

# **Syllabus for Ph.D Entrance Test, Biotechnology**

## **Cell Biology**

### **UNIT I**

Membrane structure and function: Structure of fluid mosaic model of membrane, lipid bilayer, transport across membrane, mechanism of sorting and regulation of intracellular transport.

### **UNIT II**

Organization of chromosomes: Structure of chromatin and nucleosome, heterochromatin, euchromatin.

### **Unit III**

Cellular energy transactions- role of mitochondria and chloroplast; cell cycle- molecular events and model systems.

### **Unit IV**

Cell motility – cilia and flagella of eukaryotes & prokaryotes. Cellular basis of differentiation and development mitosis, meiosis, gametogenesis and fertilization.

### **UNIT V**

Cell signaling: Peptide and steroid hormones and their receptors, signal transduction pathways, secondary messengers, regulation of signaling pathways. Cancer: Oncogenes, tumor suppressor genes, virus-induced cancer, metastasis.

## **BIostatistics & Bioinformatics**

### **Unit I**

Importance and scope of statistics in biological experimentation; Elements of probability; Mathematical and statistical definitions; Addition and Multiplication theorems.

### **Unit II**

Measures of central tendency: Arithmetic, geometric & harmonic means: Measures of dispersion: range, quartile deviation, variance, standard deviation, coefficient of variation, confidence limits of population mean.

### **Unit III**

Analysis of variance: one way analysis (sample sizes equal and unequal), completely randomized design; two way analysis (one observation per cell), randomized block design; multiple comparisons: least significance difference.

### **Unit IV**

Biological Databases: Types, importance and management. Sequence Database: Nucleotide and Protein. Bioinformatics Softwares: Clustal V Multiple Sequence Alignments, ClustalW Version 1.7, RasMol, Oligo, MolScript, TREEVIEW, ALSCRIPT.

### **Unit V**

**Computational Biology:** Datamining and Sequence Analysis, Database Similarities Searches, Multiple Sequence Alignment, Phylogenetic Analysis.

# MICROBIOLOGY

## Unit I

**Historical perspectives;** Pure culture techniques. General outline and classification of viruses, fungi, bacteria and molecular taxonomy.

## Unit II

**Microbial growth:** Growth curve, measurement of growth, continuous culture, factors affecting growth; culture collection and maintenance of cultures.

## Unit III

**Microbial nutrition and metabolism:** Metabolic diversity among microorganisms; chemolithotrophy; hydrogen-iron-nitrite-oxidizing bacteria; methanogenesis; fermentation.

## Unit IV

Structural diversity of bacteria & viruses; discovery, classification, Prokaryotic cells structure and functions, cell walls of eubacteria, peptidoglycan and related molecules, biosynthesis of cell wall; outer membrane of gram negative bacteria, cell membrane synthesis, gram +ve and gram -ve flagella,

## UNIT V

**Microbial diseases:** Tuberculosis, AIDS, candidiasis, malaria.

**Important diseases of plants:** Downy mildew of pearl millet, panama wilt of banana, bacterial leaf

# ANIMAL BIOTECHNOLOGY

## Unit I

Culture of animal cells: Primary culture: Isolation of mouse and chick embryos, human biopsies, methods for primary culture, nomenclature of cell lines, sub culture and propagation and routine maintenance.

## Unit II

**Cell characterization:** cytotoxicity assays, cell quantitation, cell culture contamination: monitoring and eradication, cryopreservation, confocal microscopy. Stem cell culture and its applications

## Unit III

Serum and protein free defined media and their application, measurement and viability and cytotoxicity, biology and characterization of the cultured cells, measuring parameters of growth, basic techniques of mammalian cell culture *in vitro*; disaggregation of tissue and primary culture; maintenance of cell culture; cell separation

## Unit IV

Applications of animal cell cultures, stem cell cultures, embryonic stem cells and their applications, cell culture based vaccines, somatic cell genetics, hybridoma technology and production of monoclonal antibodies.

## Unit V

Transgenic animals: Transgenic animals and applications: mice and other animals, Biosafety regulations- guidelines for research in transgenic animals, public awareness of the processes of producing transgenic organisms.

# BIOCHEMISTRY

## UNIT I

Principles of biophysical chemistry (pH, buffer, reaction kinetics).

## UNIT II

Composition, structure, conformation and function of biomolecules -carbohydrates, lipids, proteins, nucleic acids and vitamins.

## Unit III

Enzyme classification, specificity, active site, Enzyme kinetics- Michaelis & Menton equation, determination of kinetic parameters, bi-substrate reactions and their kinetics, enzyme inhibition and kinetics, allosteric enzymes, Mnemonical enzymes,

## UNIT IV

Antisense and ribozyme technology, molecular mechanism of anti- sense molecules, disruption of RNA structure; Biochemistry of ribozyme; hammerhead, hairpin and other ribozymes, applications of antisense and ribozyme technologies

## Unit V

Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.

## Techniques in Biology

### Unit I

Physical techniques in protein, nucleic acids and polysaccharide: structural analysis (UV-Vis, Fluorescence, IR, CD, NMR, ESR and Raman spectroscopy); differential colorimetry, X-ray crystallography, electron cryo microscopy; scanning, tunneling microscopy, MALDI TOF

### Unit II

Centrifugation Techniques Chromatographic Techniques- General principles, TLC, column chromatography, HPLC, Adsorption chromatography, Partition chromatography, Ion exchange chromatography, Exclusion chromatography, GLC, Affinity chromatography.

### Unit III

Electrophoretic Techniques: General principles, Native gels, SDS-PAGE, IEF, 2D gel electrophoresis, Agarose gel electrophoresis, Pulse field gel electrophoresis, Capillary electrophoresis.

### Unit IV

Protein and nucleic acid databases; structural comparison at secondary and tertiary levels; physical and chemical methods for immobilization of small and macromolecules

### Unit V

Radiolabeling techniques, properties of different types of radioisotopes normally used in biology, their detection and measurement, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

## **Molecular Biology & Genomics.**

### **Unit I**

DNA replication, repair and recombination in prokaryotes and eukaryotes: Mechanism of replications, enzymes, fidelity of replication, DNA damage and repair mechanisms, homologous and site-specific recombination.

### **Unit II**

RNA synthesis and processing in prokaryotes and eukaryotes: Transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing and polyadenylation.

### **Unit III**

Translation in prokaryotes and eucaryotes, machinery, mechanism and regulation of translation

### **Unit IV**

Control of gene expression at transcription and translation level: regulating the expression of prokaryotic and eukaryotic genes, role of chromatin in gene expression, DNA methylation, gene silencing.

### **UNIT V**

Gene mapping methods ,Microbial genetics: transformation, conjugation, transduction, Human genetics: Pedigree analysis, karyotypes, genetic disorders. Quantitative genetics: Polygenic inheritance, heritability and its measurements Mutation: Types, causes and detection, mutant types

## **IMMUNOLOGY**

### **Unit I**

Introduction: phylogeny of immune system, innate and acquired immunity, organization and structure of lymphoid organs, nature and biology of antigens and super antigens.

### **Unit II**

Antibody structure and function; antigen antibody interactions

### **Unit III**

Cells of the immune system; hematopoiesis and differentiation, lymphocyte trafficking; B-lymphocytes, T-lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cells, eosinophil, neutrophils and mast cells.

### **Unit IV**

Regulation of immune response, antigen processing and presentation, generation of humoral and cell mediated immune responses

### **Unit V**

Immunological techniques: ODD, immunoelectrophoresis, RIA, ELISA, Immunofluorescence, Western blot. Tumor immunology: Neoplasms, tumor-associated antigens, immune response to tumor antigens, immunologic factors favouring tumor growth, immunotherapy.

## Environmental Biotechnology

### Unit -I

Environment: Basic concepts and issues; environmental pollution: types and methods for the measurement; methodology of environmental management-problem solving approach.

### Unit II

Water pollution and its control: Water as a scarce natural resource, need for water management, sources and measurement of water pollution, waste water treatment.

### Unit III

Microbiology of waste water treatment: aerobic processes- activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds; anaerobic processes- anaerobic digestion, anaerobic filters; treatment schemes for waste waters of industrial waste water.

### Unit IV

Microbial degradation of xenobiotics in the environment-ecological consideration, oil pollution, surfactants, pesticides; bioaccumulation of metals and radio-nucleids and detoxification.

### Unit V

Biological N<sub>2</sub> fixation, H<sub>2</sub> production, biofertilizers and biopesticides; solid wastes; sources. Global environmental problems-ozone depletion, UV-B green house effect and acid rain, their impact and biotechnology approaches for management.

## Plant Biotechnology

### Unit I

Cell and Tissue Culture Technology Role of hormones in Callus Induction, Organogenesis, Somatic embryogenesis and synthetic seeds. Micropropagation: Stages and applications.

### Unit II

Cloning vector for higher plant transformation: *Agrobacterium tumefaciens* Ti and Ri plasmids, basis of tumor formation, hairy root, mechanisms of DNA transfer, role of virulence genes. Viral vectors and their applications: direct gene transfer.

### Unit III

Germplasm preservation: Short and long-term storages, gene banks, applications. Haploid Technology: Methods of haploid culture and applications. Protoplast Technology: Isolation, purification and culture of protoplasts, protoplast fusion and somatic hybridization, applications of somatic hybrids. Secondary metabolite production:

### Unit IV

Transgenic plants: Herbicide resistance, resistance against biotic stress- bacterial, viral, fungal and insect resistance, abiotic stress, improved crop productivity, improved nutritional quality.

### Unit V

Molecular pharming Intellectual Property Rights (IPR): IPRs and agricultural technology- implications for India, WTO, WIPO, GATT, TRIPS. Plant Breeder's Rights, legal implications. Ethical issues associated with consumption of GM food, labelling of GM crops and foods.

## **Unit I**

Primary and secondary metabolites, Batch culture, the growth cycle, effect of nutrients, energetics of growth.

## **Unit II**

Downstream processing: Filtration of fermentation broths, ultra centrifugation, recovery of biological products by distillation, superficial fluid extraction. Removal of microbial cells and solid matter, foam separation.

## **Unit III**

**Design of bioreactors:** Biosensors, scale up of bioreactors

## **Unit IV**

Microbiology of food: sources and types of microorganisms in food, food borne pathogens, microbiological examination of food, food preservation, fermented foods, microbial proteins.

## **Unit V**

Microbial products: Microbial production of vitamins, enzymes, organic acids, amino acids, antibiotics, ethanol. Microbes for sustainable agriculture: Biological nitrogen fixation, Biofertilizers, Biological control, Biopesticides.