Syllabus for Biotechnology (SCPH05)

Note:

i. There will be one Question Paper which will have 100 questions.

ii. All questions will be compulsory.

iii. The Question Paper will have two Parts i.e. Part A and Part B

iv. Part A will have 50 questions based on Research Methodology

v. Part B will have 50 questions based on Subject-Specific Knowledge.

Microbiology

- Microbiology; History, different branches of microbiology
- Microbial world; Brief account of bacteria, Cyanobacteria, Rickettsia's, Mycoplasmas and Archaebacteria
- Cultivation of Bacteria; Isolation, Purification, Enrichment techniques and maintenance. Culture Collection
- Growth: Phases of growth, measurement and growth yield
- Identification of bacteria; Nomenclature, classification- new approaches including molecular parameters (16S r RNA sequencing and phylogenetic tree)
- Modes of Nutrition: sources and mode of nitrate reduction, nitrifying and denitrifying bacteria, Biological N_2 fixation and microbes used as bio fertilizer.
- Viruses: Classification, morphology and composition of viruses in general, viroid's and prions.
- Extremophilic microbes-their biotechnological potentials. Microbes-role in human welfare.

Biochemistry & Biophysics

- Carbohydrates; Glycolysis, Gluconeogenesis, Krebs' Cycle, Electron transport chain, Oxidative Phosphorylation
- Fatty acids; general properties and ß- oxidation
- Amino acids (general properties); Amino acid sequencing and composition; end group analysis
- Proteins: Protein structure (primary, secondary, tertiary & quaternary), Globular, Fibrous proteins; Ramachandran plot, Circular Dichroism, Hydrophobic and hydrophilic interactions. PAGE, SDS-PAGE, Diagonal Electrophoresis, MALDI.
- Protein folding (Introduction / Tools to study folding – unfolding phenomenon)

Cell Biology

- Cell membranes: methods to study organization of membranes.
- Transport across bio membranes: facilitated transport, group translocation, Active transport, Na+-K+ATPase pump.
- Cytoskeleton: Composition, organization and functions of

Microfilaments, microtubules, intermediate filaments and associated proteins
- Basic concept of signal transduction.
- Cell adhesion; cell junctions, cell adhesion molecules.
- Cell cycle and its control.
- Biology of cancer cells and process of oncogenes is.

Genetics and Molecular Biology
- Introduction to cell division, Mendelian Laws and physical basis of inheritance, dominance and its molecular basis
- Basics of gene interaction, cis-trans-test and complementation test, lethal genes, polygenic traits, linkage and gene maps
- DNA double helix: Physico-chemical considerations
- Organization of prokaryotic and eukaryotic genomes, supercoiling, repetitive DNA
- DNA replication: Mechanism of replication of Prokaryotic & Eukaryotic Chromosome
- Mutation: Types and molecular mechanisms of mutations, mutagens, DNA Repair
- Transposition: Mechanisms of transposition, transposon mutagenesis
- Recombination: Homologous and site - specific recombination
- Gene expression in eukaryotes: Transcription, general and specific transcription factors, regulatory elements and mechanism of regulation, processing of transcripts
- Gene expression in bacteria: Transcription and its regulation; operons, attenuation, anti-termination and anti-sense controls
- Prokaryotic translation machinery, mechanism and regulation of translation, Posttranslational modifications.

Enzymology & Enzyme Technology
- History
- Classification and nomenclature of enzymes
- Isolation and purification of enzymes
- Coenzymes and Cofactors
- Steady state kinetics: Methods for estimation of rate of enzyme catalyzed reaction with special reference to Michaelis-Menten equation. Effects of substrate, temperature, pH and inhibitors on enzyme activity and stability
- Active site, chemical modification and regulation (Zymogens and Isozymes)
- Enzyme engineering
- Immobilization of Enzymes and cells.

Genetic Engineering
- Restriction endonucleases, Modification methylases and other enzymes needed ingenetic engineering.
- Cloning vectors: Plasmids and plasmid vectors, Phages and Phage Vectors, phagemids, Cosmides, artificial chromosome vectors (YAC, BAC), Animal virus derivedvectors - SV40 and retroviral vectors.

- Molecular cloning: Chromosomal DNA isolation (Animal, Plant and Bacteria), Transformation, construction of genomic DNA and cDNA. libraries, screening ofrecombinants, Recombinant DNA techniques.
- Expression strategies for heterologous genes.
- DNA analysis: labeling of DNA and RNA probes. Southern and fluorescence *in situ* hybridization, DNA fingerprinting.
- Techniques for gene expression: Northern and Western blotting, gel retardationtechnique, DNA foot printing, Primer extension, Sl mapping, Reporter assays.
- Sequencing of DNA, chemical synthesis of oligonucleotides; techniques of site- directed mutagenesis, gene replacement and gene targeting.
- Polymerase chain reaction and its applications
- Applications of genetic engineering: Transgenic animals, production of recombinant pharmaceuticals, gene therapy, disease diagnosis
- Biosafety regulation: Physical and biological containment

Immunology

- History of immunology
- Nature of antigens, Antibody structure and function, Antigen - antibody reactions andapplications
- Major histocompatibility complex
- Complement system.
- Activation of B and T-lymphocytes, Immunological tolerance.
- Cell-mediated cytotoxicity: Mechanism of cytotoxic T cells and NK cells mediated target cell lysis, Antibody dependent cell-mediated cytotoxicity, macrophages mediated cytotoxicity.
- Hypersensitivity
- Autoimmunity
- Transplantation

Plant Biotechnology

- Tissue culture media, Initiation and maintenance of callus and suspension cultures;single cell clones
- Tot potency: Organogenesis; somatic embryogenesis; transfer and establishment ofwhole plants in soil (hardening).
- Rapid clonal propagation and production of virus -free plants
- *In vitro* pollination; embryo culture and embryo rescue
- Protoplast fusion, selection of hybrid cells; symmetric and asymmetric hybrids,cybrids
- Nuclear cytology of cultured plant cells and soma clonal variations
- Production of haploid plants and their utilization
- Cryopreservation and slow growth for germplasm conservation.
- Production of Biochemicals from cells and tissue cultures
- Biochemical production
- Gene transfer in nuclear genome and chloroplasts; *Agrobacterium*-mediated gene transfer, direct gene transfer, antibiotic marker-free transgenics

- Transgenic plants: insect resistance, virus resistance, abiotic stress tolerance,
  Longershelf life (including strategies for suppression of endogenous genes), male sterility, enhanced nutrition (golden rice), edible vaccines, patent and IPR.
- Molecular markers: RFLP, RAPD, AFLP, applications of molecular markers, SNP.

Animal Cell Culture

- Introduction to the balanced salt solutions and simple growth medium. Chemical, physical and metabolic functions of different constituents of culture medium
- Basic techniques of mammalian cell cultures *in vitro*
- Organ, organotypic and histolytic cultures
- Serum & protein free defined media and their applications
- Measurements of growth, viability and cytotoxicity
- Cell synchronization and transformation
- Applications of animal cell culture including stem cell applications

Environmental Biotechnology

- Environment: Basic concepts; Environmental pollution; Types of pollution; Measurement of pollution and environmental management
- Wastewater Treatment- Basic concept, Primary & secondary treatment, Suspended and attached culture, Trickling, Rotating and biological contactors, Nitrogen and phosphorus removal, Ponds systems.
- Water Pollution and its control: Water as a resource; Water bodies; Need for water management; Sources and Measurement of water pollution, Wastewater treatment- basic concepts; Physicochemical and biological treatment processes.
- Tertiary treatment; Disinfection and disposal
- Biological treatment processes: Biochemistry and microbiology of aerobic and anaerobic treatment processes; Suspended and attached growth type aerobic processes- activated sludge, Oxidation ditch, Aerated lagoons, Oxidation ponds andtheir variations.
- Anaerobic processes- Anaerobic digesters, Fixed and fluidized types of anaerobic bioreactors, UASB bioreactors, Treatment of typical industrial effluents- Diary, distillery, sugar, and antibiotic industries.
- Global environmental problems; Ozone depletion, UV-B radiation and greenhousegases.
- Brief account of bioremediation.

Bioprocess Engineering & Technology

- Screening and improvement of industrially important microorganisms
- Microbial growth and death kinetics
- Introduction to food technology
- Air and media sterilization
- Types of fermentation processes - Analysis of batch, Fed-batch and continuous bio reactions, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photo bioreactors etc.)

- Measurement and control of bioprocess parameters
- Downstream processing
- Industrial production of chemicals - Ethanol, Acids (citric, acetic and gluconic), solvents (glycerol, acetone and butanol), Antibiotics (penicillin, streptomycin andtetracycline), Semisynthetic antibiotics, Amino acids (lysine and glutamic acid), Single cell protein
- Aeration and agitation: Requirement of oxygen in industrial processes. Concept of volumetric oxygen transfer coefficient and its determination (kLa). Factors affecting(kLa).

Bioinformatics & Biostatistics

- Introduction to bioinformatics
- Searching database, Alignment of gene sequences, Local and global
- Analysis of DNA sequence: Gene prediction and locating genes, Location of transcription start point and end point, getting polypeptide sequence of the extracted core nucleotide sequence, Designing primers of specific gene, Generation of restriction maps.
- Analyzing phylogenetic relationship based on nucleotide and protein sequences.
- Analysis of proteins: Protein classification, homology modeling, threading, Ab-initio prediction of protein structure (secondary and 3 dimensional), tools for structure prediction, validation and visualization
- Diagrammatic, graphical and tabular representations of data; measures of central tendency, dispersion, skewness and kurtosis
- Pearson correlation coefficient
- Basic concepts of hypothesis testing, two kinds of error, level significance, p value, t-Test for mean and difference between two means, partial t-test., and chi-square test for goodness of fit.
- IPR.