

COTTON COLLEGE STATE UNIVERSITY

DEPARTMENT OF MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Post Graduate Molecular Biology and Biotechnology Syllabus

DISTRIBUTION OF PAPERS/CREDITS (L+T+P format)

Semester – I

Paper Code	Paper Name	Credits
MBB 701C	Cell and Molecular Biology	3 + 1 + 0
MBB 702C	Biochemistry	3 + 1 + 0
MBB 703C	Microbiology	3 + 1 + 0
MBB 704C	Practicals for Cell and Molecular Biology, Biochemistry and Microbiology	0 + 0 + 4
MBB 1201E	Medical Microbiology	1 + 0 + 0
MBB 1202E	Biofuel	2 + 1 + 0

Semester – II

Paper Code	Paper Name	Credits
MBB 801C	Genetics	3 + 1 + 0
MBB 802C	Immunology	3 + 1 + 0
MBB 803C	Biophysics and Instrumentation	3 + 1 + 0
MBB 804C	Practicals for Genetics, Immunology, Biophysics and Instrumentation	0 + 0 + 4
MBB 1203E or MBB 1204E	Nanobiotechnology Personalised Medicine	1 + 0 + 0 1 + 0 + 0
MBB 1205E or MBB 1206E	Biomedical Genetics Bioethics, Biosafety and IPR	2 + 1 + 0 2 + 1 + 0

Semester – III

Paper Code	Paper Name	Credits
MBB 901C	Genomics and Proteomics	3 + 1 + 0
MBB 902C	Genetic Engineering	3 + 1 + 0
MBB 903C	Plant and Animal Biotechnology	3 + 1 + 0
MBB 904C	Practical for Genomics and Proteomics, Genetic Engineering & Plant and Animal Biotechnology	0 + 0 + 4
MBB 1207E or MBB 1208E	Seribiotechnology Tea Biotechnology	1 + 0 + 0 1 + 0 + 0
MBB 1209E or MBB 1210E	Molecular Markers and Breeding Environmental Biotechnology	2 + 1 + 0 2 + 1 + 0

Semester – IV

Paper Code	Paper Name	Credits
MBB 1001C	Industrial Biotechnology	3 + 1 + 0
MBB 1002C	Bioinformatics and Biostatistics	3 + 1 + 0
MBB 1003C	Mini project*	5
MBB 1004C	Practicals for Industrial Biotechnology & Bioinformatics and Biostatistics	0 + 0 + 3
MBB 1211E or MBB 1212E	Biodiversity and Conservation genetics Medical Biotechnology	1 + 0 + 0 1 + 0 + 0

MBB 1213E	Food Biotechnology	2 + 1 + 0
or		
MBB 1214E	Herbal Biotechnology	2 + 1 + 0

***Mini project:** The student will have to carry out a mini project of 45 days duration at the parent institute or any other institute in the vicinity.

Note: Student will be offered one paper from each of the two elective papers of 1 and 3 credits respectively in each semester. However, there is no option given for elective papers in Semester I

**SEMESTER I
PAPER: MBB 701C**

**CELL AND MOLECULAR BIOLOGY
CREDITS: 3+1+0**

Unit I Internal organization of the cell

10 Lectures

The chemical components of a cell, the nature of biological molecules, membrane structure and function, intracellular compartments and protein sorting, vesicular traffic in the secretory and endocytic pathways, energy conversion: mitochondria and chloroplasts, cytoskeleton and cell motility; cytoskeletal proteins-chemical nature and organization, major functions of cytoskeleton.

Unit II Cell signaling

3 Lectures

General principle of cell signalling: signaling pathways, signaling molecules and their receptors, G-protein coupled receptors, second messengers, intracellular messengers, signal transduction: protein tyrosine phosphorylation

Unit III

3 Lectures

Cell-cell interactions and cell matrix interaction.

Unit IV Cell cycle

8 Lectures

An overview of gene control, checkpoint pathways induced in response to DNA damage, the role of tumor suppressor genes and oncogenes, signal transduction pathways of apoptosis and signaling molecules, defective apoptotic/cell proliferation pathways leading to cancer etc.

Unit V Differentiation of specialized cells

5 Lectures

Stem cell differentiation, blood cell formation, fibroblasts and their differentiation, differentiation of cancerous cells and role of proto-oncogenes.

Unit VI Nucleic acid metabolism**9 Lectures**

Structure of DNA and its physico-chemical properties, types of RNAs, structure and properties. DNA replication, prokaryotic and eukaryotic, DNA repair mechanism, structure and properties of RNA polymerases in prokaryotes and eukaryotes, mechanism of transcription, eukaryotic promoters and enhancers, general transcription factors, TATA binding proteins (TBP) and TBP associated factors (TAF), activators and repressors. Post transcriptional modifications of RNA.

Unit VII Regulation of gene expression**5 Lectures**

Prokaryotic gene expression with reference to inducible and repressible operons, concept of eukaryotic gene regulation, genetic basis of pattern formation in *Drosophila*, antisense RNA and RNA interference, post transcriptional controls.

Unit VIII Translation and transport**5 Lectures**

Translation machinery, ribosomes, composition and assembly, universal genetic code, degeneracy of codons, termination codons, isoaccepting tRNA, wobble hypothesis, mechanism of initiation, elongation and termination, co- and post-translational modifications, genetic code in mitochondria, transport of proteins and molecular chaperones, protein stability, protein turnover and degradation.

Suggested Readings

1. Lewin. B. Gene IX. 9th Ed, Jones and Barlett Publishers, 2007.
2. Alberts. B., Johnson. A., Lewis. J., Morgan. D., Roberts. K. and Walter. P. Molecular Biology of the Cell, Garland Science, 6th Ed, 2014.
3. Lehninger. A. L., Nelson. D. L., Cox. M. M., Principles of Biochemistry. CBS Publications, 2001.
4. Karp. G. Cell and Molecular Biology. 6th Ed, John Wiley and Sons, Inc, 2010.
5. Brown. T. A. Gene Cloning and DNA Analysis. 5th Ed, Wiley Blackwell, 2007.
6. Cooper. G. M. and Hausman. R. E. The Cell: A Molecular Approach, 6th Ed, Sinauer Associates, Inc, 2013.

**SEMESTER I
PAPER: MBB 702C**

**BIOCHEMISTRY
CREDITS: 3 + 1+ 0**

Unit I Chemical foundation of biology and concepts of energy**9 Lectures**

Acids, bases and buffers, Henderson- Hasselbach equation, biological buffer solution, pH, pK

Concept of free energy: Principles of thermodynamics, kinetics, dissociation and association constant, energy rich bonds, weak interactions, coupled reactions and oxidative phosphorylation, group transfer.

Unit II Biochemistry of macromolecules**9 Lectures**

Sugars: Classification, occurrence, isolation, purification, properties and biological reaction, glycoproteins and proteoglycans

Proteins: Amino acids and peptides ó classification, physio- chemical properties, peptide bond, primary, secondary and tertiary structure of protein, conformation of protein and polypeptide

Lipids: Classification, structure and function, triglycerides, phospholipids, steroids and terpenes, role of lipids in biomembranes.

Nucleotides and nucleic acids: Nucleic acid structure, diversity and functions of nucleotide.

Unit III Enzymology and nucleotide metabolism**10 Lectures**

Nomenclature, enzyme kinetics, regulation of enzymatic activity, enzyme catalysis. active sites: enzymes and coenzymes: coenzymes interactions: activators and inhibitors, kinetics of enzyme inhibitors, isoenzymes, allosteric enzymes, ribozymes, abzyme. biosynthesis and degradation of nucleotide

Unit IV Bioenergetics and Metabolism**13 Lectures**

Basic principles; Equilibria and concept of free energy; Glycolysis, Gluconeogenesis, Pentose phosphate pathway; Principles of metabolic regulations; Citric acid cycle, Glyoxylate cycle; Fatty acid oxidation, Ketone bodies; Oxidative phosphorylation and Photophosphorylation; Carbohydrate biosynthesis; Lipid biosynthesis- triglycerides, phospholipids, cholesterol.

Unit V: Vitamins, minerals and hormones:**7 Lectures**

Sources, biological and biochemical functions, steroids and isoprenoid derivations from vitamins. Minerals: requirements, macro and minor minerals- source and function. Hormones: classification of hormones, function of hormones and their regulation, mechanism of hormone action, site of biosynthesis and physiological function.

Suggested Readings

1. Berg. J. M., Tymoczko. J. L. and Stryer. L. Biochemistry. 5th Ed, W. H. Freeman, New York, 2002.
2. Voet. D and Voet. J. G. Biochemistry. 3rd Ed, John Wiley, New York, 2004.
3. Nelson. D. L and Cox. M. M. Lehninger Principles of Biochemistry. 5th Ed, W.H Freeman and Company, 2008.
4. Zubay. G. L, Biochemistry. 4th Ed, Wm. C. Brown publishers, 1998.
5. Sadasivam. S. K. and Manikam. A., Biochemical methods. 2nd Revised Ed, New Age International, 2005.
6. Palmer. T. and Bonner. P. Enzymes-Biochemistry, Biotechnology, Clinical Chemistry, 2nd Ed, Woodhead Publishing Limited., 2007.

SEMESTER I
PAPER: MBB 703C

MICROBIOLOGY
CREDITS: 3 + 1+ 0

Unit I Microbial characteristics

9 Lectures

Microbiology and microbes, nutritional requirements and factors affecting bacterial growth, cell division and growth curve, bacterial culture methods, bacterial metabolism.

Unit II Microbial diversity

11 Lectures

Microbial taxonomy and the evolution of diversity, classical and modern methods and concepts, domain and kingdom concepts in classification of microorganisms, criteria for classification; classification of bacteria according to Bergeys manual; Bacteria: purple and photosynthesis, green bacteria, cyanobacteria, acetic acid bacteria, pseudomonads, lactic and propionic acid bacteria, endospore forming bacteria, mycobacteria and mycoplasmas. archaea: halophiles, methanogen, hyperthermophilic archae, thermoplasm. Eukarya: algae, fungi, slime molds and protozoa.

Unit III Control of microorganisms

9 Lectures

Microbial diseases, detection and control of microorganisms: physical and chemical control of microorganisms, antibiotics, antifungal drugs, mode of action, antimicrobial drug resistant, biological control of microorganisms

Unit IV Virology

9 Lectures

Virus and bacteriophages, general properties of viruses, viral structure, taxonomy of virus, isolation, cultivation and identification of viruses, viral replication. Control of virus, subviral particles ó viroids and prions.

Unit V Microbes – host interaction

10 Lectures

Host-pathogen interaction, symbiosis, microbes as components of environment and nutrient cycles ó carbon, nitrogen, sulphur and phosphorus; microbial communication system; microbial fuel cells; prebiotics and probiotics; vaccines

Suggested Readings

1. Pelczar. M. J. Jr, Chan. E. C. S. and Kreig. N. R. Microbiology. 5thEd, Tata McGraw Hill New Delhi, 2004.
2. Madigan. M. T., Martinko. J. M., Stahl. D. A. and Clark. D. P. Brock's Biology of Microorganisms. 13th Ed, Benjamin Cummings, San Francisco, CA, 2012.
3. Maloy. S. R., Cronan. J. E. Jr. and Freifelder. D. J. Microbial Genetics, 2nd Ed, Bartlett Publishers.1994.
4. Cappuccino. J. G. and Sherman. N. Microbiology-a Laboratory Manual. 4th Ed, Addison Wesley, Longman, USA, 1999.
5. Atlas. R. M. Principles of Microbiology. 2nd Ed, W. M. T. Brown Publishers, 1997.
6. Willey. J. M., Sherwood. L. M. and Woolverton. C. J. Prescott, Harley and Kleinø Microbiology. 7th Ed, McGraw Hill Higher Education, 2008.

7. Brooks. G. F., Carroll. K. C, Butel. J. S. and Morse. S. A. Jawetz, Melnick and Adelberg's Medical Microbiology. 24th Ed, McGraw Hill Publication. 2007.
8. Aneja. K. R. Experiments in Microbiology Plant pathology, Tissue culture and Mushroom Cultivation. 2nd Ed, New Age International, 2003.

**SEMESTER I
PAPER: MBB 704C**

**PRACTICALS FOR CELL AND MOLECULAR BIOLOGY, BIOCHEMISTRY AND
MICROBIOLOGY
CREDITS: 0+0+4**

A. CELL AND MOLECULAR BIOLOGY

1. Micrometry: Calibration of stage and ocular micrometer, and measurement of the given biological sample.
2. Haemocytometer: Calibration and measurement of biological samples.
3. DNA extraction from plant, blood, animal tissue and bacteria.
4. Agarose gel electrophoresis for DNA.
5. Spectrophotometry for DNA quantification.
6. Study of mitotic cell division in onion root tip.

B. BIOCHEMISTRY

1. Preparation of buffer and solutions
2. Quantitative estimation of plant pigments
3. Carbohydrate estimation by Anthrone method
4. Protein estimation by Bradford method
5. Estimation of Vitamin - C

C. MICROBIOLOGY

1. Sterilization techniques used in microbiological experiments.
2. Isolation and maintenance of bacteria and fungi by plating, streaking and serial dilution methods.
3. Staining techniques for the study of bacteria and fungi- Gram's staining and Ziehl-Neelsen's staining for bacteria and Lactophenol Cotton Blue staining for fungi.
4. Viable count of bacteria- standard plate count.
5. Study of bacterial growth kinetics.
6. Antibiotic sensitivity assay.
7. MPN count for checking water quality.
8. Biochemical test for identification of bacteria-sugar fermentation, indole test, MR test, H₂S production test, catalase test, citrate and urease tests.

**SEMESTER II
PAPER: MBB 801C
GENETICS**

CREDITS: 3+1+0

Unit I Physical basis of heredity

5 Lectures

Chromosome number, morphology, autosomes and sex chromosomes, gametogenesis in plants and animals.

Unit II Genomes

10 Lectures

Organization of prokaryotic DNA; plasmids, transposons in prokaryotes and eukaryotes. Human genome; genes, gene families, pseudogenes, repetitive sequences. mitochondrial and chloroplast genomes.

Unit III Patterns of inheritance

6 Lectures

Dominant and recessive alleles, Mendel's law of inheritance, multiple allelic systems, sex determining mechanisms, sex-linked, sex-influenced and sex-limited inheritance, epistasis, pleiotropy, penetrance.

Linkage and chromosome mapping: linkage, crossing over, genetic recombination, genetic mapping, map distance, test cross, gene order

Unit IV Mutagenesis

3 Lectures

Mutagenic agents, mechanisms of mutagenesis; Expression of mutations ó gene mutation; point mutations and frameshift mutations, isolation of auxotrophs, conditional lethals and suppressor mutations

Unit V Cytogenetics

5 Lectures

Cell division and errors in cell division; non disjunction; structural and numerical chromosomal abnormalities ó deletion; duplication; translocation, disorders of sex chromosomes and autosomes

Molecular cytogenetics ó Fluorescence *In Situ* Hybridization (FISH), Comparative Genomic Hybridization (CGH).

Unit VI Microbial genetics and immunogenetics

8 Lectures

Conjugation, transduction and transformation in bacteria, bacteriophages and their genetic systems. lytic and lysogenic phases of bacteriophage, lambda genetic control.

Major histocompatibility complex, immunoglobulin genes - tissue antigen and organ transplantation, Single gene disorders of immune system.

Unit VII Human genetics

5 Lectures

The human chromosome, chromosome abnormalities, types of genetic diseases, genetic screening; biochemical markers, gene linkage, pre-natal diagnosis, ethical issues, genes and cancer, concept of epigenetics.

Unit VIII Population genetics and evolution**4 Lectures**

Phenotype, Genotype, Gene frequency; Hardy-Weinberg law; Factors distinguishing Hardy Weinberg equilibrium; Mutation selection; Migration; Gene flow; Genetic drift, Human genetic diversity; Origin of major human groups.

Unit IX Genetics and society**2 Lectures**

Genetics in forensic science; DNA comparisons-RFLPs, VNTRs, genetics in medicine, transgenic animals

Suggested Readings

1. Gardner. E. J. and Sunstad. D.P. Principles of Genetics, John Wiley and Sons, 2000.
2. Strickburger. M. W. Genetics, Macmillan Pub. Co., 1994.
3. Strachan. T. and Read. A. P. Human Molecular Genetics, Garland Science, 2004.
4. Russell. P. J. Genetics, Benjamin-Cummings Publishing Company, 1998.

**SEMESTER II
PAPER: MBB 802C
IMMUNOLOGY**

CREDITS: 3+1+0

Unit I Immunology-Basic concepts and anatomy of the immune system**7 Lectures**

Components of innate and acquired immunity; hematopoiesis; cells of the immune system-B cells, T cells, NK cells, lymphoid cells; macrophage and phagocytosis; primary and secondary lymphoid organs of the immune system; mucosal and cutaneous associated lymphoid tissues; antigens-immunogenicity and antigenicity, adjuvants, epitopes, haptens; major histocompatibility complex antigens-MHC genes, HLA typing,

Unit II Immune receptors and Immune response mechanism**10 Lectures**

B-lymphocytes; B-cell receptors; B-cell generation, activation and differentiation; T-lymphocytes; T-cell receptors; T-cell maturation; activation and differentiation; antigen processing and presentation-self and non self discrimination, antigen presentation; antigen processing pathways-cytosolic and endocytic pathway.

Unit III The Immunoglobulins and antigen antibody interaction**10 Lectures**

Basic structure of immunoglobulins; classes and subclasses; multigenic organization of immunoglobulin genes; complement systems-classical and alternative pathways; antigen-antibody reactions-precipitation, agglutination, complement fixation, immunoassay using labelled reagents (RIA, solid phase radio immunoassay, ELISA), western blotting; Immuno histochemistry; cytokine immunoassays; monoclonal antibodies-production and applications.

Unit IV Cytokines and cell mediated immune response**7 Lectures**

Properties of cytokines; families of cytokines; therapeutic use; cell mediated immune response-subsets of CD4+ effector T cells and their functions; antibody dependent cellular cytotoxicity (ADCC); opsonisation.

Unit V Immunization and immunodeficiency diseases**8 Lectures**

Active and passive immunization; whole organism vaccines-killed and live but attenuated vaccines; subunit vaccines; purified macromolecules as vaccines-inactivated exotoxins, capsular polysaccharides and recombinant microbial antigens as vaccines; recombinant-vector vaccines; DNA vaccines; immunodeficiency disease-primary immunodeficiencies, acquired or secondary immunodeficiencies.

Unit VI Clinical immunology**6 Lectures**

Hypersensitivity- type I, type II, type III and type IV; immune response to infectious diseases- protozoan, bacterial, viral and parasitic; autoimmunity-types of auto immune diseases, mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; transplantation-Immunological basis of graft rejection, clinical transplantation and immunosuppressive therapy; tumour Immunology-tumour antigens, immune responses to tumours and tumor evasion of the immune system; cancer immunotherapy, reproductive immunology-Th1, Th2 shift.

Suggested Readings

1. Kindt. T. J., Goldsby, R. A., Osborne, B. A. and Kuby, J. Immunology. W. H. Freeman, 2007.
2. Roitt. I. V. and Delves, P. J. Essential Immunology. 10th Ed, Blackwell Publishing company., 2004.
3. Abbas. A. K., Lichtman. A. H. and Pillai, S. Cellular and Molecular Immunology. Elsevier. 8th Ed, 2015.
4. Shetty, N. Immunology: Introductory text book. 2nd Ed, New Age International Publishers, India.
5. Owen. J., Punt J. and Stranford. S. Kuby Immunolog. 7th Ed, W.H.Freeman, 2013.

**SEMESTER II
PAPER: MBB 803C**

**BIOPHYSICS AND INSTRUMENTATION
CREDITS: 3 + 1+ 0**

Unit I Introduction to biophysics**6 Lectures**

Scope and methods of Biophysics, level of molecular organization, structure of proteins, nucleic acid, interaction between protein and nucleic acid, role of protein and lipids in biological membrane,

Unit II Chromatography and electrophoretic techniques **9 Lectures**

Chromatography techniques: Paper chromatography, TLC, Gel filtration chromatography, Ion exchange chromatography, Affinity chromatography, GLC, HPLC and HPTLC.

Electrophoretic techniques: PAGE, SDS PAGE, Agarose gel electrophoresis, isoelectric focusing, pulse field gel electrophoresis

Unit III Centrifugation **8 Lectures**

Basic principles and theory, types of centrifuge: preparative and analytical centrifuges, density gradient centrifugation and ultracentrifugation.

Unit IV Microscopy **9 Lectures**

Principles and application of light, phase contrast, fluorescence microscopy, scanning and transmission electron microscopy, atomic force microscopy, confocal microscopy, cytophotometry and flow cytometry.

Unit V Spectroscopy Techniques **8 Lectures**

UV, IR, NMR, ESR, LASER Raman spectroscopy, mass spectroscopy, fluorescence spectroscopy, X-ray spectroscopy, circular dichroism spectroscopy, atomic spectroscopy

Unit VI Radioactivity **8 Lectures**

Radioactive decay, units of radioactivity, Geiger muller counter, Scintillation counter, Autoradiography, application of radio isotopes.

Suggested Readings

1. Upadhyay. A, Upadhyay. K and Nath. N, Biophysical chemistry. Himalayan Publishing House, Bombay, 1993.
2. Palanivelu. P. Analytical Biochemistry and Separation Techniques. 3rd Ed, 21st Century Publication, Palkalai Nagar, Madurai, 2004.
3. Wilson. K and Walker. J, Principles and techniques of Biochemistry and Molecular Biology. 7th Ed, Cambridge University Press, 2010.
4. Rickwood. D and Hames. B. D. Gel Electrophoresis of Nucleic acids-A Practical Approach. 2nd Ed, Oxford University Press, 1990.
5. Veerakumari. L. Bioinstrumentation, 1st Edition, MJP Publishers, 2015.

**SEMESTER II
PAPER: MBB 804C**

**PRACTICALS FOR GENETICS, IMMUNOLOGY, BIOPHYSICS AND
INSTRUMENTATION
CREDITS: 0+0+4**

A. GENETICS

1. Isolation/identification of auxotroph mutants in bacteria
2. Bar body staining

B. IMMUNOLOGY

1. Preparation of blood smear and study of blood cells by Giemsa/Leishman staining .
2. Experiment on agglutination and radial immunodiffusion for testing the antigen antibody reaction.
3. Demonstration of Enzyme Linked Immunosorbent Assay (ELISA) technique.
4. Blood grouping test for detection of ABO group and Rh factor.
5. Experiment on raising antisera in animal model to understand the mechanism of immune response.

C. BIOPHYSICS AND INSTRUMENTATION

1. Calibration of pH meter
2. Microscopy-components and function
3. Separation and identification of amino acids by paper chromatography and TLC
4. Separation of mixture of gases by GC.
5. Spectrophotometric analysis of biomolecules

**SEMESTER III
PAPER: MBB 901C**

**GENOMICS AND PROTEOMICS
CREDITS: 3 + 1+ 0**

Unit I Basics of genomics and proteomics

5 Lectures

Prokaryotic and eukaryotic genome organization, extra-chromosomal DNA: mitochondria, chloroplast, bacterial plasmids.

Unit II Genome mapping and sequencing**8 Lectures**

Genetic and physical maps; markers for genetic mapping- RAPD, RFLP, AFLP, SSLP, SSR, SNPs linkage and pedigree analysis in genome mapping. Techniques for physical mapping- restriction mapping, Fluorescence *in situ* Hybridization (FISH), Sequence Tagged Sites (STS).

Sequencing and analyzing genome ó Sequencing strategies for the systematic sequencing of complex genomes, sequence assembly and analysis, gene location in genome sequence and gene function prediction.

Unit III Genome sequencing projects**4 Lectures**

Microbes, plants and animals, accessing and retrieving genome project information from web, Human Genome Project.

Unit IV Comparative genomics**5 Lectures**

Identification and classification of organisms using molecular markers-16S rRNA typing/sequencing, SNPs. Use of genomes to understand the evolution of eukaryotes, to track emerging diseases, to design new types of antibiotics and new class of medication, gene location in genome sequence, gene function determination by different methods.

Unit V Proteomics**10 Lectures**

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing), 2-D electrophoresis of proteins, isoelectric focusing, peptide fingerprinting, LC/MS-MS for identification of proteins and modified proteins, MALDI-TOF, PAGE and differential display proteomics, protein-protein interactions, Yeast two hybrid system.

Unit VI Functional genomics and proteomics**12 Lectures**

Cloning systems used in genomics-cosmids, P1 bacteriophage, BAC and YAC cloning vectors, isolation of high molecular weight DNA and separation of chromosomes by PFGE, transcriptome analysis for identification and functional annotation of gene, contig assembly, chromosome walking and map-based cloning, mining functional genes in the genome, gene function-forward and reverse genetics, gene tagging strategies and application. ESTs and its utility in genomics, differential gene profiling methods, DNA chips/Microarrays, reverse transcription PCR, Real time PCR, protein and peptide microarray-based technology, structural proteomics.

Unit VII Application of genomics and proteomics**4 Lectures**

Genomics application: Genomics in biopharmaceutical industry, pharmacokinetics, chemoinformatics, new pathogen discovery and microbial typing, gene therapy, drug discovery and development, toxicology etc.

Proteomics applications: Understanding the mechanism of pathogenesis, drug discovery, disease diagnosis, identification and characterization of novel proteins, proteomics in plant genetics and breeding.

Suggested Readings

1. Voet. D., Voet. J. G and Pratt. C.W. Fundamentals of Biochemistry, 2nd Ed, Wiley, 2006.
2. Brown. T. A. Genomes 3rd Ed, Garland Science, 2006.
3. Primrose. S. and Twyman. R. Principles of Gene Manipulation and Genomics, 7th Ed, Blackwell, 2006.
4. Liebler, D. C. Introduction to proteomics- tools for the new biology, Humana Press, Totowa, NJ., 2002.

**SEMESTER III
PAPER: MBB 902C**

**GENETIC ENGINEERING
CREDITS: 3 + 1+ 0**

Unit I Tools and techniques in Genetic Engineering**10 Lectures**

Restriction Endonuclease-Nomenclature, restriction mapping, type I to IV; isoschizomers and neoschizomers; start activity; DNA ligase; DNA modifying enzymes-nucleases, DNA polymerases, alkaline phosphatase, polynucleotide kinase, and terminal transferase; labeling of DNA-end labelling, nick translation, random priming, radioactive and non-radioactive techniques; Northern, Southern and colony hybridization; Fluorescence *in situ* Hybridization.

Unit II Cloning Vectors**10 Lectures**

Cloning vectors-plasmid vectors, phage vectors, cosmids, YACs, BACs, PACs, BIBACs, plant transformation vectors (Ti and Ri plasmids), protein expression vectors; protein expression and purification; animal virus derived vectors-SV-40, vaccinia/baculo and retroviral vectors; host cells for cloning.

Unit III Polymerase chain reaction and application**11 Lectures**

Polymerase Chain Reaction (PCR); primer design; PCR types-multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, Long-distance PCR (LD-PCR), RACE; PCR based methods for site-directed mutagenesis; mutation detection methods-Single Strand Conformation Polymorphism (SSCP), Denaturing Gradient Gel Electrophoresis (DGGE), Restriction Fragment Length Polymorphism (RFLP), Chemical Cleavage of Mismatch (CCM), Enzyme Cleavage of Mismatch (EMC).

Unit IV Cloning strategies**10 Lectures**

Transformation and transfection; construction of genomic and cDNA libraries; jumping and hopping libraries; phage display; cDNA and genomic cloning; expression cloning; protein-protein interactive cloning and Yeast two hybrid system; selection and screening of transformants- marker and reporter genes, positive and negative selection, insertion inactivation, alpha complementation; cloning strategies for PCR product cloning.

Unit V: Nucleic acid sequencing methodologies:**7 Lectures**

Sanger's method of DNA sequencing; automated DNA sequencing by capillary electrophoresis; dye chemistries and sequencing platforms; interpretation of Electropherogram; next generation sequencing technologies and single molecule sequencing.

Suggested Readings

1. Primrose. S. B., Twyman. R. M. and Old. R.W. Principles of Gene Manipulation. 7th Ed, Blackwell, 2006.
2. Brown. T. A, Genomes 3. 3rd Ed, Garland Science, 2007.
3. Brown. T. A, Gene Cloning and DNA Analysis: An Introduction, 7th Ed, 2016.
4. Desmonf. S. and Nicholl. T. An introduction to Genetic Engineering, 3rd Ed, Cambridge University Press.
5. Kingsman. S. M and Kingsman. A . J, Genetic Engineering, An Introduction to gene analysis and exploitation in eukaryotes, Blackwell Scientific Publications, Oxford, 1998.
6. Primrose. S. B. and Twyman. R. M, Principles of Gene Manipulation and Genomics. Wiley Blackwell, 7th Ed, 2007.
7. Watson, J. D., Gilman M., Witkowski, J. and Zoller. M. Recombinant DNA Technology. 2nd Ed, Scientific American Books, 1992.
8. Sambrook . J. and Russel. D.W. Molecular Cloning: A Laboratory Manual, Vols 1-3, 3rd Ed, Cold Spring Harbour Laboratory, 2001.

**SEMESTER III
PAPER: MBB 903C**

**PLANT AND ANIMAL BIOTECHNOLOGY
CREDITS: 3+ 1+ 0**

Unit I Organization of Genome**4 Lectures**

Introduction to nuclear genome organization in prokaryote and eukaryote; gene structure and expression in eukaryotes; chloroplast genome and mitochondrial genomes; endosymbiont theory of chloroplast evolution; plastid encoded and nuclear-encoded proteins in chloroplast; coding capacity of mitochondrial genome; RNA editing; mitochondrial genome and cytoplasmic male sterility.

Unit II DNA marker technology in plants**4 Lectures**

Role of DNA markers with special emphasis on RFLPs, linkage analysis, RAPD markers, STS, EST, microsatellites, SNP (single nucleotide polymorphism), SCAR (sequence characterized amplified regions), SSCP(single strand conformational polymorphism), AFLP; map based cloning.

Unit III Plant cell and tissue culture**4 Lectures**

Tissue culture media; callus and suspension culture; somaclonal variation; micropropagation; organogenesis; somatic embryogenesis; transfer and establishment of whole plants in soil; embryo culture and embryo rescue; protoplast fusion and somatic hybridization, production of haploid plants.

Unit IV Techniques and vectors for plant transformation**8 Lectures**

Agrobacterium mediated gene transfer-Agrobacterium and crown gall disease, Ti plasmids, organization of T-DNA and vir region, T-DNA transfer mechanism; Ri plasmids; direct gene transfer methods; chloroplast transformation, basic features of a plant transformation vector- promoters and terminators, selectable markers, reporter genes, binary vectors and co-integrative vectors; plant virus vectors- CaMV, Gemini virus, TMV, MBV

Unit V Plant transformation and metabolic engineering**7 Lectures**

Genetic manipulation of herbicide resistance; pest resistance; plant disease resistance- natural disease resistance; chitinase, 1,3-beta glucanase, ribosome-inactivating protein (RIP), antimicrobial proteins; viral resistance; antisense RNA approaches; strategies for engineering stress tolerance, Phenylalanine and Shikimate pathway, phytohormones, Chorismate pathway, molecular pharming.

Unit VI Animal cell and tissue culture**4 Lectures**

Laboratory facilities for animal cell and tissue culture; substrate for cell culture; culture media-natural media, synthetic media, serum free media and its advantages; organ culture: embryo culture and tissue engineering

Unit VII Primary culture and establishment of cell lines**5 Lectures**

Primary culture-Isolation of tissue, tissue disaggregation methods and selection of viable cells, establishment of cell lines, immortalization of cell lines and maintenance, characterization of cell lines; application of animal cell culture-vaccine production, interferons, recombinant proteins.

Unit VIII In vitro fertilization and embryo transfer:**4 Lectures**

Media for IVF; steps in IVF; different techniques of micromanipulation to assist fertilization; stem cells; embryonic stem cell and their applications; ethical issues in animal biotechnology.

Unit IX Expression of recombinant DNA in animal cells**8 Lectures**

Cell lines; gene transfer techniques; gene construct, selectable markers; transient expression of cloned genes; virus based vector for gene cloning-Adenovirus, Adeno-associated virus, Retrovirus, Herpes virus, Vaccinia virus, and Baculovirus; expression of therapeutic proteins in yeast, transgenic animals, knockout mice; gene therapy-somatic and germline, gene replacement, in vivo and ex vivo gene delivery, retrovirus gene transfer system, gene correction, replacement/augmentation, editing, regulation and silencing; gene therapy of human diseases.

Suggested Readings**Plant Biotechnology**

1. Slater. A. N. S. and Fowler. M. Plant Biotechnology: The genetic manipulation of plants, oxford University Press, Oxford, 2008.
2. Grierson. C. and Covey. S. N. Plant Molecular Biology, Springer Netherlands, 1991.
3. Hammond. J. H., Mcgarvey. P. and Yusibov. V. Plant Biotechnology. Springer Verlag, Heidelberg, 2000.
4. Buchanan. B. B., Gruissen. W. and Jones R. L. Biochemistry and Molecular Biology of Plants. American Society of Plant Biologist, Rockville, USA, 2000.
5. Das. H. K. Text Book of Biotechnology. Wiley India Pvt Ltd., New Delhi, 2004.

6. Razdan. M.K. Plant Tissue Culture. Oxford and IBH Pub. Co. Pvt. Ltd.

Animal Biotechnology:

1. Spier. R. E and Griffiths .J. B. Animal cell biotechnology. Academic Press, 1994.
2. Ian. F. R. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. 6th Ed, Wiley-Blackwell, 2010.
3. Puhler. A, Genetic Engineering of Animals. Vch Publisher, 1993.
4. Martin. C., Animal cell culture Techniques. Springer, 1998.

**SEMESTER III
PAPER: MBB 904C**

**PRACTICALS FOR GENOMICS AND PROTEOMICS, GENETIC ENGINEERING &
PLANT AND ANIMAL BIOTECHNOLOGY
CREDITS: 0+0+4**

A. GENOMICS AND PROTEOMICS

1. Extraction of RNA and cDNA synthesis
2. Amplification of DNA using Polymerase Chain Reaction
3. Restriction digestion of amplified DNA by PCR-RFLP
4. PCR-RAPD analysis to study the genetic diversity.
5. SDS-PAGE for protein analysis.
6. Demonstration of Western Blotting technique for detection of protein

B. GENETIC ENGINEERING

1. Isolation of plasmid DNA from bacteria and visualization in Agarose gel.
2. Restriction digestion and separation of digested fragments by Agarose gel electrophoresis
3. Competent cell preparation
4. Cloning and transformation in *E. coli*.
5. Demonstration of DNA insert in the recombinants by Polymerase Chain Reaction.

C. PLANT AND ANIMAL BIOTECHNOLOGY

1. Plant tissue culture media and hormone stock preparation
2. Sterilization, callus induction, organogenesis and acclimatization
3. Agrobacterium mediated transformation of plant tissues and verification by PCR
4. GUS histochemical staining
5. Animal cell culture; demonstration of animal cell culture techniques

SEMESTER IV
PAPER: MBB 1001C

INDUSTRIAL BIOTECHNOLOGY
CREDITS: 3 + 1+ 0

Unit I Principles of industrial microbes **9 Lectures**

Sources of industrially important microbes, bioprospective of microbial diversity, isolation and selection of industrially important microorganisms. Development of inocula for yeast, bacterial, mycelial and vegetative fungal processes; aseptic inoculation of the fermentor, strain improvement and selection, preservation and maintenance of microbial culture.

Unit II Media formulation and design of bioreactors **10 Lectures**

Microbial substrates and media formulation; components of microbial fermentation process; design of laboratory bioreactor; types of bioreactor: continuous stirred tank flow reactors, loop reactors, air lift reactors, fed batch reactors, fluidized bed reactors, rotatory disc reactors.

Unit III Bioprocess technology **10 Lectures**

Types of fermentation process: batch process, continuous process, recycled and non recycled processes, liquid and solid state fermentations. bioreactor operation; sterilization; aeration; sensors; instrumentation; analysis of mixed microbial populations, specialized bioreactors upstream and downstream processing, scale up, unit processes, applications : concept of control, basic control theory, turbidostatic and chemostatic control. Basic principles of scale up, working parameters.

Unit IV Production of pharmaceuticals **9 Lectures**

Production of proteins - bacteria and yeast, recombinant and synthetic peptide vaccine production, production of insulin, interleukin, growth hormones using rDNA technology. primary metabolites - amino acid and secondary metabolite- antibiotics production, biotransformation of steroids and sterol.

Unit V Biotechnology in generation of other industrial products **10 Lectures**

Biomass production, ethanol production, bioweapons and bioshields; pigments, bioremediation and biomass utilization, bioaugmentation, microbial degradation of xenobiotics, waste water treatment, microorganism in mineral recovery, microbial fuels- hydrogen and methane. Extremophiles and their biotechnological applications. Microbes as source of industrially important enzymes, immobilized enzymes and their applications. Microbial polysaccharides and polyester, biosurfactant, microbial insecticides. Plant growth promoting bacteria, microbes as source of food.

Suggested Readings

1. Glazer. A. N. and Nikaido B. H. Microbial Biotechnology, Fundamentals of Applied Microbiology. 2nd Ed, Cambridge University Press, 2007.
2. Glick. B. J. and Pasternak J. J, Molecular Biotechnology: Principles and Applications of Recombinant DNA. 4th Ed , AMS Press, 2010.
3. Rittmann. B. and McCarty. P, Environmental Biotechnology: Principles and Applications. Mc Graw Hill, 2000.
4. Casida. L.E, Industrial Microbiology. 1st Ed, Wiley Eastern Limited, 1991.
5. Stanbury. P. F. Whittaker. A and Hall. S. J, Principles of Fermentation Technology. 3rd Ed, Pergamon Press, Oxford, 2015.
6. Patel. A. H, Industrial Microbiology. 1st Ed, Macmillan India Limited, 1996.

SEMESTER IV PAPER: MBB 1002C

BIOINFORMATICS AND BIOSTATISTICS CREDITS: 3+1+0

BIOINFORMATICS

Unit I

4 Lectures

Introduction to bioinformatics; biological databases; sequence data formats; conversion of sequence formats; sequence submission to databases; exploring resources at NCBI; data searching engine and retrieval tools

Unit II

12 Lectures

Sequence alignment and similarity search- sequence identity, sequence similarity and sequence homology, global alignment, local alignment, pairwise alignment, multiple alignment, alignment algorithm, scoring matrix, alignment score, Basic Local Alignment Search Tool (BLAST); sequence assembly; gene prediction methods; functional annotation of genes; primer designing; introduction to Microarray array data analysis; computational tools for gene expression analysis; comparative genome analysis

Unit III

3 Lectures

Introduction to computer hardware; computational infrastructure for bioinformatics; types of operating systems-introduction to LINUX and basic commands, Windows operating system; introduction to PERL.

Unit IV

3 Lectures

Molecular phylogeny-molecular evolution, phylogenetic tree, types of trees, methods of phylogenetic analysis, tree building methods, software for phylogenetic analysis.

Unit V**8 Lectures**

Protein modelling and drug design- protein secondary structure prediction, visualisation of molecular structures- RasMol and Pymol; fold recognition; transmembrane topology prediction ; protein modelling methods-homology modelling, fold recognition/threading, *Ab initio/Denovo* methods; drug discovery process; techniques in drug design; molecular docking; introduction to molecular dynamic simulation.

BIostatISTICS**Unit VI****4 Lectures**

Terms and symbols used in Biostatistics; sample and sampling methods; data collection and representation-collection, classification and tabulation of data, graphic and diagrammatic representation of data

Unit VII**11 Lectures**

Measure of central tendency and dispersion-types of measure of central tendency-mean, mode, median; measure of dispersion- range, mean deviation, standard deviation, variance; test of significance-null hypothesis, alternative hypothesis, hypothesis testing, Z-test, T-test, ANOVA; Chi-square test; probability distribution-binomial, Poisson and Normal; introduction to correlation and regression.

Unit VIII**3 Lectures**

Introduction to statistical software packages and application : Microsoft Excel for basic statistical analysis; Statistical Package for the Social Sciences (SPSS); XLSTAT; Numerical Taxonomy and Multivariate Analysis System (NTSYS)

Suggested Readings

1. Campbell. A. M. and Heyer. L. J. Discovering Genomics, Proteomics, and Bioinformatics. 2nd Ed, Benjamin Cummings, 2002.
2. Cynthia. G. and Per. J. Developing Bioinformatics Computer Skill. 1st Ed, O'Reilly Publication, 2001.
3. Baxevanis. A. D. and Ovellette B. F. F. Bioinformatics: A practical guide to the analysis of genes and proteins. Wiley-Interscience, 2002.
4. Prem. S. M. Introductory Statistics. Latest Ed, Wiley.
5. John. A. R., Mathematical Statistics and Data Analysis. 3rd Ed, Duxbury Press, 2007.
6. Xiong. J. Essential Bioinformatics. 1st Ed, Cambridge University Press, 2006.

**SEMESTER IV
PAPER: MBB 1004C**

**PRACTICALS FOR INDUSTRIAL BIOTECHNOLOGY AND BIOINFORMATICS AND
BIOSTATISTICS
CREDITS: 0+0+3**

A. INDUSTRIAL BIOTECHNOLOGY

1. Isolation and screening of industrially important microorganisms from natural environments
2. Parts and designs of bioreactor
3. Isolations of amylase producing bacteria
4. Production of microbial products in bioreactors.
5. Production of antibiotics and pigments by microbial cultures.
6. Experiment on the technique of enzyme immobilization.

B. BIOINFORMATICS AND BIOSTATISTICS

Bioinformatics

1. To explore various resources at NCBI
2. To explore various protein sequence analysis tools on ExPASy server.
3. Retrieval of protein and nucleotide sequences from online databases.
4. Submission of DNA sequences to public database
5. To perform multiple sequence alignment for a given set of sequences.
6. Phylogenetic tree construction using MEGA.
7. ORF finding from a gene sequence.
8. Functional annotation of genes using Blast2GO online suit.
9. Homology searching using BLAST
10. PCR primer designing using online tools
11. Protein structure prediction through homology-modelling

Biostatistics

12. Data presentation (tables/figures): 1-D and 2-D bar charts, pie diagrams, graphs (using computer software packages)
13. Calculation of mean, mode, and median, standard deviation and standard error.
14. Application of statistical software package.

ELECTIVE PAPERS**PAPER: MBB 1201E: MEDICAL MICROBIOLOGY****CREDITS: 1+0+0****Unit I Normal microbiota of human body****3 Lectures**

Microbiota of skin, eyes, upper respiratory system, mouth, large intestine, urinary and reproductive systems, normal microbiota-host relationship.

Unit II Concept of disease**5 Lectures**

Pathogenesis and infection, classification of infectious diseases, nosocomial infections, emerging infectious diseases

Unit III Infectious diseases**6 Lectures**

Infections caused by bacteria- Gram positive cocci, Staphylococcus and Micrococcus, Streptococcus, Enterococcus. Gram positive rods *Bacillus anthracis*, Coryneforms, Mycobacterium. Gram negative rods - Klebsiella, Salmonella, Shigella, Neisseria, Haemophilus and Pseudomonas

Infections caused by virus- Influenza, Polio, Rabies, Hepatitis, AIDS, Herpes virus infections, dengue fever, Chikungunya Infections caused by fungus- *Candida* and *Cryptococcus neoformans* – Filamentous fungi: *Aspergillus* sp. infection, dermatophytic infections: infections caused by protozoa- Malaria, Leishmaniasis, Trypanosomiasis, *Ascaris*.

Unit IV Disease management**2 Lectures**

Epidemiology, prevention and treatment of diseases

Suggested Readings

1. Rajan. S. Medical Microbiology. MJP Publishers.
2. Gillespie. S. H and Kathleen. B. Medical Microbiology and Infection at a Glance, Bamford.

PAPER: MBB 1202E: BIOFUEL**CREDITS: 2+1+0****Unit I Introduction to biofuels****3 Lectures**

Fossil fuels-production, demand and depletion of sources; concept of biofuels; advantages of biofuel over fossil fuel; global and Indian scenario of biofuel production.

Unit II Advances in biofuel production and future trend**4 Lectures**

Conventional and advanced biofuels-first generation biofuels, 2nd generation biofuels and 3rd generation biofuels, biorefineries, biomass for biofuel production; constrain in biofuel productions.

Unit III Algal lipids and their metabolism**7 Lectures**

Algal lipids, polar glycerolipids- phosphoglycerides, glycosylglycerides, betaine lipids; non-polar storage lipids-triglycerols, hydrocarbons; biosynthesis of glycerolipids- fatty acid and polar glycerolipid biosynthesis, biosynthesis of TAG.

Unit IV Biofuel from algae**11 Lectures**

Introduction to microalgae; potential microalgae for biofuel production; isolation techniques of microalgae; criteria for species and strain selection for biofuel production; production of algal biomass-culture media, photobioreactors and raceway reactors; harvesting methods for algal biomass; extraction/processing of algal biomass for biodiesels; properties of extracted oils; processing of algal biomass for production of biohydrogen, bioethanol and biogas. Challenges of biofuel production from microalgae.

Unit V Wastewater treatment and algal biofuel production**7 Lectures**

Wastewater treatment ponds- High Rate Algal Ponds (HRAP), Algal production in HRAPs, algal grazers and pathogens; wastewater treatment in HRAPs-aerobic treatment, nutrient removal, disinfection; harvesting of wastewater treatment HRAP algae; wastewater algal biofuel production-biogas, biodiesel, bioethanol, bio-crude oil.

Suggested Readings

1. Babu. V., Patel. G. K. and Thapliyal. A. Biofuels production-John Wiley and sons, 2013.
2. Borowitzka. M. A. and Moheimani. N. R. Algae for Biofuels and Energy. Springer Netherlands, 2013.
3. Pandey. A., Lee. D. J., Chisti. Y and Soccol. C. R. Biofuels from Algae. 1st Ed, Elsevier, 2014.
4. Moheimani. N. R., McHenry. M. P., Boer. K. D and Bahri. P.A. Biomass and Biofuels from Microalgae-Advances in Engineering and Biology. Vol, 2 Springer, 2015.

PAPER: MBB 1203E: NANOBIO TECHNOLOGY**CREDITS: 1+0+0****(16 Lectures)**

Introduction to nano-biotechnology; nanotechnology-definition and concepts; cellular nanostructures; production of nanoparticles: collision / coalescence mechanism of primary particle formation, nanoparticles agglomerates and aerogels; biological production of nanoparticles: fungi and bacteria; techniques for nanoparticle characterization- Optical Microscopy, Atomic Force

Microscopy, SEM etc; criteria for suitability of nanoparticles for biological applications; nanostructures for drug delivery-concepts, targeting, routes of delivery and advantages;

Suggested Readings

1. Niemeyer. C. M. and Mirking C.A. Nano biotechnology concepts: concepts, application and perspectives. Wiley-VCH, 2004.
2. Jain. K.K. Nanobiotechnology in Molecular Diagnostics: Current Techniques and Application. Horizon Biosciences, 2006.
3. Xie. Y., The Nanobiotechnology Hand Book. CRC Press, Taylor & Francis Group, 2013.

PAPER: MBB 1204E: PERSONALISED MEDICINE

CREDITS: 1+0+0

(16 Lectures)

Basic aspects of personalized medicine; molecular diagnostics in personalized medicine; role of biomarkers in personalized medicine; pharmacogenetics; pharmacogenomics; pharmacoproteomics; personalized biological therapies; personalized therapy of cancer; personalized management of infectious disease, neurological disorders, psychiatric disorders, cardiovascular disorders, pulmonary disorders, genetic disorders, immune disorders; personalized approach to miscellaneous problems; development of personalized medicine; ethical aspects of personalized medicine; regulatory aspects of personalized medicine; economics of pm; future of personalized medicine.

Suggested Readings

1. Jain. K. K . Textbook of Personalized Medicine. 2nd Ed, 2015.

PAPER: MBB 1205E: BIOMEDICAL GENETICS

CREDITS: 2+1+0

Unit I Human cytogenetics and biochemical genetics

10 Lectures

Chromosome number and morphology, banding techniques, karyotype, idiogram, sex chromatin, dosage compensation, normal variable chromosome features, numerical chromosome abnormalities,

structural chromosome rearrangements, Turner females, Klinefelter syndrome, Down's syndrome and Philadelphia chromosome.

Inborn errors in metabolism of carbohydrates, amino acids, lipids, galactosemia, glycogen storage disease, lysosomal storage disorders, peroxisomal disorders, phenylketonuria etc.

Unit II Human molecular genetics

10 Lectures

Molecular basis of genetic diseases: single gene disorders-cystic fibrosis, huntington's disease, Duchenne muscular dystrophy, hemophilia, neurofibromatosis, thalassemias.

Genetics of human infertility: the mutations in genes expressed in hypothalamus, pituitary, gonadal and outflow tract.

Cancer genetics: oncogenes, viral oncogenes, activation of protooncogenes by mutation, activation of proto-oncogenes by insertions, translocations and amplification, tumor suppressor genes, regulation of gene expression by oncoproteins, signal transduction by oncoproteins, gene-environment interaction, hereditary cancers.

Unit III Genetic screening

4 Lectures

Identification of genetic disorders, biochemical markers, prenatal diagnosis, and preimplantation genetic diagnosis.

Unit IV Gene therapy

5 Lectures

Concept, vectors used in gene therapy, gene therapy in adenine deaminase deficiency, cystic fibrosis and cancer.

Unit V Molecular epidemiology

3 Lectures

Concept of genetic epidemiology, genetic association study, disease susceptibility genes, gene × environment interactions.

Suggested Readings

1. Jorde. L.B., Carey. J.C., White R.L., Medical Genetics. Mosby Press, 2002.
2. Scriver et al., The metabolic and molecular basis of inherited disease. 8th Ed, McGraw & Hill, 2002.
3. Strachan. T and Andrew. P. Human Molecular Genetics. John Wiley&New York, 2001.

PAPER: MBB 1206E: BIOETHICS, BIOSAFETY AND IPR**CREDITS: 2+1+0****Unit I Bioethics****5 Lectures**

Fundamentals of bioethics: Animal rights, environmental protection, the complex nature of human society, social experimentation and role of ethics, right to information, ethical committees' role, biopiracy.

Biotechnology in agriculture and environment: benefits and risks, ethical aspects of genetic testing, ethical aspects relating to use of genetic information ó genetic engineering and biowarfare.

Unit II Ethical implications of cloning**6 Lectures**

Reproductive cloning , therapeutic cloning ; ethical, legal and socio-economic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research- genetically modified crops and genetically modified organisms, transgenic animals.

Unit III Case studies and issues in Bioethics**5 Lectures**

Silicon womb, IVF, cloning humans, designer babies, allotransplantation, stem cell research, sexing the unborn, sex discrimination, monopolizing economy and starvation, biodiversity, clinical trials, etc.

Unit IV Biosafety**8 Lectures**

Biosafety- definition, requirement, biosafety issues- biosafety for human health and environment, biosafety in relation to transgenic research of applications, MSDS, laboratory and industrial precautions, assessing environmental impact, etc.

Biosafety levels and containment facilities: introduction to biological safety cabinets, primary containment for biohazards, biosafety levels of specific microorganisms, recommended biosafety levels for infectious agents and infected animals.

Biosafety guidelines: roles of institutional biosafety committee, RCGM, GEAC etc. for GMO applications in food and agriculture; environmental release of GMOs, risk analysis, risk management and communication; overview of national regulations and relevant international agreements including Cartagena protocol.

Unit V Intellectual property rights**8 Lectures**

Introduction to Intellectual Property: types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; international framework for the protection of IP, IP as a factor in R & D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRI

Core areas of biotechnology involving IPR: Nutraceuticals, pharmaceuticals, bioprocess engineering, technology in genetic manipulations of cells and organisms, development of crop varieties, transgenic plants and animals, bioremediation, biopesticides, enzymes, vaccines, diagnostic tests, bioinformatics, bioinstrumentation and biosensors.

Suggested Readings

1. BT guidelines, Biotech Consortium India Limited, New Delhi.
2. Galston. A. W. and Peppard. C. Z. Expanding horizons in bioethics. Springer, 2005.
3. Casey Chosewood, L and Deborah E. Wilson, Biosafety in Microbiological and Biomedical Laboratories. 5th edition. U.S. Government Printing Office, 2007.
4. Krishna. V. S. Bioethics and Biosafety in Biotechnology. New Age International Publisher, 2007.

PAPER: MBB 1207E: SERIBIOTECHNOLOGY

CREDITS: 1+0+0

(16 Lectures)

Introduction to sericulture; silkworm species (mulberry and non-mulberry) and their distribution; present scenario of sericulture in NE India with special reference to muga silkworm; life cycle of silkworms (Muga, Tasar, Eri and Mulberry silkworm) and their host plants; metamorphosis; indoor rearing of Eri and Mulberry silkworm; artificial diet for rearing; outdoor rearing of Muga and Tasar silkworms; silk gland and silk production; structure and composition of silk; silkworm diseases and their management (bacterial and viral diseases); antimicrobial activity of silkworm proteins, silkworm proteins for biomedical applications, silk as biomaterial (tissue engineering), silkworm transgenesis and application.

Suggested Readings

1. Kumar. R. V, Kumar V. S. , Nair. K. S. and Kamble. C. K. Application of Biotechnology in Sericulture. Studium Press, 2011.
2. Gilbert. L. I., Insect Molecular Biology and Biochemistry. Elsevier, 2012.
3. Babu. K. M., Silk-Processing, Properties and Application. Woodhead Publishing, 2013.

PAPER: MBB 1208E: TEA BIOTECHNOLOGY

CREDITS: 1+0+0

(16 Lectures)

Tea and Camellia, morphological descriptions, taxonomy and nomenclature; types of tea; health benefits of tea. Tea cultivation and propagation methods.

Genome size, diversity of the genus, karyotype, breeding techniques, genetic resources of tea.

Molecular marker study in tea biotechnology; transcriptomic analysis of abiotic stress and biotic stress in tea; basics of tea manufacturing process; application of biotechnology in tea processing; abiotic and

biotic stress in tea and their effects on quality of made tea; genetic transformation of tea; research progress in cloning and functional characterization of genes related to quality and stress tolerance.

Suggested Readings

1. Mondal. T. K., Breeding and Biotechnology of Tea and its Wild Species. 1st Ed, Springer, 2014.
2. Mullick, A, Biotechnology in tea processing, Book chapters in Encyclopedia of Industrial Biotechnology. Willey, 2009.

PAPER: MBB 1209E: MOLECULAR MARKERS AND BREEDING

CREDITS: 2+1+0

Unit I: The dynamics of Plant genome and organization

5 Lectures

Genetic variation-DNA recombination, mutations; traits- quantitative and qualitative; plant genome duplication-small scale duplication, large scale duplication (polyploidy); genome organization-unique and repetitive DNA sequences, type of repeat elements-tandem, interspersed, micro and mini satellites and VNTRs.

Unit II: Tools for Molecular Breeding

7 Lectures

Classical Genetic markers-morphological markers, cytological markers, protein markers; DNA markers-Restriction Fragment Length Polymorphism (RFLP), Randomly Amplified Polymorphic DNA (RAPD), Sequence Tagged Sites (STS), Sequence Characterized Amplified Region (SCAR), Amplified Fragment Length Polymorphism (AFLP), Target Region Amplified Polymorphism (TRAP), Simple Sequence Repeat (SSR), microsatellite and minisatellite, SNP based markers.

Unit III Mapping strategies in plants

10 Lectures

Mapping populations-F₂ populations, Recombinant Inbred Lines (RILs), backcross population, Near Isogenic Lines (NILs), Double Haploids (DHs), Bulk Segregant Analysis (BSA); methods and software for genetic mapping- construction of genetic linkage maps, linkage-mapping softwares, map based cloning for gene discovery

Unit IV Exploiting Genetic Maps and Molecular Markers Through MAS

10 Lectures

Marker Assisted Selection (MAS)- genetic distance analysis, variety identification, indirect selection, monogenic traits, polygenic (quantitative) traits, marker-assisted backcrossing; Marker-Assisted Breeding (MAB); physical mapping of plant chromosomes- classical physical mapping techniques, molecular physical mapping techniques.

Suggested Readings

1. Meksem. K. and Kahl. G. The Handbook of Plant Genome Mapping: Genetic and Physical Mapping. Wiley-Blackwell, 2005.
2. Newbury. H. J. Plant Molecular Breeding. CRC Press, 2003.
3. Kole. C. and Abott. A.G. Principle and practices of plant genomics. (Vol 1-3), Science Publishers, 2008.
4. Xu. Y. Plant Molecular Breeding. CABI, 2010.
5. Borem, A., Fritsche-Neto. R., Omics in Plant Breeding. Wiley Blackwell, 2014.

PAPER: MBB 1210E: ENVIRONMENTAL BIOTECHNOLOGY**CREDITS: 2+1+0****Unit I Introduction****6 Lectures**

Definition, scope and importance of environmental studies; concept of ecosystem, structure and function; ecosystem management; renewable and non-renewable resources; conservation of renewable resources; biotechnology in environmental protection.

Unit II Environmental pollution**8 Lectures**

Sources and nature of environmental pollution; air pollution: Sources and classification of air pollutant; biomonitoring of air pollution; water pollution: Sources and classification of water pollutant; biomonitoring of water pollution; waste water and sewage treatment; soil pollution; pesticides; radiation; green house effect and global warming; depletion of ozone; acid rain.

Unit III Bioremediation and environmental management**8 Lectures**

Microorganisms in bioremediation; types of bioremediation; biodegradation of hydrocarbons; natural products and green synthesis/green technology; bio-plastic; bio-composting; bio-fertilizers; organic farming; phytoremediation; enzymes and genetically modified organisms in bioremediation; bioremediation of soil and ground water; industrial waste water treatment.

Unit IV Biotechnology, health and society**10 Lectures**

Recombinant therapeutic products in human healthcare; genetically modified organisms; gene and environment; metagenomics; remote sensing and GIS in ecological mapping and environmental hazard prediction; bioindicators and biosensors; Environmental Impact Assessment (EIA).

Suggested Readings:

1. Evans. G. M., Judith. C. and Furlong, Environmental Biotechnology: Theory and Application. 1st Ed., Wiley, 2000.
2. Bhattacharyya. B. C and Banerjee. R, Environmental Biotechnology. Oxford University Press., 2007.

3. Abbasi. S. A. and Ramaswami. E, Biotechnological Methods of Pollution Control, 1st Ed. Universities Press, 1999.
4. Allsopp. D., Seal. K. J. and Gaylard. C. C, Introduction to Biodeterioration. 1st Ed, Cambridge Univ. Press, U. K, 2004.
5. Wainwright. M. An Introduction to Environmental Biotechnology. 1st Ed. Kluwer Academic Publishers, Springer, 1999.

PAPER: MBB 1211E: BIODIVERSITY AND CONSERVATION GENETICS

CREDITS: 1+0+0

Unit I Introduction

4 Lectures

Definition of biodiversity; levels of biological diversity; importance of genetic diversity and need of biodiversity conservation; ex-situ and in-situ conservation; biodiversity hot-spots.

Unit II Biodiversity documentation and assessment

4 Lectures

Morphological and molecular characterization of biodiversity; introduction to biodiversity databases; Endemism; Red data book; germplasm conservation and biological repository.

Unit III Population genetics

3 Lectures

Hardy-Weinberg equilibrium; low genetic diversity and threatened species; genetic drift, mutation; natural selection; migration and gene flow; bottleneck and founder effect.

Units IV Molecular tools and techniques for biodiversity conservation

3 Lectures

Allozymes; microsatellites; RFLP; RAPD; AFLP; ISSR; SSR; VNTRs; SNPs; chloroplast DNA; Mt DNA; DNA barcoding; DNA sequencing

Unit V Bioinformatics

2 Lectures

Biodiversity databases; data submission and data retrieval; phylogenetic tree.

Suggested Readings

1. Wilson. E. O, Biodiversity. National Academy Press, Washington, D.C, 1988.
2. Frankham. R, Ballou. J. D. and Briscoe. D. A. A primer of Conservation Genetics. Cambridge University Press, 2004.
3. Falk. R, Genetic Analysis: A History of Genetic Thinking. Cambridge University Press, 2011.
4. Hamilton. M. B, Population Genetics. 1st Ed, Wiley - Blackwell, 2009.
5. Nei. M. and Kumar. S. Molecular Evolution and Phylogenetics. 1st Ed, Oxford University Press, 2000.

6. Mayr. E and Ashlock. P. D. Principles of Systematic Zoology. Mcgraw-Hill Book Comp., 1991.
7. Radford. A. E. and Caddell. G. M. Fundamentals of Plant systematic. Harper and Row, 1986.

PAPER: MBB 1212E: MEDICAL BIOTECHNOLOGY

CREDITS: 1+0+0

Unit I Monoclonal antibodies

3 Lectures

Monoclonal antibody cloning techniques, monoclonal antibody expression systems, applications of monoclonal fragments.

Unit II Antisense RNA technology

3 Lectures

Mechanisms of inhibition, chemically modified oligonucleotides, oligonucleotide delivery, potential applications of antisense oligonucleotides, viral diseases, cancer

Unit III Cell culture techniques

1 Lectures

Cultivation of virus and production of vaccines.

Unit IV Gene therapy

4 Lectures

Recombinant retroviruses, recombinant adenoviruses, recombinant adeno-associated viruses, direct injection of naked DNA, particle-mediated gene transfer, liposome-mediated gene delivery, other gene transfer methods

Unit V Stem Cell Technology

2 Lectures

Definition, functions, origin and types of stem cells, therapeutic cloning for embryonic stem cells, ethical issues in stem cell research

Unit VI Tissue Engineering

1 Lectures

Introduction-bioartificial organs, protein engineering by site directed mutagenesis

Unit VII Assisted reproductive techniques

2 Lectures

Causes of infertility, IVF, Intra uterine insemination, cryopreservaton of germ cells.

Suggested Readings

1. Trivedi. P. C., Medical Biotechnology. Aavishkar, Jaipur. 2008
2. Pongracz. J., Keen. M. Medical Biotechnology. 1st Ed, Churchill Livingstone (E-book)
3. Walsh. G. Biopharmaceuticals: Biochemistry and Biotechnology. Wiley India Pvt Ltd. 2012.
4. Kindt. T. J., Goldsby, R. A., Osborne, B. A. and Kuby, J. Immunology. W. H. Freeman, 2007.

PAPER: MBB 1213E: FOOD BIOTECHNOLOGY**CREDITS: 2+1+0****Unit I Food chemistry****7 Lectures**

Water in food, water activity and shelf life of food. carbohydrates- chemical reactions, functional properties of sugars and polysaccharides in foods. Lipids- use of lipids in food, properties and functions of proteins in food, pigments in food, food flavours, browning reaction in food, spoilage of food.

Unit II Food production technology**6 Lectures**

Single cell protein, pickling and alcoholic beverages, genetically manipulated crop. fermented food- sauerkraut, youghurt, cheese.

Unit III Food production**6 Lectures**

Technology for improved process, enzymes in food industries, protease in cheese making and beverage production, utilization of food waste for production of valuables. Application of genetics to food production.

Unit IV Food preservation**6 Lectures**

Principles and methods of food preservation ó freezing, heating, dehydration, canning, additives, fermentation, irradiation. Storage of food, modified atmosphere packaging, refrigeration, freezing and drying of food.

Unit V Food analysis and quality control**7 Lectures**

Food quality and control, analysis of food, major ingredients present in different product, food additives colour, flavour, vitamins, microbial safety of food products, chemical safety of food products, heavy metal, fungal toxins, pesticide and herbicide contamination. Regulatory and social aspects of biotechnology of food.

Suggested Readings

1. Frazier. W. C. and Westhoff. D. C. Food Microbiology. 3rd Ed, Tata McGraw-Hill Publishing Company Ltd, New Delhi, India. 1992.
2. Pelczar. M. J. Jr., Chan. E. C. S. and Kreig. N. R. Microbiology. 5th Ed, Tata McGraw Hill New Delhi, 2004.
3. Joshi. V. K. and Pandey. A. Biotechnology: Food Fermentation. Education publication, New Delhi, 1999.
4. Crueger. W and Crueger. A. Biotechnology: A textbook of Industrial Microbiology. 2nd Ed, Panima Publishing Co. New Delhi, 2000.
5. Tortora. G. J., Funke. B. R. and Case. C. L. Microbiology: An Introduction. 9th Ed, Pearson Education. 2008.

PAPER: MBB 1214E: HERBAL BIOTECHNOLOGY**CREDITS: 2+1+0****Unit I: Introduction****7 Lectures**

Medicinal plants in traditional system, importance of herbal drugs in Indian system of medicine. Organoleptic, macroscopic and microscopic description of various plant parts with examples used as drug storage and ergastic substances of cells.

Unit II: Herbal preparation**6 Lectures**

Herbal extraction methods and preparation, method of isolation and separation of pharmaceutical compounds from plant materials. Chemical properties, characterization and therapeutic uses of bioactive compounds. Future prospects of biomolecules in drug industry. Quality and safety for herbal products.

Unit III: Agrotechnology, propagation and nursery management**6 Lectures**

Study of agrotechnology developed for medicinal plants and aromatic plants. Seed propagation, propagation through specialized organs ó tubers, bulbs, corm, rhizome and micropropagation.

Biofertilizers, biological control of pests, nursery technology and transplantation protocols.

Unit IV: Harvesting and post harvest technology**7 Lectures**

Methodologies for harvesting and post harvest technology: Drying processes, garbling, sorting, packing, storage. Avoiding desiccation, decay and microbial contamination and spoilage, impact on drug yield, quality and action. Agroeconomics of medicinal and aromatic plants.

Unit V: Medicinal plant conservation**6 Lectures**

In situ conservation: national parks, sanctuaries, biosphere reserves. *ex situ* conservation : Cryopreservation, synseeds. Field gene banks of medicinal taxa, improvement of drugs and drug action through biochemical engineering. International diversity and national policies.

Suggested Readings:

1. Ramawat. K. G. and Mérillon, J. M. Bioactive Molecules and Medicinal Plants. 1st Ed, Springer-Verlag, 2008.
2. Talapatra. S. K. and Talapatra. B. Chemistry of Plant Natural Products, Stereochemistry, Conformation, Synthesis, Biology, and Medicine. Springer-Verlag, 2015.
3. Janardhan. R. K, Bahadur. B. Bhadraiah. B. and Rao. M. L. N. Advances in medicinal plants. Universities Press, 2007.
4. Khan. I. A and Atiya. Role of Biotechnology in Medicinal and Aromatic Plant- Vol-III. Ukaaz Publication, 2000.

5. Ramachandran. S. Hand Book on Herbal Medicine: With Special Reference to Pharmacognostical studies of Indian Medicinal Plants. Laxmi Book Publication, Solapur, 2015.