



Indus University
Institute of Sciences, Humanities and Liberal Studies
Syllabus of IURAT-2022
Department of Life Sciences

Molecules and their interaction relevant to biology

Structure of atoms, molecules and chemical bonds. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties). Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds). Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). Stability of proteins and nucleic acids. Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins.

Microbial Taxonomy and Physiology

Microbial World, Concepts and Scope, Classifying and Naming Microorganisms, ICNB Rules, Major Characteristics used to Classify Microorganisms, Importance and Conservation of Microbial Diversity, Metagenomics, In situ Conservation and Ex situ Conservation, Role of Culture collection centers in conservation. Microbial Energetics, Microbial enzymes, Metabolism of Carbohydrate, Alternate pathways of Carbohydrate Metabolism, Gluconeogenesis, Utilization of sugars other than glucose, Lipid metabolism, Nitrogen metabolism, Nucleic acid metabolism, Photosynthetic bacteria, Autotrophic Mechanisms in bacteria, Microbial Stress Responses to different conditions.

Food and agricultural biology

Concepts and scope, Detection of food-borne microorganisms, Microbial spoilage of foods, Food poisoning and intoxication, Food borne diseases, Food preservation, Microbial indicators of food safety and quality, Food laws and standards. Introduction to Agricultural Microbiology, Plant pathology, Diagnosis of plant diseases, Parasitism and disease development, Entry of pathogens to the host, Effect on physiology of host, Plant disease epidemiology, Environment and Plant diseases, Defense Mechanism of Plant Disease, Plant Diseases and their management, Host pathogen interaction, Biofertilizer, PGPR, Biopesticides.

Microscopic techniques Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze fracture methods for EM, image processing methods in microscopy

Bioinformatics and Biostatistics Overview of various primary and secondary databases of protein and nucleic acid sequences, Use of sequences to determine phylogenetic relationship, Methods for searching sequence databases (FASTA and BLAST algorithms), Statistical analysis and evaluation of BLAST results. Measures of central tendency and dispersal; Probability distributions (Binomial and normal); Sampling distribution. Parametric and non-parametric statistics; Errors; Levels of significance. History and Applications of bioinformatics. Classification and Presentation of Data. Quality of data, private and public data sources.

Molecular Biology and Genetic Engineering

Concept and scope of Molecular Biology and Genetic engineering, Microbes in Molecular Biology, DNA as Genetic material, DNA replication, Differences in prokaryotic and eukaryotic DNA replication, Protein synthesis, Gene expression, Regulation of gene expression in prokaryotes, eukaryotes and bacteriophages, Gene silencing, Importance of gene cloning and future perspectives, Enzymes in genetic engineering, Cloning vectors, Applications of Genetic Engineering, Antisense technology, Safety of rDNA technology, Restriction and regulation for the release of GMOs into Environment, Ethical, Legal, Social and Environmental Issues related to rDNA technology.

Cell and Its Structure

Structure of pro and eukaryotic cells, Membrane structure and function, Intracellular compartments, protein sorting, secretory and endocytic pathways, membrane channels and pumps, ligand and voltage gated channels, Na/K pump. Biochemistry of specialised tissues, biochemical basis of blood clotting, vision, muscle contraction, nerve impulse transmission and hormone action.

Immunology

History of immunology; Functional role of Immune System; Types of Immunity: Innate and adaptive immunity; Physical barriers to infection; Cells and organs of the innate and adaptive immune system; Haematopoiesis. Antigen: Characteristics of antigens; Factors that influence immunogenicity; Cross reactivity; Epitopes; Haptens, Adjuvants. Immunoglobulins: Structure, Classification & Functions; Organization & Synthesis of Light chain genes & Heavy chain genes, Class & Isotype Switching. Monoclonal Antibodies: Production by Hybridoma Technology & Applications. Antigen and Antibody Interactions- Agglutination, Precipitation, ELISA, RIA, Immunofluorescence & Western Blotting). MHC molecules and organisation of their genes; Structure and function of MHC gene products; Antigen Processing and Presentations. T- Cell Receptor; T- Cell Maturation, Activation, Differentiation; B- Cell Maturation, Activation, Differentiation. Hypersensitivity, Autoimmunity and Transplantation Immunology.

Analytical Techniques

Principles and applications of gel-filtration, ion-exchange and affinity chromatography, Thin layer and gas chromatography, High pressure liquid chromatography (HPLC), Electrophoresis and electro focussing, Differential centrifugation, Density gradient centrifugation, Ultracentrifugation. Principles and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy. Principles of biophysical methods used for analysis of biopolymer structure, UV, Visible, IR and NMR spectroscopy, Atomic absorption spectroscopy. Principles and applications of tracer techniques in biology, Radiation dosimetry, Radioactive isotopes and half life of isotopes, Effect of radiation on biological system, Autoradiography; Liquid scintillation spectroscopy.