UNIVERSITY OF MYSORE
Syllabus for Entrance Examination for Ph.D.
Subject: Biotechnology

Unit 1: Biochemistry and Biophysics

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

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

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

Principles of catalysis and enzymes, enzyme kinetics, enzyme regulation, inhibition, isozymes.

Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).

Unit 2: Methods in Biology

Centrifugation Techniques

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

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

Spectroscopic techniques: UV/visible, fluorescence, circular dichroism, NMR, ESR spectroscopy, X-ray diffraction, mass spectrometry.

Radiolabeling techniques: Detection and measurement of radioisotopes, molecular imaging of radioactive material, safety guidelines.

Microscopic techniques: Light microscopy, scanning and transmission electron microscopy, fluorescent and confocal microscopy.

Statistical Methods: Measures of central tendency and dispersion; probability distributions (Binomial, Poisson and normal); Sampling distribution; parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance; Regression and Correlation; t-test; Analysis of variance and multiple range tests, chi-square test, experimental design, data transformation

Unit 3: Microbiology

Historical perspectives; Pure culture techniques.

General outline and classification of viruses, fungi, bacteria and molecular taxonomy.

Archaea: Halophiles, methanogens, thermophiles.

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

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

Microbes and environment: Nutrient cycles; quorum sensing; biofuels; prebiotics and probiotics.

Microbial diseases: Tuberculosis, AIDS, candiasis, malaria.

Important diseases of plants: Downy mildew of pearl millet, panama wilt of banana, bacterial leaf blight of rice, TMV.

Antibiotics: Types, mode of action and resistance.

Unit 4: Cell Biology

Membrane structure and function: Structure of fluid mosaic model of membrane, lipid bilayer, transport across membrane, mechanism of sorting and regulation of intracellular transport.
Structural organization and function of intracellular organelles.
Organization of chromosomes: Structure of chromatin and nucleosome, heterochromatin, euchromatin.
Cell division and cell cycle: Mitosis and meiosis, cell cycle and regulation.
Cell signaling: Peptide and steroid hormones and their receptors, signal transduction pathways, secondary messengers, regulation of signaling pathways.
Cellular communication: Cytoskeletal elements, cell adhesion molecules, extracellular matrix, neurotransmission and its regulation.
Cancer: Oncogenes, tumor suppressor genes, cancer and cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, chemotherapy.

Unit 5: Molecular Biology and Genetics

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.
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.
Protein synthesis and processing in prokaryotes and eukaryotes: Ribosome, formation of initiation complex, initiation factors, elongation, termination, genetic code, aminoacylation of tRNA, translational inhibitors, Post-translational modification of proteins.
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.
Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.
Microbial genetics: transformation, conjugation, transduction, fine structure analysis of genes.
Human genetics: Pedigree analysis, karyotypes, genetic disorders.
Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.
Mutation: Types, causes and detection, mutant types– lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.
Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

Unit 6: Gene Technology and Bioinformatics

Isolation, purification, analysis of RNA and DNA (genomic and plasmid).
Molecular cloning of DNA and RNA fragments in cloning vectors and expression.
Construction of genomic and cDNA libraries and screening.
DNA sequencing methods, strategies for genome sequencing.
Methods for analysis of gene expression at RNA and protein level, micro array, DNA chips.
PCR, RFLP, Southern and Northern blotting, AFLP techniques, Real-time PCR.
In situ localization, FISH and GISH.

Bioinformatics

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, Genetic Analysis Software, Phylip.

Computational Biology: Datamining and Sequence Analysis, Database Similarities Searches, Multiple Sequence Alignment, Phylogenetic Analysis, Predictive methods using Nucleic acid and Protein Sequences, Submitting DNA Sequences to the Databases.

Unit 7: Immunology and Immunotechnology

Innate and adaptive immune system: Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. Generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell-mediated immune responses, primary and secondary immune modulation, the complement system, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity.

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.

Unit 8: Bioprocess and Microbial Technology

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

Design of bioreactors: Biosensors, scale up of bioreactors

Transport phenomena in bioprocess: Mass transfer resistance, oxygen transfer coefficients, biological heat transfer, heat transfer coefficients.

Downstream processing of biologicals: Separation of cells, foam separation, flocculation, filtration, plate filters, rotary vacuum filter, centrifugation, Stokes law, basket centrifuge, bowl centrifuge, disintegration of microorganisms, mechanical and non-mechanical methods, membrane filtration, ultra filtration and reverse osmosis, chromatographic techniques, absorption, spray drier, drum dryers, freeze dryers.

Microbial products: Microbial production of vitamins, enzymes, organic acids, amino acids, antibiotics, ethanol.

Microbes for sustainable agriculture: Biological nitrogen fixation, Biofertilizers, Biological control, Biopesticides.

Unit 9: Plant Biotechnology

Cell and Tissue Culture Technology

Role of hormones in Callus Induction, Organogenesis, Somatic embryogenesis and synthetic seeds.

Micropropagation: Stages and applications.

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: Induction of secondary metabolites by plant cell culture; Bioreactor systems for mass cultivation of plant cells.

Seed Biotechnology

Seed development and structure, Hybrid seed production technology: Genetic determinants of flowering, seed development and germination, male sterility and apomixes.

Transgenics

Plant transformation techniques: Methods of gene transfer in plants, *Agrobacterium*-mediated gene transfer, direct gene transfer methods- electroporation, microinjection, particle bombardment, selection of transformants.

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

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 10: Animal Biotechnology

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.

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

Cell and Tissue engineering: Growth factors for *in situ* tissue regeneration, biomaterials in tissue engineering, approaches for tissue engineering of skin, bone grafts, nerve grafts. Haemoglobin-based blood substitutes, bio artificial or biohybrid organs. Limitations and possibilities of tissue engineering.

***In vitro* fertilization and Embryo transfer:** *In vitro* fertilization in Humans, Embryo transfer in Humans, Super ovulation and embryo transfer in farm animals e.g: Cow.

Cloning of Animals: Methods and uses. Introduction, nuclear transfer for cloning, cloning from-embryonic cells, adult and fetal cells. Cloning from short-term and long-term cultured cells: cloning of sheep, Cloning of cows from aged animals. human cloning: ethical issues and risks.

T**ransgenic 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.