KRISTU JAYANTI
(DEEMED TO BE UNIVERSITY)
Under Section 3 of UGC Act 1956
A CMI INSTITUTION | BENGALURU | INDIA

Centre for Research and Development
Office of Doctoral Studies

Syllabus for the Part B of
Kristu Jayanti University Entrance Test (KJUET)

Ph. D. Programme in Biotechnology/ Microbiology/ Biochemistry

Unit 1: Molecular and their Interactions that Drive Biological Processes

Structure of atoms, molecules and chemical bonds; non-covalent interactions including hydrogen bonds, Van der Waals forces, electrostatic interactions, hydrophobic interactions, and π-π stacking; principles of biophysical chemistry including pH, buffer systems, reaction kinetics, thermodynamics, and colligative properties; composition, structure, function and metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins; conformation and stability of proteins including Ramachandran plot, secondary structures, domains, motifs and folds, and nucleic acids including A, B, Z helices, t-RNA and micro-RNA, with stability via base stacking and hydrogen bonding; DNA/RNA-protein interactions and ribonucleoprotein complexes; bioenergetics including glycolysis, pentose phosphate pathway, TCA cycle, oxidative phosphorylation, coupled reactions, group transfer and biological energy transducers; enzyme structure and catalysis including active site architecture, catalytic residues, enzyme specificity, kinetics, inhibition, regulation, mechanism of catalysis, isozymes, cofactors and coenzymes; biomolecular interactions in disease including Alzheimer's, Parkinson's, Huntington's, prion diseases, therapeutic approaches to protein misfolding, and metabolic disorders such as diabetes and lipid metabolism disorders.

Unit 2: Organization of Cellular Components and Cell Cycle

Membrane structure, composition and function including fluid mosaic model, lipid bilayer, membrane proteins, membrane asymmetry and fluidity, membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, intracellular transport and electrical properties; cell surface specializations including glycocalyx, cell recognition, cell junctions, microvilli, cilia and flagella; cytoplasm organization including cytosol composition, cytoplasmic streaming, gel-sol transitions, and inclusion bodies; cytoskeletal components including microfilaments, microtubules and intermediate filaments with structure, assembly and functions; structural organization and function of membrane-bound organelles including endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes and vacuoles; mitochondria and energy conversion including structure, functions, cellular respiration, ATP synthesis, electron transport chain, chemiosmotic hypothesis, apoptosis, biogenesis and dynamics; chloroplast structure, biogenesis, protein import and division; nucleus organization including chromatin, genes and chromosomes, DNA packaging, modifications, epigenetics, heterochromatin, euchromatin, operons, unique and repetitive DNA, interrupted genes, gene families and transposons; cell division and cyclic regulation including cell cycle phases, mitosis, meiosis, checkpoints, quality control, cyclin-dependent kinases, microbial strategies of cell division, and gametogenesis.

Unit 3: Molecular Biology of the Gene

DNA replication in prokaryotes and eukaryotes including semi-conservative mechanism, replication forks, leading and lagging strand synthesis, Okazaki fragments, DNA polymerases, proofreading, telomere replication, and organelle DNA replication; types of DNA damage including spontaneous and induced damage, base modifications and strand breaks; mechanisms of DNA repair pathways including direct repair, base excision repair, nucleotide excision repair, mismatch repair and double-strand break repair; DNA recombination including homologous and site-specific recombination, transposition and SOS response; RNA synthesis including prokaryotic and eukaryotic transcription, RNA processing including 5' capping, 3' polyadenylation, splicing, and RNA editing; non-coding RNAs including rRNA, tRNA, miRNA, siRNA, lncRNA and CRISPR RNAs; translation machinery including ribosomes, tRNA, aminoacyl-tRNA synthetases; protein synthesis including initiation, elongation, and termination in prokaryotes and eukaryotes; protein processing and modifications including co-translational and post-translational modifications, folding, quality control and translational inhibitors; gene regulation in prokaryotes and eukaryotes including negative and positive control, attenuation, transcriptional activators and repressors, chromatin-level regulation, post-transcriptional and translational control, epigenetic regulation, and control of gene expression in viruses and phages.

Unit 4: Cellular Communication and Signal Transduction

Host-pathogen interaction including fundamentals of host-parasite relationships, molecular basis of interaction, pathogen evasion mechanisms, host defence mechanisms, and specific host-pathogen systems; cell signalling and communication including autocrine, paracrine, endocrine and juxtacrine signalling, signalling molecules, receptor structure and mechanisms, intracellular receptors, signal transduction pathways, bacterial chemotaxis, quorum sensing, two-component systems, cell-cell communication and neuronal signalling; cancer biology including benign and malignant tumours, hallmarks of cancer, oncogenes, tumor suppressor genes, DNA repair genes, epigenetic alterations, cell cycle dysregulation, apoptosis, cancer cell signalling, tumor microenvironment, cancer stem cells and therapeutics; innate and adaptive immune system including cells and molecules involved, antigens, antibodies, MHC, antigen processing and presentation, B and T cell activation, humoral and cell-mediated responses, complement system, Toll-like receptors, inflammation, hypersensitivity, autoimmunity, immune responses to infections, immunodeficiency and vaccines.

Unit 5: Ontogenetic Biology

Basic concepts of development including potency, commitment, specification, induction, competence, determination and differentiation, morphogenetic gradients, cell fate and lineages, stem cells, genomic equivalence, cytoplasmic determinants, imprinting, mutants and transgenics; gametogenesis, fertilization and early development including gamete production, sperm-egg recognition, embryo sac development, zygote formation, cleavage, blastula formation, embryonic fields, gastrulation, germ layer formation, embryogenesis, symmetry establishment in plants, seed formation and germination; morphogenesis and organogenesis in animals including cell aggregation, axes and pattern formation, organogenesis, neuronal differentiation, post-embryonic development, metamorphosis and sex determination; morphogenesis and organogenesis in plants including meristems, tissues, shoot and root apex organization, quiescent centre, shoot, root and leaf development, phytohormones and organ development, floral meristems, ABCDE model of floral development by MADS box genes.

Unit 6: Physiological Systems of Plants and Animals

Photosynthesis including light harvesting complexes, electron transport, photoprotection, CO2 fixation (C3, C4, CAM pathways); respiration and photorespiration including citric acid cycle, mitochondrial electron transport, ATP synthesis, alternate oxidase, photorespiratory pathway; nitrogen metabolism including nitrate and ammonium assimilation, amino acid biosynthesis; plant hormones including biosynthesis, storage, breakdown, transport, physiological effects, mechanisms of action and interactions; sensory photobiology including phytochromes, cryptochromes, phototropins, stomatal movement, photoperiodism and biological clocks; solute transport and photoassimilate translocation, mineral uptake, water and solute transport; roles and biosynthesis of secondary metabolites including terpenes, phenols and nitrogenous compounds; stress physiology in plants including biotic and abiotic stresses; cardiovascular system including heart structure, myogenic heart, blood vessels, cardiac activity regulation, blood composition, haemostasis, blood cells and plasma lipoproteins; respiratory system including mechanics and regulation, ventilation, gas transport, acid-base balance; nervous system including neuron types and structure, action potential, neurotransmitters, synaptic transmission, autonomic and central nervous systems; digestive system including secretion, regulation, composition and functions of digestive juices, hormones, digestion, absorption and BMR; excretory system including kidney structure, urine formation, nephritis, nephrosis, hormones and water-electrolyte balance; endocrinology and reproduction including endocrine glands, hormone mechanisms, reproductive processes, gametogenesis, ovulation and neuroendocrine regulation.

Unit 7: Genetics and Inheritance

Mendelian principles and concept of gene including laws of inheritance, genetic terminology; extensions of Mendelian principles including incomplete dominance, co-dominance, pleiotropy, phenocopy, gene interactions, multiple alleles, polygenic inheritance, linkage, crossing over, sex linkage, sex-limited and sex-influenced characters; gene mapping methods including linkage maps, tetrad analysis, molecular markers, somatic cell hybrids, mapping population development; extra-chromosomal inheritance including maternal inheritance, cytoplasmic inheritance, episomes and plasmids; microbial genetics including transformation, conjugation, transduction and sex-duction; human genetics including inheritance patterns, pedigree analysis, chromosomal disorders, genetic diseases, population genetics; quantitative genetics including polygenic inheritance, heritability, QTL mapping; mutations including types, mutagenic agents, detection methods, structural and numerical chromosome alterations.

Unit 8: Biological Diversity and Ecosystem Dynamics

Principles and methods of taxonomy including species concepts, hierarchical taxa, nomenclature, classical and quantitative methods; levels of structural organization including unicellular, colonial and multicellular forms, tissues, organs and organ systems, comparative anatomy, adaptive radiation and modifications; organisms of health and agricultural importance including common parasites and pathogens; environment, habitat and niche including niche width, fundamental and realized niche, resource partitioning, character displacement; species interactions including interspecific competition, herbivory, carnivory, pollination and symbiosis; ecosystem ecology including ecosystem structure and function, energy flow, mineral cycling, primary production, decomposition and Indian ecosystems; applied ecology including environmental pollution, global change, biodiversity status, monitoring, drivers of change and management approaches; conservation biology including principles, approaches, and Indian case studies such as Project Tiger and biosphere reserves.

Unit 9: Applied Biological Sciences

Microbial fermentation and production of small and macromolecules; application of immunological principles, vaccines, diagnostics, tissue and cell culture methods for plants and animals; transgenic animals and plants, molecular approaches to diagnosis and strain identification; genomics and applications to health and agriculture including gene therapy; bioresource utilization; breeding in plants and animals including marker-assisted selection; bioremediation and phytoremediation; biosensors and their applications.

Unit 10: Tools and Techniques for Biological Investigation

Molecular biology and recombinant DNA methods including isolation and purification of RNA, DNA and proteins, electrophoresis, molecular cloning, expression and purification of recombinant proteins, construction of genomic and cDNA libraries, site-directed mutagenesis, engineered nucleases, CRISPR, protein sequencing, DNA sequencing, next-generation sequencing, RNA-seq, gene expression analysis, carbohydrate and lipid analysis, RFLP, RAPD, AFLP techniques; immunotechniques including antibody generation, ELISA, RIA, immunoprecipitation, flow-cytometry, immunofluorescence microscopy, live cell imaging, FISH, GISH, immunohistochemistry; biophysical methods including UV/Vis, fluorescence, IR, CD, FTIR, NMR, ESR, X-ray diffraction, calorimetry, chromatography, surface plasmon resonance, protein purification; statistical methods including measures of central tendency, data distribution, hypothesis testing, parametric and non-parametric tests, correlation, regression, experimental design, probability distributions; radiolabeling techniques including radioisotope detection, measurement, incorporation, molecular imaging and safety guidelines; microscopic techniques including light, phase contrast, dark field, polarized light, confocal, SEM, TEM, cryo-EM, STED, live cell imaging, fixation and staining, image processing and statistical analysis; electrophysiological methods including single neuron recording, patch-clamp, ECG, brain activity recording, lesion and stimulation studies, pharmacological testing, PET, MRI, fMRI, and CAT.