

Part B- BIOTECHNOLOGY

Unit 1- Biochemistry: Structure of atom and molecules; Bonding - strong and weak interactions; Structure and properties of water; Importance of biological buffers; Composition, structure and function of biomolecules (carbohydrates, proteins, nucleic acid and lipids); Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structures: motifs and folds) and nucleic acids; Forces stabilizing structure of protein and nucleic acid; Metabolism of Carbohydrate, Protein, Nucleic acid, Lipids, vitamins, its regulation and bioenergetics; Enzymes-nomenclature, classification, kinetics, regulation of enzyme activity, coenzymes, Abzymes, Ribozymes. Biotechnological applications of enzymes.

Unit II- Microbiology, Immunology, Cell Biology

Microbiology: Ultra structure of bacteria, fungi, algae, protozoa and viruses; classification of microbes; molecular taxonomy; current methods of microbial identification; Microbial physiology- aerobic and anaerobic respiration, fermentation; Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases; Pathogenicity and diagnosis of infection caused by bacteria, fungi, protozoans and viruses; control of microorganisms – physical and chemical agents; antibiotics, antiviral agents, interferons, and chemotherapeutic agents; antimicrobial resistance and its mechanisms, alternative strategies for antibiotics; Microbial communities and ecosystems interactions; biogeochemical cycling.

Immunology: Types of immunity - Innate and Acquired; Humoral and cell mediated immunity; Lymphoid tissues and cells - Ontogeny, development and differentiation of lymphocytes; Immunization - Active and passive; Immunoglobulins - classification, structure, function and diversity; Genetic control of immune response – MHC restriction, Clonal selection theory; Immunological tolerance – Autoimmune disorders, Hypersensitivity reaction; Transplantation immunology; Edible vaccines;

Cell Biology: Structure of Prokaryotic and Eukaryotic cell; Compartmentalization; Cell organelles, cytoplasmic matrix ; Three dimensional organization of cytoskeleton; Molecular organization of nucleus and nuclear transport; Hormones and receptors; Membrane structure and function (Structure of model membrane, lipid bilayer, membrane proteins and glycoproteins); mechanism of membrane transport; Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle); Intracellular protein sorting in mitochondria and chloroplast; Protein insertion in Endoplasmic reticulum and protein trafficking; Cell to cell communication; Cell fusion and its applications; Proteasome – structural organization and function; Chaperons-Classification and cellular functions; cell signaling – Hormones and receptors, cell surface receptor, signal transduction pathways; cell senescence and death; Apoptosis-Process and Mechanism; Cancer-metastasis, tumor suppressor genes, oncogenes, cell cycle and cancer.

Unit III- Molecular biology, rDNA technology and Genetics

Molecular biology: Genetic Material - Structure and functions of DNA & RNA; Organization of genes and chromosomes (Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin). Types & Mechanisms of DNA replication; DNA Repair; Mutations and mutants; tRNA structure and relation to function; Ribosomes and rRNA; Prokaryotic and Eukaryotic transcription; Post transcriptional modification; protein coding genes; Protein biosynthesis, genetic code; Components and mechanism of Translation; Post translational modification; Regulation of gene expression in prokaryotes and Eukaryotes; Role of chromatin in regulating gene expression.

rDNA technology: Introduction to recombinant DNA technology- Enzymes used in recombinant technology, Plasmids: replication and copy number control; Bacterial plasmids; Plasmid and Cosmid vectors; Restriction modification systems in Bacteria; Bacteriophage lambda vectors; M-13 based vectors; Yeast Vectors; *E. coli* expression systems; Eukaryotic vectors and gene regulation; Attenuation and Antitermination mechanisms in Bacteria; type and applications of PCR; Eubacterial identification based on 16S rRNA sequences; Culture independent analysis of bacteria- DGGE; Molecular diagnosis of fungal pathogens based on 18S rRNA sequences; Detection of viral pathogens through PCR; PCR in forensic science- Determination of Paternity, Human identification and sex determination;

Genetics: Human genetics - human chromosomes, chromosomal abnormalities, inherited disorders, genetic counselling. Genotype and Phenotype. Methods of genetic transfers – transformation, conjugation- (Hfr, triparental mating, self transmissible and mobilizable plasmids,) transduction (general and specialized), mapping genes by interrupted mating; Transposons

Unit IV- Animal Biotechnology and Plant Biotechnology

Animal Biotechnology: Tissue engineering and tissue modeling; Transgenic animals-xenotransplantation; Transgenic mice: (Retrovirus vector, DNA microinjection, Engineered embryonic stem cell, Cre-loxP recombination system, High capacity vectors), Transgenic mice: applications (Alzheimer disease, test systems, conditional regulation, control of cell death), Cloning livestock by nuclear transfer, Transgenic cattle, sheep, goats and pigs, Transgenic birds, Transgenic fish; Biology of Animal viral vectors - SV40, adeno virus, retro virus, vaccinia virus, herpes virus, adeno associated virus and baculovirus; Applications of yeast system to study eukaryotic gene function; production of regulatory proteins, blood products, vaccines and hormones; Gene therapy - *Ex vivo* and *in vivo*, viral and non- viral; Biotechnological applications-HIV diagnostics and therapy; Bioethics and stem cell research. Bioethics: Biosafety regulation for transgenic animals: - animal ethics; Ethical clearance norms for conducting studies on human subjects. Bioethics: Guidelines for use of lab animals and Hazardous microorganisms.

Plant Biotechnology: Structural features of plant genes with functions; organization of chloroplast and mitochondrial genome; chloroplast transformation and transplastomic plants; Promiscuous DNA; Molecular markers – RAPD, DAMD, STS and Microsatellites for plant identification, and genetic diversity analysis; Artificial seeds and their applications; *Agrobacterium tumefaciens* and crown gall tumours; Ti-plasmid based vectors (binary and super binary) for plant transformation; *Agrobacterium* mediated transformation of food crops; Hairy root induction through *Agrobacterium rhizogenes* and the role of roI genes; Molecular biology of plant stress response - drought, salinity, dehydration and osmotic stress; Direct and Indirect methods of gene transfer into plant cells and development of transgenic plants; Genetically modified crops (Golden rice, Flavr Savr, Bt cotton, virus resistant papaya); Terminator seed technology.

Unit V- Recent trends in Biotechnology

Recent trends in Biotechnology: Genome Editing- CRISPR, Gene Silencing – Transcriptional: Genomic Imprinting, Transposon Silencing; Post Transcriptional: RNA interference, RNA Silencing, Cell therapy and regenerative medicine-Clinical biofabrication, Drug repositioning/ Drug repurposing, Biosensors, Bioenergy production and management. Application of AI in Biotechnology, Personalized Medicine. Synthetic Biology, Bprinting, Microfluidics, Tissue Engineering.