

**Department of Bioengineering
Faculty of Engineering
Integral University, Lucknow**

**SYLLABUS FOR ENTRANCE TEST TO Ph.D PROGRAMME
w.e.f. July, 2015 onwards**

UNIT 1. MOLECULAR CELL BIOLOGY AND GENETICS

Structure of atoms, molecules and chemical bonds, pH, buffer, reaction kinetics, Thermodynamics, Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins), Bioenergetics, Enzymology, Conformation of proteins & nucleic acids (DNA & RNA), Metabolism of biomolecules.

DNA replication, mutation, repair and recombination; RNA synthesis and processing; Protein synthesis and processing; Operon, interrupted genes, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, transposons; regulation of prokaryotic and eukaryotic gene expression; role of chromatin in regulating gene expression; gene silencing.

Membrane structure and function, Structural organization and function of intracellular organelles, Cell division and Cell signaling, Hormones, cell-surface receptors, signal transduction pathways and their regulation, Cellular communication, Basic developmental biology, Cancer Biology. Mendelian principles, deviation from Mendelian inheritance, Concept of gene: (Allele, multiple alleles, pseudoallele), linkage and crossing over, gene mapping, extra chromosomal inheritance, Microbial genetics, Methods of transfer of genetic material in microbes, Human genetics: Pedigree analysis, karyotypes, genetic disorders, Structural and numerical alterations in chromosomes, Population genetics.

UNIT 2. IMMUNOLOGY AND MICROBIOLOGY

Innate and adaptive immune system, antigens, antigenicity, immunogenicity, structure and function of antibody molecules, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, inflammation, hypersensitivity, autoimmunity, immune response during infections, congenital and acquired immunodeficiencies.

History and Scope of Microbiology, Classification systems, structural and chemical composition of cell wall, Microbial growth kinetics, Bacterial Metabolism, Fermentation and anaerobic respiration, Chemotherapeutic agents and antibiotics, Drug Resistance, Host parasite interaction, Microbial spoilage of food, Food preservation, Food borne diseases, Virology, Distinctive properties of Viruses, Viroids and Prions, Bacteriophages, Lytic and Lysogenic viral life cycles, Control of viruses, Interferon, Antiviral antibiotics.

UNIT 3. FERMENTATION TECHNOLOGY AND BIOPROCESS ENGINEERING

History and development of fermentation industry: Introduction to submerged and solid state fermentation, primary and secondary metabolite. Raw material availability, quality, processes and pretreatment of raw materials. Media design and optimization; Microbial growth in closed, semi-open cultivation systems; Maintenance energy and yield concepts; Estimation of biomass. Sterilization: Concept and methods; Sterilization of medium; Kinetics of thermal death of microorganisms; Batch sterilization; Continuous sterilization; Sterilization of air: Filters and design of depth filters. Steady state and unsteady state Material and Energy Balance calculations of different bioprocesses such as fermentation, sterilization, filtration etc. Microbial kinetics of growth and substrate utilization; Product formation in batch, Fed batch and continuous culture; Microbial pellet formation; Kinetics and dynamics of pellet formation

UNIT 4. BIOINFORMATICS AND NANOBIO TECHNOLOGY

Nucleic acid and protein sequence/structure databases (GenBank, UniProt, PDB); data mining methods for sequence analysis (BLAST, CLUSTALW); web-based bioinformatics tools including (but not limited to): Expasy, CORINA, molecular modeling and docking servers, servers for structure-activity relationships, servers for file format conversions. Introduction: Introduction to nanotechnology and overview of nanoscale materials, effect of length scale on properties, introduction to bionanotechnology, challenges and opportunities associated with biology on the Nanoscale, bionanotechnology systems, biological and medical applications of Bionanomaterials. Characteristics of nanoparticles, Environmental behaviour of nanoparticles, biological activity of nanomaterial. Principles of toxicology; toxicology models, experimental toxicology studies; activation and detoxification mechanisms.

UNIT 5. BASIC BIOLOGY, EVOLUTION AND ECOLOGY

Photosynthesis, Respiration, Nitrogen metabolism, Plant hormones, Sensory photobiology, Secondary metabolites, Plant Cell and Tissue culture, Circulatory, Cardiovascular, Respiratory, Nervous, Sensory, Excretory, Digestive, Endocrine and Reproductive Systems. Principles and methods of taxonomy, Levels of structural organization, classification of plants, animals and microorganisms, Organisms of clinical and agricultural importance, Common parasites and pathogens of humans, domestic animals and crops, Molecular Evolution, Population genetics, The Environment: biotic and abiotic interactions, Habitat and niche, Population ecology, Species interactions: Types of interactions, Community ecology, Ecological succession, Ecosystem, Biomes, Applied ecology, Conservation biology.

UNIT 6. METHODS IN BIOLOGY AND SCIENTIFIC ENGLISH

Isolation and purification of RNA, DNA and proteins and associated separation methods; one and two dimensional gel electrophoresis, isoelectric focusing; molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems; expression of recombinant proteins using bacterial, animal and plant vectors; generation of genomic and cDNA libraries, in vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms; protein and DNA sequencing methods, methods for analysis of gene expression at RNA and

protein level, large scale expression analysis, microarray, PCR; RFLP, RAPD and AFLP techniques. Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, structure determination using X-ray diffraction and NMR; Mass spectrometry, Antibody generation, ELISA, RIA, western blot , immunoprecipitation , flow cytometry, *in situ* localization by techniques such as FISH and GISH, Radiolabeling techniques, light and fluorescence microscopy, scanning and transmission electron microscopy. Plant and Animal tissue culture. Statistical Methods: Students t test, Chi Square Test, Probability, ANOVA, Basics of English Grammar, correct use of verbs and prepositions, Tense, Introductory knowledge of terminologies related to scientific communications: Impact Factor, Journal, Citation, Manuscript, Original Article, Review, Acknowledgements, Conflict of interests, Corresponding Author, First Author, Plagiarism.