



JAM 2027 Biotechnology (BT)



The Biotechnology (BT) Test Paper comprises Biology / Biotechnology, Chemistry, Mathematics and Physics.

Section 1: General Biology

Cell Biology: Structure of prokaryotic and eukaryotic cells; Membrane structure and function; Organelles and internal organization of the eukaryotic cell; Cell communication – signalling pathways: endocrine and paracrine signalling; Extracellular matrix and apoptosis; Cell cycle – stages of mitosis and meiosis.

Biochemistry: Structure and function of biological macromolecules; Enzymes – basic mechanisms of enzyme catalysis and regulation, Hill coefficient, Michaelis-Menten kinetics, enzyme inhibition, vitamins as coenzymes; Bioenergetics – free-energy change, high-energy compounds, biological oxidation-reduction reactions and reduction potential; Metabolism – glycolysis, TCA cycle and their regulation, oxidative phosphorylation, photosynthesis, nitrogen fixation, urea cycle.

Genetics: Mendelian inheritance; Exception to Mendelian law of independent assortment; Genetic interactions, linkage, recombination and chromosome mapping, Chromosomal mutations; Genetic disorders; Population Genetics

Molecular Biology: Landmark experiments that established DNA is the genetic material; DNA replication; Proof-reading and repair of DNA; DNA recombination; Transcription; RNA processing; Translation; Regulation of gene expression including operons and differential gene expression in multicellular eukaryotes.

Evolution and Ecology: Darwinian view – natural selection, fossil record and descent with modification; Different types of speciation; Phylogenetic classification; Origin of life – abiotic synthesis of biological macromolecules, protocell, dating fossils and origin of multicellularity; Climate patterns; Terrestrial and aquatic biomes; Environmental constraints on species distribution; Factors affecting population density; Interactions among communities; Ecosystems; Ecological remediation.

Section 2. Microbial, Plant and Animal Biotechnology

Microbiology: Microbial genetics - transformation, conjugation and transduction; Structural features of viruses, bacteria, fungi and protozoa; Pathogenic microorganisms; Nutrition-based classification of microbes; Microbial metabolism; Isolation and Cultivation of microorganisms; Growth kinetics; Microbial control and sterilization; Microbial fermentation – batch, fed-batch and continuous; Bioreactor and its components; Introduction to downstream processing - product recovery and purification; Effluent treatment.

Plant Biology: Types of tissues and organs; Primary and secondary growth; Morphogenesis; Transport in vascular plants; Plant nutrition; Development of flowering plants – gametophytic and sporophytic generations; Plant growth regulators; Photobiology; Plant Tissue Culture – Cellular totipotency and microporopagation; Transgenic plants; Plant response to biotic and abiotic stresses.

Animal Biology: Digestive, circulatory, respiratory, excretory, nervous, reproductive and endocrine systems; Basics of immunology – Innate and adaptive immunity, Immune cells, immunoglobulins and major histocompatibility complexes; Animal development – Fertilization, embryonic pattern formation, cleavage, gastrulation, cellular differentiation and morphogenesis; Mammalian cell culture, animal cloning; Transgenic animals.

Section 3: Biotechniques

Biochemical and Microscopy Techniques: Chromatography; Centrifugation; Electrophoresis; ELISA, Western blotting and immunostaining; Principles of light, fluorescence and electron microscopy.

Molecular Biology Techniques: DNA cloning – plasmid vectors, and restriction enzymes; Polymerase Chain Reaction; Expression of cloned eukaryotic genes in bacteria; Hybridization techniques; DNA sequencing; Recombinant DNA technology in medicine, agriculture and forensic sciences.

Computational Biology: Bioinformatics; Sequence and structure databases; DNA, RNA and protein sequence analysis; Secondary structure and 3D structure prediction; Biochemical databases.

Instrumental Techniques – Spectroscopy: fundamentals of molecular spectroscopy, emission and absorption spectroscopy, UV-Vis, circular dichroism, FTIR and 1-D proton NMR spectroscopy, basics of mass spectrometry; Basics of calorimetry; Basic concepts of crystallography; Flowcytometry.

Section 4: Chemistry (10+2+3 level)

Structure and properties of Atoms: Bohr's theory; Periodicity in properties.

Bonding in molecules: Chemical bonding; Complex formation; Physical and chemical basis of molecular interactions.

Chemical kinetics, thermodynamics, and equilibrium: Chemical equilibrium; Chemical thermodynamics (first and second law); and Chemical kinetics (zero and first order reactions).

Physical and chemical properties of compounds: Chemical catalysis; Acid-base concepts; Concepts of pH and buffer; Conjugative effects and resonance; Inductive effects; Electromeric effects; Photochemistry; and Electrochemistry.

Chemistry of organic compounds: Hydrocarbons; Alkyl halides; Alcohols; Aldehydes; Ketones; Carboxylic acids; Amines and their derivatives; Aromatic hydrocarbons, halides, nitro and amino compounds, phenols, diazonium salts, carboxylic and sulphonic acids; Soaps and detergents; Stereochemistry of carbon compounds.

Section 5: Mathematics (10+2 level)

General mathematics: Sets; Relations and Functions; Logarithms; Complex numbers; Linear and Quadratic equations; Sequences and Series; Trigonometry; Cartesian System of Rectangular Coordinates; Straight lines and Family; Three Dimensional Geometry; Permutations and Combinations; Binomial Theorem; Vectors; Matrices and Determinants; Functions; Limits and Continuity; Differentiation; Ordinary Differential Equations; Application of Derivatives; Integration as inverse process of differentiation; Definite and indefinite integrals; Methods of Integration; Integration by parts.

Probability & Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Section 6: Physics (10+2 level)

General physics: Units and measurements; Motion in one and two dimensions; Laws of motion; Work and kinetic energy; Conservation of energy; System of particles and rotational motion; Mechanical properties of solids and fluids; Thermal properties of matter; Heat and laws of thermodynamics; Kinetic theory of gases; Electric charge and field; Electric potential and capacitance; Current, resistance and simple circuits; Moving charges and magnetic field; Magnetism and matter; Electromagnetic induction; Electromagnetic waves; Alternating currents; Optics: Geometrical Optics – Reflection by spherical mirrors, Refraction at spherical surfaces and lenses, Total internal reflection and Optical instruments; Wave optics – Reflection and refraction of plane waves, Interference, Diffraction, Polarization, and Young's experiment: Dual nature of radiation and matter; Atoms, nuclei and nuclear physics; Semiconductor materials, devices and simple circuits.