BIOTECHNOLOGY SYLLABUS

UNIT-I

Cell Biology, Genetics and Biochemistry

1. Cellular organelles-Plasma membrane, cell wall, Mitochondria, Chloroplast, Nucleus, Intracellular compartments-I: Golgi apparatus and endoplasmic reticulum; Intracellular compartments-II: Lysosomes, peroxisomes; their structural organization; Cytoskeleton: Microtubules, intermediate filaments and microfilaments.
2. Cell cycle: Molecular models and events. Regulators and checkpoints in cell cycle; Molecular mechanisms of cell division.
3. Transport across cell membrane: Major types of membrane transport, Active transport, Co-transport, Symports, Antiports, Ion channels, Osmosis; Protein sorting: Transport of proteins into mitochondria, chloroplast and lysosomes.
4. Mendel's laws of inheritance and chromosomal theory of heredity; Gene linkage and crossing over, Chromosomal mapping, Tetrad analysis; Pedigree analysis. Lod score for linkage testing, Karyotypes, Genetic disorders, Polygenic Inheritance, Heritability and its measurements, QTL mapping.; Spontaneous and chemical mutation, Frame-shift mutation, point mutations and chromosomal aberrations; Human chromosomes, Genetic diseases and syndromes.
5. Weak Interactions in aqueous solution (Dipole movement, van der Waal's, ionic and hydrophobic interactions. Hydrogen bonding). Weak acids, bases, pH and buffers, Blood buffering system. Bioenergetics: Laws of Thermodynamics, entropy, enthalpy and free energy, standard free energy, free energy change, chemical equilibrium. Phosphoryl group transfer and ATP.
6. Peptide bond, ionization behavior of peptides, biologically active peptides. Levels of protein structure. Determination of primary structure of protein. Three dimensional structures of proteins. Protein denaturation and Protein folding; Biosynthesis of Amino acids, Amino acid catabolism
7. Enzymes: Nomenclature, classification and properties; Enzyme kinetics; Enzyme inhibition; Regulation of enzyme action
8. Carbohydrate metabolism: Glycolysis, TCA cycle, glyoxalate cycle, pentose-phosphate pathway; Gluconeogenesis; Oxidative phosphorylation, electron transport and ATP synthesis; Photosynthesis

9. Lipids: Classification, storage lipids, structural lipids; Biosynthesis and oxidation of fatty acids. Nucleotides and Nucleic acids. Biosynthesis and degradation of Nucleotides.

UNIT-II

Molecular Biology, analytical techniques and Biostatistics

1. Prokaryotic and eukaryotic Genome organization, organelles genomes; DNA Replication: prokaryotic and eukaryotic DNA replication, Mechanism of DNA replication, Enzymes and accessory proteins involved in DNA replication; Mutability and DNA repair; Genetic Recombination
2. Prokaryotic and Eukaryotic transcription and regulation; Post transcriptional modifications (processing, capping and polyadenylation, splicing). Prokaryotic and eukaryotic translation and regulation; co- and post-translational modifications of proteins.
3. Signaling pathways that control gene activity: TGFß receptors and Smads, Cytokine Receptors and JAK-STAT pathway, Receptor Tyrosine kinases and Ras, MAP kinase pathways; Signaling at the cell surface: Signalling molecules and cell-surface receptors, second messengers, G protein coupled receptor, activation of gene transcription by G protein coupled receptors.
4. Microscopy: Principle of operation and Instrumentation, Ultraviolet-visible absorption spectroscopy: Principle, Instrumentation and application. Fluorescence spectrophotometry: Principle, Instrumentation and application. Centrifugation techniques: Basic principles of sedimentation, Methods in preparatory ultracentrifugation. Principles of chromatography, types and applications, Electrophoretic techniques: General principles, electrophoresis of proteins and nucleic acids. Western Blotting, ELISA, ChIP, FACS.
5. Statistics: Definition, functions and limitations, frequency distribution, Descriptive Measures: Averages and Dispersions (Grouped and ungrouped). Probability in statistics, Inferential statistics: Definition-parameter, Statistic sampling distributors, standard error, Test of Hypothesis, type I and Type II errors. Large sample tests: Z tests, small sample tests: t and F tests. Chi-square test: Goodness of fit and Test of independence. Curve Fitting, Simple correlation and Regression. Correction and Regression. Analysis of variance: one way and two way classification.

UNIT-III

Microbiology, Immunology and Bioinformatics

1. Historical background of Microbiology, Microbial Ecosystem, Branches of Microbiology and its application. Sterilization, Culture Media, Culture techniques, Microbial staining and identification methods, Maintenance and preservation.
2. Microbial growth: Growth curve, factors affecting microbial growth. Microbial evolution, metabolic strategies and their molecular coding, bacterial taxonomy and nomenclature, Bergey's manual, Ribotyping. Bacteria: Cell structure, genetic recombination in bacteria. Metabolic diversity among micro-organisms: microbial photosynthesis. Archaea, Eukarya and Viruses: classification and structure of viruses, replication of DNA- and RNA- viruses, Infectious microorganism,
3. Microbial diseases: Disease reservoirs, epidemiological technology, infectious disease transmission, respiratory infections, STDs, and diseases transmitted by animals, insects, ticks. Food and water-borne diseases, Microbial toxins: virulence and pathogenesis.
4. Chemotherapeutic agents, Antibiotics and their mode of action: Penicillins and Cephalosporins, broad-spectrum antibiotics, antibiotics from prokaryotes, antifungal antibiotics, antibiotics resistance, Multiple Drug Resistance, Antiviral chemotherapeutic agents.
5. Immune system, types of immunity, Immune cells, Haematopoiesis and differentiation, B-lymphocytes, T-lymphocytes, Macrophages, Dendritic cells, Natural Killer cells, Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast cells.
6. Organization and Structure of Lymphoid Organs Activation and regulation of B and T lymphocytes. Structure and function of antibody molecule, Antigen – Antibody interaction, Major histocompatibility complex and MHC restriction, Transplantation
7. Antigen Processing and Presentation, Generation of humoral and cell mediated immune response. BCR and TCR, generation of diversity Complement system Cytokine and their role in immune regulation
8. Cytotoxicity and its types (Cell-mediated, Antibody dependent cell mediated cytotoxicity, and macrophage mediated), Hypersensitivity and Autoimmunity. Tumor Immunology, immunodeficiency diseases.
9. Bioinformatics, Database management system, e.g. Genebank, EMBL, Swiss-Prot, Sequence database like FASTA, BLAST algorithm and Bioinformatics tools. Pairwise sequence alignment, multiple sequence alignment, Gene prediction and Protein structure prediction.

UNIT-IV

Genetic Engineering, Bioprocessing Engineering and Environmental Biotechnology & IPR

1. Genetic engineering, Molecular tools: DNA modifying Enzymes, Hosts (E. coli, yeast, animal cells and Plant cells) and Cloning and expression vectors (Plasmids, Bacteriophages, Cosmids, Phagemids and Artificial Chromosomes). Screening (Phenotypic, antibiotic and through hybridization)
2. Genome mapping, physical mapping, map-based cloning. Genome sequencing: Construction of Genomic and cDNA libraries, application in identification of defective genes. Expression cloning, Jumpingor hopping libraries, Molecular markers in genome analysis (RFLP, RAPD, AFLP, SSLPs, STRs and SNPs). Molecular markers for disease resistant genes, Application of molecular markers.
3. DNA transfection methods: Physical methods, Chemical method, Virus mediated transfection, Heterologous genes expression, DNA-protein interactions: EMSA, DNase foot printing, Methyl interference assay,CHIP, Phage display.
4. Site-directed Mutagenesis and protein engineering, Processing of recombinant proteins, Role of gene tagging in gene analysis, Gene therapy: Vector engineering. Strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation, Knockout and transgenic technologies, Gene silencing
5. Industrial application of enzymes: Enzyme immobilization, Whole cell immobilization and their industrial application. Types of Microbial metabolism process, nitrogen fixation , biofertilizers, Industrial production of biofertilizers
6. Bioreactors (types, construction, working principle, application), Uses of immobilizedenzymes in bioreactors, specialized bioreactors (pulsed, fluidized and photo-bioreactors). Downstream processing, removal microbial cells from bioreactors, foam preparation,filtration, drying and crystallization.
7. Industrial production of chemicals: alcohols, Acids, solvents, Antibiotics, Amino acid. Large scale production methods of biofertilizers and their use. Food technology: Canning and packing, Sterilization and pasteurization Food preservation, Single cell proteins. Micro-algal technology.
8. Wastewater Treatment, Oxidation Pond, Anaerobic process of treatment, Solid waste management (Composting, Vermicultre and Biogas production), Biopesticides, Biofuels. Acid rain, Arid and semi-arid plant biotechnology, Green house technology, Environmental pollution and measures; Air, Water, Soil, Radioactive pollutions. Bioremediation, Degradation of Xenobiotoc compounds, Bioprospecting of Marine Organisms, Sea weeds as food, Phycocolloids and source of Pharmaceuticals compounds.

9. Introduction to intellectual property: Types of IP (Trademarks, Copyright & Related rights, Industrial design, Traditional knowledge, Geographical indications, Protection of GMOs) Agreements and Treaties (GATT & TRIPS agreement, Madrid agreement, Hague Agreement, WIPO treaties, Budapest treaty, PCT, Indian Patent Act 1970 & recent amendments. Basics of patents (Types of patent application and Specifications), concept of Prior Art and patent filing procedures.

UNIT V

Animal and Plant Biotechnology

1. Animal cell culture: Primary culture, maintenance and preservation. Tissue disaggregation, Culture media, types and composition, Cell separation Method, Cell cloning techniques, characterization and identification'
2. Organ culture, In vitro fertilization, Three-dimensional culture. Tissue engineering: Design stages for tissue engineering, cell substrates and support materials, cell sources, orientation and protocol.
3. Cytotoxicity studies, Necrosis and apoptosis, cell preservation: Cryopreservation. Hybridoma technology, monoclonal antibodies. Stem cell culture and its application.
4. Plant cell and tissue culture. Tissue culture media, callus and suspension culture; single cell clones. Morphogenesis and Organogenesis; Organization of shoot and root apical meristem, development of shoot, root, Leaf, flower and Phyllotaxy.
5. Shoot tip culture, Clonal propagation and production of virus free plants, Anther, pollen and ovary culture for production of haploid plants and homozygous lines, Embryo culture and embryo rescue. Protoplast isolation, culture and fusion, regeneration of hybrid plants, symmetric and asymmetric hybrids, cybrids.
6. Plant transformation technology: Tumor formation, hairy root, features of Ti and Ri plasmids, *Agrobcterium*-mediated of DNA transfer, role of virulence genes, use of Ti and Ri as vectors. 35S and other promoters, genetic markers, Reporter genes, reporter gene with introns, and scaffold attachment regions. Methods of nuclear transformation.
7. Application of plant transformation: resistance to Biotic and abiotic factors. Abiotic stress, use of ACC synthease, ACC oxidase, ADP glucose pyrophosphatase.
8. Chloroplast transformation, Metabolic Engineering and industrial products: Plant secondary metabolites, control mechanisms and manipulation biochemical pathways.