First Semester

Course -1. CELL BIOLOGY

Unit 1.

1. Diversity of cell size and shape.
2. Cell Theory
3. Structure of Prokaryotic and Eukaryotic cells – isolation and growth of cells .
4. Microscopic techniques for study of cells.
5. Sub-Cellular fractionation and criteria of functional integrity.

Unit 2.

1. Cellular Organelles Animal & Plant Cell Plasma membrane, cell wall, their structural organization; Mitochondria; Chloroplast; Nucleus and other organelles and their Organization.
2. Transport of nutrients, ions and macromolecules across membranes.
3. Cellular energy transactions- role of microchondria and chloroplast.
4. Cell cycle-molecular events and model systems .

Unit 3.

1. Cellular response to environmental signals in plants and animals mechanism of signal transaction.
2. Cell motility – cilia , flagella of eukaryotes and prokaryotes .
3. Biology of cancer .
4. Metabolite pathway and their regulation .

Unit 4.

1. Cellular basis of differentiation and development, mitosis, gametogenies and fertilization, development in Drosophila and Arabidopsis ; Spatial and temporal regulation of gene Expression .
2. Brief introduction the life cycle and Molecular Biology of some important pathogen of Malaria, Hepatitis , Tuberculosis , (Filarial Kalazar).

Unit 1.

1. Chemical foundations of biology –pH, pK, acids, base , buffer , weak bonds , covalent bonds.
2. Principles of thermodynamics .
3. Classes of organic compounds and functional groups – atomic a molecular dimensions , space filling and ball and stick models.

Unit 2.

1. Carbohydrate Classification, Structure, Physio-chemical properties.
2. Metabolism: Glycolysis, TCA cycle, ETC & other pathway of Glucose Metabolism.
3. Heterocyclic compounds and secondary metabolites in living systems nucleotides , pigments, isoprenoids.

Unit 3.

1. Lipids: Physio-chemical properties, Classification, Structure and Functions.
2. Metabolism: Oxidation of fatty acids, Biosynthesis of lipids.
3. Polysaccharides: Types and structural features.
4. Amino-acid and Peptides: Classification, Reaction and Physical properties.

Unit 4.

1. Proteins: Classification, Structure and functions.
2. Glyco & Lipoprotiens: Structure and functions.
3. Enzymes: Classification, properties and functions.
4. Enzyme catalysis in solution: Kinetics and thermodynamic analysis, effect of organic solvents on enzyme catalysis.

Unit 1

1. **The Beginning of Microbiology:**
   Discovery of the microbial world by Anatomy van Leeuwonhock: Controversy over spontaneous generation. Role of microorganisms in transformation of organic matter and in the causation of diseases: Development of Pure culture methods , Enrichment culture methods: Development of microbiology in the twentieth century.
2. **Methods in Microbiology:**
   Pure culture techniques : Theory and practice of sterilizations : Principles of microbial nutrition : Construction of culture media : Enrichment culture techniques for isolation of chemo-autotrophs, chemo-hetrotrophs and photosynthetic microorganisms.
3. **Microbial evolution, Systematic and Taxonomy:**
   Evaluation of earth and earliest life forms: primitive organisms and their metabolic strategies and molecular coding : New approaches to bacterial taxonomy, Classification including Ribo-typing: Ribosomal RNA sequencing : Characteristics of primary domains taxonomy: Nomenclature and Bergey's Manual.

Unit-2

1. **Overview of basic metabolism & Microbial Nutrition.**
2. **Metabolic Diversity among Microorganisms:**
   Photosynthesis in microorganism: Role of chlorophylls: Carotenoids and Pycobilins: Calvin cycle: Chemolithotrophy: Hydrogen-ion-nitrate-oxidizing bacteria: Nitrate and Sulfate reduction: Methanogenesis and Acetogenesis: Fermentation-Diversity: Syntrophy. Role of anoxic decomposition: Nitrogen metabolism, Nitrogen fixation: Hydrocarbon transformation.
3. **General characteristics of Prokaryotes, Eukaryotes, Viruses, Viriods and Prions**

Unit-3

1. **Microbial Diseases:**
   Disease reservoirs: Epidemiological terminologies infectious disease transmission Respiratory infections caused by bacteria and viruses, tuberculosis, sexually transmitted diseases including AIDS disease transmitted by animals (rabies, plague) insects and ticks (rickettsiae, Lyme disease, malaria) Food and water borne diseases, public health and water quality pathogenic fungi, Emerging and resurgent infectious diseases.

2. **Host- Parasite Relationships:**
   Normal micro flora of skin, Oral cavity, Gastrointestinal tract Entry of Pathogens into the host, Colonization and factors predisposing to infection: types of toxins (Exo-Endo-Entero) and their structure Mode of actions Virulence and pathogenesis.

3. **Prokaryotic Cells: Structure-function:**
   Cell wall of Eubacteria (Peptidoglycan) and related molecules, Outer membrane of Gram-negative bacteria, cell wall and cell membrane synthesis, flagella and motility ,cell inclusions like endospore, gas vesicles.

4. **Chemotherapy Antibiotics:**
   Antimicrobial agents: Sulfa drugs: Antibiotics: Penicillin's and Cephalosporin's: Board – Spectrum antibiotics, Antibiotics from prokaryotes: Antifungal antibiotics: Mode of action, resistance to antibiotics.

of growth and growth yields: Synchronous growth: Continuous culture: Growth as affected environmental factors like temperature acidity, alkalinity water availability and oxygen: Culture collection and maintenance of culture.

Unit- 4

1. **Genes, Mutation and mutagenesis:**
   UV and chemical mutagens, Type of mutation: Ames test for mutagenesis methods of genetic analysis.
2. **Bacterial genetic System:**
   Transformation, Conjugation, Transduction, Recombination. Plasmids and Transposoons: Bacterial genetics map with reference to E-coli.
3. **Viruses and their genetic System:**
   Phage I and its life cycle : RNA phages: RNA various retro-viruses.
4. **Genetic System of Yeast and Neurospora.**
5. **Extra-Chromosomal inheritance.**

Unit-1

1. Brief description and tabulation of data in its graphical representation.
2. Measures of central decency and dispersion. Mean median mode range standard deviation variance.

Unit-2

1. Simple linear regression and correlation
2. Idea of two types of errors and level of significance test of signification (F & t- test) chi-square tests.

Unit-3

1. Introduction of digital computers. Organization: low-level and high-level language binary number system.
2. Flow charts and programming techniques.
3. Introduction to programming techniques
4. Introduction to data structures and database concepts. Introduction to internet and its applications.

Unit-4

1. Introduction to MS-office software. Covering word processing spreadsheets and presentation software- Introduction to Hardwar graphics/Corel Draw.
2. Computer-Oriented Statistical Techniques: Frequency table of single discrete variable Bubble Sort, Computation of mean variance and standard deviation correlation coefficient mass maker.
3. Genomic analysis, Database management of Software sequence data.
4. Computer added drug designing-Computational techniques in structural analysis.

SECOND SEMESTER

Course-V : MOLECULAR BIOLOGY

Unit 1

1. Introduction to Molecular Biology and Genetics
2. DNA Replication:-

   Prokaryotic and Eukaryotic DNA replication, Mechanics of DNA replication, Enzymes and accessory proteins involved in DNA replication.
3. DNA repair and Recombination
4. Transcription

   Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, general and specific transcription factors, regulatory elements and mechanism of transcription regulation, transcriptional and post transcriptional gene silencing.

Unit 2

1. Modification in RNA

   5' – Cap formation termination, 3' end processing and polyadenylation, splicing, editing, Nuclear export of mRNA, mRNA stability.
2. Translation

   Prokaryotic and Eukaryotic translation, the translation machinery, Mechanism of initiation, elongation and termination. Regulation of translation. co- and post-translational modifications of proteins.
3. Protein Localization and Transport

   Synthesis of secretary and membrane proteins. Import into nucleus, mitochondria, E.R., Golgi complex, chloroplast and peroxisomes, Receptor mediated endocytosis, chaperons.

Unit 3

1. Oncogenes and Tumor Suppressor Genes:

   Viral and cellular Oncogenes, tumor suppressor genes from humans, Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins.
2. Antisense and Ribozyme Technology:

   Molecular mechanism of antisense molecules, Inhibition of splicing, Polyadenylation and translation, disruption of RNA structure and capping Biochemistry of Ribozymes; hammerhead, hairpin and other Ribozymes, strategies for designing Ribozymes, Application of Ribozymes and antisense technologies.
3. Homologous Recombination

   Holiday junction, gene targeting, gene disruption, FLP/FRT and CRE/LOX recombination, RecA and other recombinases.

Unit 4

1. Molecular Mapping of Genome:

   Genetics and Physical maps, Physical mapping and Map based cloning, choice of mapping population, Simple sequence repeat loci, Southern and fluorescence *in situ* hybridization for genome analysis, Chromosome microdissection and microcloning, Molecular Markers in genome analysis: RFLP, RAPD and AFLP analysis, Molecular markers linked to disease resistance genes, Application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, variety etc.
2. Genome Sequencing:

   Genome sizes, organelle genomes, Genomic libraries, YAC, BAC libraries, Strategies for sequencing genome, Packaging, transfection and recovery of clones, Application of sequence information for identification of defective genes, Sequence database management.

Course VI: - Instrumentation and Techniques in Biotechnology

Unit I

Physical techniques in proteins, nucleic acid and Polysaccharides, structural analysis: UV,IR,NMR,ESR,Raman spectroscopy, Mass spectroscopy, Fluorescence spectroscopy, Differential calorimetry,X-ray crystallography, Ultra centrifugation,Electron cryomicroscopy,Scanning tunneling microscopy.

Unit II

Purification Techniques :

1.Chromatography : Paper, Thin layer, Column (Adsorption, Gel filtration, Ion exchange, affinity, Gas, HPLC).

2. Electrophoresis: Agarose gel, PAGE, SDS- PAGE, Iso-electric focusing, Two dimensional gel electrophoresis, Immuno electrophoresis, Capillary electrophoresis, Pulse field gel electrophoresis.

Unit III

1.Sequencing of proteins and nucleic acids.

2.Protein- ligand interactions. Physical and chemical methods for study.

3.Protein folding- biophysical and cellular aspects , Protein denaturation..

4.Protein and nucleic acid database: structural comparison at secondary and tertiary level.

Unit IV

1.Physical and chemical methods for immobilization of small and macromolecules.

2..Nucleic acid hybridization- structural analysis and biological studies.

3. Catalytic antibodies-functional proteins- structure and drug targets (enzyme and receptor).

4.Fundamentals of nanobiotechnology,Proteomics and Genomics.

Course VII : BIOLOGY OF IMMUNE SYSTEM

Unit 1

1. Introduction
   - Phylogeny of Immune System
   - Innate and Acquired immunity
   - Clonal nature of immune response
2. Organization and Structure of lymphoid organs
3. Nature and Biology of antigens and super antigens
4. Antibody structure and function
5. Antigen-antibody interactions

Unit 2

1. Major Histocompatibility Complex
2. BCR and TCR, generation of diversity
3. Complement system
4. Cells of the immune system; Hematopoiesis and differentiation, Lymphocyte trafficking, B-lymphocytes, Macrophages, Dendritic cells, Natural Killer and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast Cells.
5. Regulation of Immune Response
   - Antigen processing and presentation, generation of humoral and cell mediated immune response.
   - Activation of B- and T- lymphocytes.
   - Cytokines and their role in immune regulation.
   - T-cell regulation, MHC restriction.
   - Immunological tolerance.

Unit 3

1. Cell –Mediated cytotoxicity: Mechanism of T cell and NK cell mediated lysis, Antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity.
2. Hypersensitivity
3. Autoimmunity

Unit 4

1. Transplantation
2. Immunity of infectious agents (intracellular, parasites, helminthes & viruses)
3. Tumor Immunology
4. AIDS and other Immunodeficiencies
5. Hybridoma Technology and Monoclonal antibodies

Course – VIII : PLANT BIOTECHNOLOGY

Unit 1

1. Conventional plant breeding
2. Introduction to cell and tissue culture, tissue culture as a technique to produce novel plants and hybrids.
3. Tissue culture media (composition and preparation)
4. Initiation and maintenance of callus and suspension culture; single cell clones.

Unit 2

1. Organogenesis; somatic embryogenesis; transfer and establishment of whole plants in soil.
2. Shoot-tip culture: rapid clonal propagation and production of virus free plants.
3. Embryo culture and embryo rescue.
4. Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids.
5. Anther, pollen and ovary culture for production of haploid plants and homozygous lines.
6. Cryopreservation, slow growth and DNA banking for germplasm conservation.

Unit 3

1. Basic techniques in rDNA technology
2. Plant Transformation Technology:

   Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanisms of DNA transfer, role of virulence genes, use of Ti and Ri as vectors, binary vectors, use of 35S and other promoters, genetic markers, use of reporter genes, reporter genes with introns, use of scaffold attachment regions, methods of nuclear transformation, viral vectors and their applications, multiple gene transfer, vectorless or direct DNA transfer, particle bombardment, electroporation, microinjection, transformation of monocots, transgene stability and gene silencing.
3. Application of Plant Transformation for Productivity and Performance:

   Herbicide resistance, phosphoinothricin, glyphosate, sulfonyl urea, atrazine, insect resistance, bt genes, non-bt like protease inhibitors, alpha amylase inhibitor, virus resistance, coat protein mediated nucleocapsid gene, disease resistance, chitinase, 1-3 beta glucanasem, RIP, antifungal proteins, rhionins, PR proteins, nematode resistance, abiotic stress, postharvest losses, long half life of fruits and flowers, use of ACC synthase, polygalacturanase, ACC and storage, ADP glucose pyrophosphatase.
4. Chloroplast Transformation

   Advantages, vectors, success with tobacco and potato.

Unit-4

1. Metabolic Engineering and Industrial Products

   Plant secondary metabolites, control mechanism and manipulation of phenylpropanoid pathway, shikimate pathway, alkaloids, industrial enzymes, biodegradable plastics, polyhrdroxybutyrate, therapeutic proteins, lysosomal enzymes, antibodies, edible vaccines, purification strategies, oleosin partitioning technology.
2. Green House .

MSC BT – (Dr BR Amb)

Third Semester

Course –IX: ANIMAL CELL SCIENCE AND TECHNOLOGY

Unit I

1. Structure and organization of animal cell.
2. Equipment and materials for animal cell culture technology.
3. Primary and established cell line culture.
4. Introduction to the balanced salt solutions and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon-dioxide; Role of serum and supplements.
5. Serum and protein free defined media and their application.

Unit II

1. Measurement of viability and cytotoxicity.
2. Biology and characterization of culture cells. Measuring parameters of growth.
3. Basic techniques of mammalian cell culture in vitro; disagregation of tissue and primary culture; maintenance of cell culture; cell separation.
4. Scaling-up of animal cell culture.

Unit III

1. Cell synchronization
2. Cell cloning and micromanipulation.
3. Cell transformation.
4. Application of animal cell culture.
5. Stem cell culture, embryonic stem cells and their applications.
6. Cell culture based vaccines.

Unit IV

1. Somatic cell genetics.
2. Organ and histotypic culture.
3. Measurement of cell death.
4. Apoptosis.
5. Three dimensional culture and tissue engineering.

Course –X ;GENETIC ENGINEERING

Unit I

1. Scope of Genetic Engineering.
2. Milestones in Genetic Engineering.
   Isolation of enzymes. DNA sequencing, synthesis and mutation, detection and separation, cloning, gene expression. Cloning and patenting of life forms Genetic Engineering guidelines.
3. Molecular Tools and their application.
   Restriction enzymes. modification enzymes. DNA ~~and RNA~~ markers.

Unit II

1. Nucleic Acid Purification. Yield Analysis.
2. Nucleic Acid Application and Its Application.
3. Gene Cloning Vectors
   Plasmids. bacteriophage. phagemides. cosmids. Artificial Chromosomes.
4. Restriction mapping of DNA fragments and Map Construction. Nucleic Acid Sequencing.
5. cDNA Synthesis and cloning.
   mRNA enrichment. reverse transcription. DNA primers. linkers. Adapters and their chemical synthesis. Library construction and screening.
6. Alternative Strategies of Gene Cloning.
   Cloning interacting genes- Two and three hybrid systems. cloning differentially expressed genes. Nucleic acid microarrys.

Unit III

1. Site directed Mutagenesis and Protein Engineering.
2. How to study the Gene Regulation?
   DNA transfection. Northern blot. Primer extension. SI mapping. Rnase protection assay. ~~Receptor~~ assay.
3. Expression Strategies for heterologous genes
   Vector engineering and codon optimization. host engineering. In vitro transcription and translation. expression in bacteria. expression in Yeast, expression in insects and insect cells. expression in mammalian cells, expression in plants
4. Processing of Recombinant proteins.
   Purification and refolding characterization of recombinent proteins stabilization of proteins.

Unit IV

1. Phase Display
2. T-DNA and Transposon Tagging.
   Role of gene tagging in gene analysis. T-DNA and transposan tagging, Identification and isolation of genes through T-DNA or transposon.
3. Transgenic and gene Knock out Technologies
   Targeted gene replacement, Chromosome engineering.
4. Gene Therapy
   Vector engineering, Strategies of gene delivery, gene replacement/ augmentation, gene correction, gene editing, regulation and silencing.

Course –XI: BIOPROCESS ENGINEERING AND TECHNOLOGY

Unit I

1. Introduction to Bioprocess Engineering.
2. Bioreactor.
3. Isolation, Preservation and Maintenance of Industrial Microorganism.
4. Kinetic of Microbial Growth and death.

Unit II

1. Media for industrial fermentation.
2. Air and media sterilization.
3. Types of fermentation process; Analysis of batch. fed batch and continuous bioreactors. stability of microbial reactors, analysis of mixed microbial populations. specialized bioreactors (pulsed fluidised photobioreactors etc).

Unit III

1. Measurement and control of bioprocess parameters.
2. Downstream Processing: Introduction, Removal of microbial cell and Solid matter. Foam precipitation. filtration, centrifugation, cell disruptions. liquid-liquid extraction. chromatography, Membrane process Drying and crystallization Effluent treatment; D.O.C. and C.O.D. treatment and disposal of effluents.
3. Whole cell Immobilization and their Industrial Application.

Unit IV

1. Industrial production of chemicals: Alcohol (ethanol), Acids (citric, acetic and gluconic) solvents (glycerol, acetone, butanol), Antibiotics (penicillin. streptomycin. tetracycline) Amino acids (lysine, glutamic acid), Single cell Protein.
2. use of microbes in mineral beneficiation and oil recovery.
3. Introduction to food technology:
   - Elementary idea of canning and packing.
   - Sterilization and pasteurization of food products.
   - Technology of typical food/ Food products (bread, cheese, idli)
   - Food preservation.

Course –XII: ENVIRONMENTAL BIOTECHNOLOGY

Unit I

1. Environment: Basic concepts and issues.
2. Environmental pollution: types of pollution, Methods for the measurement of pollution, Methodology of environment management-the problem solving approach, its limitation.
3. Air pollution and its controls through Biotechnology.
4. Water Pollution and its control: Water as a source natural recourse, Need for water management, Measurement and water pollution, source of water pollution. Waste Water collection, Waste water treatment –physical and chemical processes.

Unit II

1. Microbiology of Waste water Treatment, Aerobic Process: Activated sludge, Oxidation ditches, trickling, towers, rotating dises, rotating drums, oxidation ponds.
2. Anaerobic Processes: Anaerobic digestion, anaerobic filters, Upflow anaerobic sludge blanket reactors.
3. Treatment schemes of wastewaters of dairy, distillery, tannery, sugar, antibiotic industries.

Unit III

1. Microbiology of degradation of Xenobiotics in Environment-Ecological considerations, decay behavior & degradative plasmids; hydrocarbons. Substituted hydrocarbons, oil pollution, surfactants, pesticides.
2. Bioremediation of contaminated soils and wasteland.
3. Biopesticides and integrated pest management.
4. Solid wastes: Sources and management (composting, wormiculture and methane production)

Unit IV

1. Global Environment Problems: Ozone depletion, UV-B, green house effect and acid rain, their impact and biotechnological approaches for management.

M.Sc. Biotechnology - IV Semester

6th month Project Work & VIVA