution abatement, Environmental sensors.

SUGGESTED BOOKS:

1. Challa S.S.R. Kumar (Ed). 2006. Biological and pharmaceutical nanomaterial's. Wiley – VCH Verlag Gmbh & Co., KgaA.
2. KK. Jain 2006 Nano biotechnology in Molecular Diagnostics: Current Techniques and Application Horizon Biosciences.
3. Niemeyer, C.M. Mirking C.A., (Eds) 2004. Nano biotechnology concepts.
4. Application and Perspectives, Wiley – VCH, Weinheim – 2004.

ELECTIVE - III

B. BACTERIOLOGY

Objective: To familiarize students the contribution of microbiologist. Pathological and industrial significance of bacteria

UNIT - I

Introduction to Microbiology – Scope, Ancient Microbiology, Discovery of penicillin, Discovery of vaccination. Major contribution of scientists – Leuwenhoek, Edward Jenner, Alexander Flemming, Joseph Lister, Robert Koch, Louis Pasteur, Har Gobind Singh Khorana. Modern Microbiology - Landmark achievements in 20th century.

UNIT - II

Microbial Taxonomy - Definition and systematics, Nomenclatural rules and identification. Haeckel's three kingdom classification, Whittaker's five kingdom approach, Woese domain system. Major characteristics used in taxonomy – morphological, physiological and metabolic. Genetic and molecular taxonomy. Bergey's classification of bacteria.

UNIT - III

Biology of bacteria - *Staphylococcus, Streptococcus, Pneumococcus, Nesseria, Corynebacterium, Bacillus, Clostridium, Proteus, Shigella, Salmonella, Vibrio, Pseudomonas, Yersinia, Haemophilus, Bordetella, Brucella, Mycobacterium, Spirochetes, Mycoplasmas, rickettsiae and chlamydiae.*

UNIT - IV

Microbial nutrition: Microbial nutrient requirements – macro-nutrients, micro-elements. Growth factors. Sources of nutrients, Nutritional classification of bacteria - Phototroph, Chemotroph, Autotroph (lithotroph), Heterotroph (organotroph), Photoautotroph, Photoheterotroph, Chemoautotroph, Chemoheterotroph. Nutritional patterns of pathogens – Saprophytes, Auxotroph.

UNIT - V

Economic importance of bacteria – Agriculture - Nitrogen fixing organisms. Ecological importance - Bioremediation and biopesticides. Industrial importance - Source of antibiotics, production of recombinant proteins - growth factors, hormones, vaccines etc. Normal flora in the GIT and their advantages.

SUGGESTED BOOKS:

1. Prescott, Harley and Klein- Microbiology-5th edition; Publisher: McGraw Hill science 2002.
2. Jacquelyn G. Black-Microbiology Principles and Explorations-6 th edition; Publisher:John Wiley &Sons, Inc. 2004.
3. Robert W. Bauman -Microbiology Brief edition, Publisher: Benjamin Cummings, 2004.
4. Gerard J. Tortora, Berdell, R. Funke, Christine L. Case, Microbiology: An Introduction.8th edition Hardcover: 944 pages, Publisher: Benjamin Cummings. 2004.
5. Kenneth J. Ryan,C. George Ray, John C. Sherris, Sherris Medical Microbiology : An Introduction to Infectious Diseases , Hardcover: 992 pages, Publisher: McGraw-Hill Professional, 2003.
6. John G. Holt, Bergey's Manual of Determinative Bacteriology. Lippincott Williams & Wilkins, 1993.

ELECTIVE - III

C. MEDICAL MICROBIOLOGY

Objective: To understand the causative agents which cause human health discomfort**.**

UNIT - I

Medical Microbiology - Introduction and historical developments – Developments in medical bacteriology, developments in medical virology. Normal microbiota of human body – Host, microbe interactions. Classification of diseases.

UNIT - II

Bacterial infection - Introduction, causative agents, characteristic features, virulence, pathogenesis, diagnosis, treatment and prevention of pneumonia, diphtheria, meningitis, whooping cough, Tb, leprosy, diarrhoea, cholera, typhoid, gonorrhea, syphilis, tetanus and gastroenteristis.

UNIT - III

Viral infection - Introduction, causative agents, characteristic features, virulence, pathogenesis, diagnosis, treatment and prevention of small pox, common cold, influenza, measles, mumps, tubella, hepatitis, AIDS and polio.

UNIT - IV

Parasitology - General characteristics of parasites – Habitat, structure, life cycle, clinical manifestation, diagnosis, treatment and control of amoebiosis, malaria, ascariasis, enterobiasis, giardiasis, sleeping sickness.

UNIT - V

Clinical symptoms - zoonotic infection, nosocomial infection, mycoplasma. Factors in Diseases - Environmental factor - physical injury, chemical injury, thermal injury, electrical injury. Developmental and genetic factors in diseases - gene defects. Abnormal fetal development – agenesis, dysgenesis, hypoplasia, aplasia, hypoplasia of mandibles, cleft palate.

SUGGESTED BOOKS:

1. 1.Immunology by Roitt- (2006) 2.Immunology by Kuby-(2003)
2. Medical Physiology Guyton and Hall-(1996)
3. Medical microbiology Mims Play fair Roitt, wekelin Williams.-(2009)
4. .Biopharmaceuticals: Biochemistry and biotechnology, Harvard Academic publishers-(1998) 6.Human Genetics- Gangane –(2000)
5. Medical Microbiology by Green
6. Fundamentals of Biochemistry- J. L. Jain-(2006)
7. Text book of Biotechnology by R. C. Dubey - (2008)
8. Biotechnology by Satyanarayana- (2010)

ELECTIVE – IV

A. APPLIED BIOTECHNOLOGY

Objective: To understand and familiarize with some of the techniques applied in agriculture, medicine, animal husbandry.

UNIT – I

PCR Technology: Introduction, Principle, Components of standard PCR – PCR Buffers and enzymes. Variants of PCR – Multiplex, Nested, Quantitative, RT-PCR. Medical applications of PCR.

UNIT – II

Vaccine Technology – Introduction, Generation of vaccine – First generation vaccines, Second generation vaccine (Cell Culture vaccine), Third generation vaccine (Recombinant and sub-unit and synthetic vaccines), fourth Generation vaccine (DNA vaccine). Medical Applications - Edible vaccines.

UNIT – III

RNA Technology - Introduction – Biogenesis of micro RNA, miRNA, siRNA. Applications –

Medical, Veterinary and Agriculture fields.

UNIT – IV

Biosensor Technology – Introduction, Types, Immunosensors – Application, Medical. Blood Glucose monitoring for diabetes. Agricultural application – Pathogen detection, Food, Toxicology test. Industrial applications – Drug delivery - Military application – DID stick test. **UNIT – V**

DNA foot printing – Southern blotting, Western blotting. Hybridoma technology - Monoclonal antibody production, application, advantages and disadvantages – DNA finger printing.

SUGGESTED BOOKS:

1. Biotechnology and medicine and agriculture principles and practices – Anil kumar, Ashwan's Pareak, Sanjay Mohan Gupta. International Publishing House Pvt. Ltd. NewDelhi..
2. Biotechnology By Satyanarayana – (2010).
3. A text book of Biotechnology, RC Dubey, S. Chand and Company Ltd (2006).
4. Industrial Microbiology A. H. Patel II Edition (2007)

ELECTIVE - IV

B. HUMAN DISEASES

Objective: To get the understanding of pathogenic spectrum of human**.**

UNIT - I

Infectious Diseases - Mycobacterial Diseases - Tuberculosis and Leprosy. Bacterial diseases - Typhoid, Diphtheria, Syphilis. Viral diseases - Polio, Herpes, Rabies, Measles, AIDS. Fungal diseases and opportunistic infections. Parasitic Diseases - Malaria, Filaria, Amoebiasis.

UNIT - II

Cardiovascular Pathology - Rheumatic fever and Rheumatic Heart Disease - Pathogenesis, Morphology and effects. Hypertension and Hypertensive Heart Disease. Respiratory Pathology - Inflammatory diseases of bronchi - chronic bronchitis, bronchial asthma, Pneumonia, Pulmonary Tuberculosis - Primary and Secondary.

UNIT - III

Urinary Tract Pathology - Acute Renal Failure - Acute tubular and cortical necrosis, Urinary Tract Tuberculosis. Pathology of the Gastro-Intestinal Tract **-** Peptic ulcer, Gastritis - types. Inflammatory diseases of small intestine - Typhoid, Tuberculosis, Crohn's, Appendictis, Amoebic colitis, Bacillary dysentery, Ulcerative Colitis.

UNIT - IV

Hematopathology - Anaemia - classification and clinical features, Blood transfusion - grouping and cross matching, untoward reactions, transmissible infections including HIV and hepatitis.

Liver and Biliary Tract Pathology - Jaundice, Hepatitis, Cirrhosis. **Reproductive System -** Diseases of the breast - Mastitis, Abscess, Neoplastic lesions, Carcinoma of penis, Genital Tuberculosis.

UNIT - V

Immunopathology – Hypersensitivity - types and examples. Antibody and cell mediated tissue injury with examples. Auto-immune disorders like systemic lupus erythematosis, organ specific and non-organ specific such as polyarteritis nodosa, Hashimoto's disease. Tumor Immunity - Organ transplantation. Immunologic basis of Rejection and Graft versus host reaction.

SUGGESTED BOOKS:

1. Textbook of Human Disease in Dentistry, Mark Greenwood, Robin Seymour, John Meechan, May 2009, Wiley-Blackwell.
2. Glycobiology and Human Diseases, Gherman Wiederschain, February 17, 2016 by CRC Press
3. Human Diseases (8th Edition) (Human Diseases: A Systemic Approach (Mulvihill)) 8th Edition by Mark Zelman Ph.D.
4. Elaine Tompary, Jill Raymond, Paul Holdaway M.A, Mary Lou E. Mulvihill Ph.D.
5. Essentials of Human Diseases and Conditions, 5e 5th Edition by Margaret Schell Frazier RN CMA BS, Jeanette Drzymkowski RN BS, Elsevier publications, 2013.
6. Diseases of human body, Carol D Tamparo. Davis and Company, 2016.

ELECTIVE - IV

C. SYSTEMS BIOLOGY

Objective: To imbibe the information to the students, computational cell biology and fabrication of data base of genetic apparatus of the biological system.

UNIT I - Principles of Systems Biology

Systems Biology and modeling, Properties of models, Variables, parameters and constants. Model development, Data integration. Techniques – Elementary and Advanced - Standard models and approaches in systems biology. Elementary flux models and extreme pathways - Flux balance analysis, Metabolic control analysis.

Unit – II - Metabolomics

Digestion of proteins and protein metabolism, Urea Cycle, Transport metabolism, Carbohydrate metabolism – metabolism of glucose – glycolysis, TCA cycle, glycogenesis, Pentose phosphate shunt, Electron transport. Lipid metabolism - beta oxidation. Interconnection of pathways, metabolic regulations. Phylogeny, RNA secondary Structure, Gene Prediction.

Unit – III - Computational Cell Biology:

Principle and levels of simulation – Virtual Erythrocytes, Pathological analysis. Flux Balance Analysis, Graphical Biological Network Editor and Simulator (Cell Designer).

Unit IV- Location Proteomics:

Protein subcellular location - Pattern Recognition. Predicting ligand binding function, Use of gene cluster, detecting protein – protein interaction. Methods for Protein-Protein Interaction Analysis- Yeast Two Hybrid System (Y2H), Peptide Mass Fingerprinting (PMF).

Unit V - Creative Bioinformatics:

Novel use for database. Use of EST database, Unigene, Gene discovery, Primer design, Restriction mapping, Position specific cloning, KEGG, SNP database, Target identification, Epitope identification. Spatial Signalling Dynamics – Methods and Quantification of receptor signaling.

SUGGESTED BOOKS:

1. Foundation of Systems Biology – Hi Roaki Kitano
2. Introduction to Systems Biology – Sangdun Choi
3. Shanmughavel, P. 2005. Principles of Bioinformatics, Pointer Publishers, Jaipur, India.
4. Shanmughavel, P. 2006. Trends in Bioinformatics, Pointer Publishers, Jaipur, India.
5. The underlying pathway structure of biochemical reaction networks. Christopher H. Schilling et. al. 1998. PNAS. 95:4193-8
6. Towards metabolic phenomics: Analysis of Genomics Data Using Flux Balances. Christopher H. Schilling et. al. 1999. Biotechnology. Prog. 15: 288-295.
7. The Minimal Gene Complement of Mycoplasma genitalium. Claire M. Fraser et. al. 1995. Science, 270: 397- 403.
8. Molecular Classification of Cancer: Class Discovery and Class prediction by Gene Expression Monitoring. Golub TR. et. al. 1999. . Science, 286: 531 – 537.
9. The Escherichia coli MG. 1655 in silico metabolic genotype: its definition, characteristics and capabilities. Jeremy S. Edwards et. al. 2000. PNAS. 97:5528-33.
10. Whole cell simulation: a grand challenge of the 21st Century. Masaru Tomita, 2001. Trends in Biotechnology. 19: 205-210
11. Cluster Analysis and Display of Genome – wide expression patterns. Michael B.Eisen et. al. 1998, Proc. Natl. Acad. Sci. USA. 95: 14863 – 14868.

MAIN PAPER – 10
RESEARCH METHODOLOGY

Objective: To inculcate the research methods and designing.

To access various data sources for research and also to write a thesis, research articles and project proposals.

UNIT - I

Research – Meaning, Purpose, Types. Steps in Research - Identification, selection and formulation of research problem. Formulation of hypothesis- types, testing of the hypothesis.

UNIT - II

Literature Survey - sources of information - primary, secondary, tertiary. Journals, reviews, books, monographs, bibliography. Web resources - E-Journal, Journal access, TOC alerts, Citation index, Impact factor, H-Index, E-Consortium, UGC infonet, E-Books, Internet discussion groups and communities, Scirus, Pubmed, Google Scholar, ChemIndustry, Wiki Databases, Science Direct, Sci Finder, Scopus.

UNIT - III

Research proposal - Purpose and scope, Sponsor identification, Format, Proposal development, Structure of research proposal - style of write up. Research Report - Types of reports -Technical report, Popular report. Contents - Styles of reporting, Steps in drafting reports, Editing the final draft. Evaluating the final draft.

UNIT - IV

Scientific papers – Short communication, Research articles, Review articles, book reviews, justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style.

UNIT - V

Synopsis - Thesis writing, Presentations - Oral and poster, publications of scientific works in journals, proceedings and chapters in book.

SUGGESTED BOOKS:

1. Writing the doctoral dissertation. Barrons Educational series, 2nd edition, Davis, G.B. and C.A. Parker, 1997. pp 160.
2. Authoring a PhD, thesis: how to plan, draft, write and finish a doctoral dissertation, Duncary, P. 2003. Macmillan, pp 256.
3. MS office, Sexena, S. 2001. Vikas Publishing House Pvt. Ltd., New Delhi M
4. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS
5. Publishers'Distributors
6. Kothari, C.R.,1985, Research Methodology- Methods and Techniques, New Delhi,

ELECTIVE - V

A. BIOSAFETY, BIOETHICS & IPR

Objective: To create awareness regarding safety and ethical issues about genetic modifications, stem cell research, patents and copy rights aspects of the biotechnological products and process.

UNIT - I

Biosafety – Introduction, biosafety issues in biotechnology, historical background. Introduction to Biological Safety Cabinets - Primary Containment for Biohazards, Biosafety Levels, Biosafety Levels of Specific Microorganisms. Recommended Biosafety Levels for Infectious Agents and Infected Animals.

UNIT - II

Biosafety Guidelines - Biosafety guidelines and regulations - National and International. operation of biosafety guidelines and regulations of Government of India, Definition of GMOs & LMOs. Roles of Institutional Biosafety Committee - RCGM, GEAC for GMO applications in food and agriculture. Environmental release of GMOs, Risk Analysis, Risk Assessment, Risk management and communication. Overview of National Regulations and relevant International agreements including Cartegana Protocol.

UNIT - III

Bioethics - What is bioethics - legal and socioeconomic impacts of biotechnology, Public education of the process of biotechnology, making ethical concerns of biotechnology research and innovation.

UNIT - IV

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

UNIT - V

Patents and patent laws - 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.

SUGGESTED BOOKS:

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Del
2. Ethics in engineering, Martin. M.W. and Schinzinger.R. III Edition, Tata McGraw-Hill, New Delhi. 2003.
3. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
4. Hoosetti, B.B.2002. Glimpses of Biodiversity. Daya, New delhi.
5. Senthil Kumar Sadhasivam and Mohammed, Jaabir. 2008. IPR, Biosafety and Biotechnology Management. Jasen Publications, Tiruchirapalli, India.
6. http://www.cbd.int/biosafety/background.shtml
7. http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section 3.html.

ELECTIVE - V

B. BIOSTATISTICS

Objectives: To understand basics in biostatistics and also To calculate and interpret various statistical tools in biology

Unit 1

Biostatistics: Introduction – definition – functions – scopes; Collection of data: primary – secondary; Sampling of data; Classification of data; tabulation of data; Presentation of Data: graphical representation – diagrammatic representation; Charting of data using MS-Excel.

UNIT 2

Measure of central tendency for individual, discrete and continuous series: mean, median, mode; Use of Excel in measures of central tendency; Measure of variation: range – quartile deviation – standard deviation – standard error.

UNIT 3

Correlation analysis: types and methods – calculation r- value; regression analysis: regression line and regression equation

UNIT 4

Sampling and test of significance: Random sampling – Test of significance – large samples and small samples – chi square test – Null Hypothesis

UNIT 5

Probability: Basic concept – types – Measure of probability – theorems of probability – permutation and combinations – ANOVA and ANCOVA (one way and two way)

SUGGESTED BOOKS:

1. **Biostatistics**, Daniel, W.W. 1987. New York, John Wiley sons
2. **An introduction to biostatistics**, 3rd Edn, Sundarrao, P.S.S. and Richards, J Christian Medical College, Vellore
3. **Statistics for Biology**, Boston, Bishop, O.N. Houshton, Mifflin.
4. **Statistics for biologist**, Campbell, T.C. 1998. Cambridge University press.
5. **Elements of biostatistics**, Prasad, S. Rastogi Pub
6. **Textbook of Computer applications and biostatistics,** Remeth Dias and Kailas K Mali, TRINITY PUBLISHING HOUSE, Satara - 415 001. India.2011.

ELECTIVE - V

C. STEM CELL BIOLOGY

Objective: To impart the knowledge to the students basics of stem cells – culture and application.

UNIT – I

Stem Cells – Introduction – History - Concepts in stem cell biology - Germline stem cells and germ line derived pluripotent - Embryonic Stem cells - Induced pluripotent stem cells & direct differentiation cells.

UNIT – II

Types of Stem cells: Chromatin in stem cell biology - Cardiac Stem cells - Hematopoietic Stem cells – Notch – Regeneration - Prostate and Mammary Stem cells; TGFß and GPCRs

UNIT III

Telomeres in Stem cell Biology - Neuro stem cells - Mesenchymal SCs - Intestinal and skin stem cells - Cancer and stem cells; RTKs, TGFß

UNIT IV

Stem cell culture - Embryonic stem cell, therapeutic uses of stem cell, disease recovery of stem cell, isolation and preservation of stem cell, clinical application of placenta in offspring - Ethical issues associated with stem cell biology.

UNIT V

Stem cell based treatment of diseases - stem cell used organogenesis in animals and human, clinical diagnosis of stem cell. Assisted reproductive technology - IUI, IVF, ICSI. Isolation of sperm and ova, role of sperm bank and ova bank, cryopreservation.

SUGGESTED BOOKS:

1. Essentials of Stem Cell Biology (Second Edition) Edited by: Robert Lanza, John Gearhart, Brigid Hogan, Douglas Melton, Roger Pedersen, E. Donnall Thomas, James Thomson and Sir Ian Wilmut
2. Essentials of Stem Cell Biology, Third Edition 3rd Edition by Robert Lanza (Editor), Anthony Atala (Editor)
3. Stem Cells: A Short Course 1st Edition by Rob Burgess (Author), John Wiley publisher, New Jersey.
4. Stem Cells: Basics And Applications, Kaushik D Deb and Satish M Totey, Tata McGraw-Hill Education, 2009.
5. Stem Cells, Anna M. Wobus, Kenneth Boheler Springer Berlin Heidelberg, 02-Dec-2005