Institute of Chemical Technology, Matunga, Mumbai
Syllabus for PhD (Science) Biochemistry & Biotechnology Common Entrance Test

Section I: Basic Physics and Chemistry (XII standard level) and General scientific and mathematical aptitude

Section II: Biological Sciences

Organization of life. Importance of water, Cell structure and organelles. Structure and function of biomolecules: Amino acids, Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques and characterization: ion exchange, size exclusion and affinity chromatography, electrophoresis, UV-visible, fluorescence and Mass spectrometry. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, Ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics including its regulation and inhibition, Vitamins and Coenzymes.

Metabolism and bioenergetics. Generation and utilization of ATP. Metabolic pathways and their regulation: glycolysis, TCA cycle, pentose phosphate pathway, oxidative phosphorylation, gluconeogenesis, glycogen and fatty acid metabolism. Metabolism of Nitrogen containing compounds: nitrogen fixation, amino acids and nucleotides. Photosynthesis: the Calvin cycle.

Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications: PCR, site directed mutagenesis and DNA-microarray.

Immune system. Active and passive immunity. Complement system. Antibody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

Advanced techniques in gene expression and analysis: PCR and RT-PCR, microarray technology, DNA fingerprinting and recombinant DNA technology; prokaryotic and eukaryotic expression systems; Vectors: plasmids, phages, cosmids and BAC.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells and development of transgenic plants; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/immobilized cell culture; expression of animal protein in plants; genetically modified crops.

Animal cell metabolism & regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for mass culture of animal cell lines; application of animal cell culture for production of vaccines, growth hormones; interferons, cytokines & therapeutic proteins; hybridoma technology and gene knockout; stem cells, its application in organ synthesis; gene therapy; transgenic animals & molecular pharming.

Industrial bioprocesses: microbial production of organic acids, amino acids, proteins, polysaccharides, lipids, polyhydroxyalkanoates, antibiotics and pharmaceuticals; methods and applications of immobilization of cells and enzymes; kinetics of soluble and immobilized enzymes; biosensors; biofuels; biopesticides; environmental bioremediation.

Microbial growth kinetics; batch, fed-batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media, design and operation of stirred tank, airlift, plug flow, packed bed, fluidized bed, membrane and hollow fibre reactors; aeration and agitation in aerobic fermentations; bioprocess calculations based on material and energy balance; Downstream processing in industrial biotechnology: filtration, precipitation, centrifugation, cell disintegration, solvent extraction, and chromatographic separations, membrane filtration, aqueous two phase separation.

Historical Perspective: Discovery of microbial world; Landmark discoveries relevant to the field of microbiology; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases, Methods in Microbiology: Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Enrichment culture techniques for isolation of microorganisms; Light-, phase contrast- and electron-microscopy.

Microbiology: Bacteria, Archea and their broad classification; Eukaryotic microbes: Yeasts, molds and protozoa; Viruses and their classification; Molecular approaches to microbial taxonomy. Prokaryotic and Eukaryotic Cells: Structure and Function: Prokaryotic Cells: cell walls, cell membranes, mechanisms of solute transport across membranes, Flagella and Pili, DNA replication, repair and recombination: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms. RNA synthesis and processing: Protein synthesis and processing Control of gene expression at transcription and translation level. PCR and RT-PCR, microarray technology, DNA fingerprinting and recombinant DNA technology; prokaryotic and eukaryotic expression systems; Vectors: plasmids, phages and cosmids. Gene mutation: Types of mutation; UV and chemical mutagens; Selection of mutants; Ames test for mutagenesis; Bacterial genetic system: transformation, conjugation, transduction, recombination, transposons; DNA repair and chromosomal aberrations

Bioinformatics: genomics; proteomics and computational biology

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