ASBT PhD. Entrance Examination Syllabus

LIFE SCIENCES

1. Biochemistry

Principles of chemical bonding, pH, Buffers, structure, function, energetics and metabolism of biomolecules (carbohydrates, lipids, proteins and nucleic acids), Enzyme kinetics, Mechanism of catalysis and regulation.

2. Cell Biology & Cell Signalling

Organisation and function of cellular organelles, Membrane structure and function, Organisation of genes & chromosomes, Cell division and cell cycle.

3. Molecular Biology

Replication, Repair and recombination of DNA, Synthesising and processing of RNA, Synthesising and Processing of proteins, Control of gene expression.

4. Immunology

Immune cells, B cells and antibodies, Immunoglobulin genes, Monoclonal antibodies, Antibody engineering, T cell receptors, The complement system, Toll-like receptors, Cell-mediated effector functions, Inflammation, Hypersensitivity and autoimmunity, Congenital and acquired immunodeficiencies, Vaccines, Immunotherapy.

5. Microbiology

Microbial Physiology: Microbial growth and growth curve kinetics, Growth yield and characteristics, Strategies of cell division and cytoskeleton architecture.

Stress responses: Heat and pH, Two component Signal transduction mechanism, Flagellar motility and chemotaxis, Quorum sensing and biofilm formation, Three domain classification and characteristics, Microbial preservation and decimal reduction time.

Microbial control methods: Physical and chemical. Types and architecture of fungi and algae and storage products.

6. Methods in Biology

Recombinant DNA techniques: Isolation and purification of RNA and DNA, PCR, Restriction enzyme analysis, Molecular cloning, DNA sequencing, next generation sequencing (NGS), Generation of Genomic and cDNA libraries, Blotting techniques, DNA markers, use in diagnostics, genetic and genome engineering tools (CRISPR).

Biophysical techniques: Centrifugation, Electrophoresis, Chromatography, Spectroscopy-UV-Visible, Fluorescence, IR, Mass Spectrometry, Protein sequencing.

Microscopic techniques: Light microscopy, Scanning electron microscopy, Transmission electron microscopy.

Immunological techniques: ELISA, RIA, Immunoprecipitation, Methods for detection of molecules in living cells.

7. Developmental Biology

Reproductive structures, Meiosis: Gametogenesis and fertilisation, Early development, Developmental process: Induction, Determination, Differentiation, Morphogenesis and metamorphosis, Stem cells and iPSC.

8. Inheritance Biology

Genetic foundations: Mendelian inheritance, Pedigree analysis, Non-mendelian inheritance, Prokaryotic genetics, Genetic mapping, Karyotypes, Chromosomal aberrations, Polytene chromosomes.

Genome sequence organization: Introns and exons, Single-copy and repetitive DNA, Transposable elements.

9. Ecology and Evolution

Environment/organism interaction, Biogeographic patterns, Population structure and function, Communities, Interspecific relationships, Community structure and diversity, Change and succession, Ecosystems, Productivity and energy flow, Genetic variability, Hardy-Weinberg equilibrium, Gene flow and genetic drift, Natural selection, Speciation, History of life, Palaeontology and paleoecology.

10. Systems Physiology

Plant system physiology: Photosynthesis, Respiration and photorespiration, Nitrogen metabolism, Plant hormones, Sensory photobiology, Solute transport and photo-assimilate translocation, Secondary metabolites and their roles, Stress physiology.

Animal system physiology: Blood and circulation, Cardiovascular System, Respiratory system Nervous system, Sense organs, Excretory system, Thermoregulation, Stress and adaptation, Digestive system, Endocrinology and reproduction.

11. Diversity of life forms

Principles & methods of taxonomy, Levels of structural organization, Outline classification of plants, animals & microorganisms, Natural history of Indian subcontinent, Organisms of health & agricultural importance, Organisms of conservation concern.

12. Applied Biology

Pharmacology, Biomedical applications.

Bioinformatics

1. Bioinformatics

Introduction to Bioinformatics - Biological Data Acquisition - Retrieval methods for DNA sequence - Protein sequence and protein structure information - Databases – Format and Annotation- Conventions for database indexing and specification of search terms - Common sequence file formats - Standard search engines - Data retrieval tools - Sequence Similarity Searches - Scoring matrices - Dynamic programming algorithms - Needleman-Wunsch and Smith-waterman. Heuristic Methods of sequence alignment - Multiple Sequence Alignment and software tools for pairwise and multiple sequence alignment - ORF finding -Phylogenetic analysis

2. Computer Science

Fundamentals of Computer Sciences - Database Management and Administration - Programming Language Concepts - Fundamental data structures - Operating systems concepts - Machine Learning – Basic Web Technologies.

3. Biostatistics & Applied Mathematics

Linear equations – Matrices - Basic matrix operations - Vector addition and multiplication – Collection - Classification and tabulation of data - Probability and Bayes theorem - Measures in central tendency - Measures of dispersion.

Chemistry

1. Inorganic Chemistry

Electronic configuration of atoms and ions, Periodic table and periodic properties, Ionic and covalent bonding, VSEPR theory and shape of molecules, hybridization, resonance, dipole moment, HSAB principle, hydrogen bonding and van der Waals interactions. Ionic solids, ionic radii and lattice energy, s, p and d Block Elements, Coordination complexes: valence bond and crystal field theory. Bioorganic Compounds (haemoglobin, chlorophyll etc.)

2. Physical Chemistry

Chemical Equilibria: Osmotic pressure, elevation of boiling point and depression of freezing point, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications. Equilibrium constants, Electrochemistry: Conductance, Kohlrausch law, cell potentials, EMF, Nernst equation, thermodynamic aspects and their applications, .Chemical Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, catalysis and elementary enzyme reactions.

Reversible and irreversible inhibition of enzymes. Thermodynamics: state and path functions, First law, reversible and irreversible processes, internal energy, enthalpy, Second law, entropy and free energy. Gibbs-Helmholtz equation, free energy change and spontaneity

3. Organic Chemistry

Acids and bases, electronic and steric effects, Stereochemistry, optical and geometrical isomerism, tautomerism, conformers and concept of aromaticity. SN1, SN2, E1, E2 and radical reactions, addition reactions. Aromatic electrophilic substitutions, Identification of common functional groups by chemical tests. Basics of *organic spectroscopy/spectrometry* UV, IR, Raman, ^{1}H NMR, ^{13}C NMR, Mass and ESR

4. Chemistry of Biomolecules

Amino acids, proteins, nucleic acids and nucleotides, Peptide sequencing by chemical and enzymatic proteolytic methods. DNA sequencing by chemical and enzymatic methods. Carbohydrates, Lipids Principles of biomolecule purification chromatography. Identification of these biomolecules and Beer-Lambert's law.

Physics

1. Mechanics

Motion along a straight line, motion in two and three dimension, projectile motion, circular motion, relative motion. Force, Friction, Work, Energy, Power. System of particle, collisions, Rotational motion, combined rotational and translational motions.

2. Waves and Oscillations

Oscillations: Oscillatory systems, Harmonic motion, Simple harmonic oscillator, applications of simple harmonic motion. Types of oscillations, Resonance. Waves: Types, Wave equation-power, intensity, principle of superposition-interference, standing waves - reflection, resonance. Sound-properties, interference, vibrating system and sources of sound, beats, Doppler effect, Effects at high speed ultrasonic's .

2. Light

Electromagnetic spectrum, Properties of light, Reflection, Refraction, Optical fiber, Interference-Thin film interference, Diffraction- Single slit, double slit, multipleslit diffraction, grating. X-ray diffraction, Polarization-Types, production and detection of polarized light. Dichroism, polarizing sheets. Laser - principle, types, uses.

3. Properties of Matter

Properties of solids: Elasticity, Stress-strain relation, Crystalline solids, Crystal structure and Systems, Bragg's law, X-ray diffraction, semiconductors, IC's, Mems, introduction to Nanotechnology. Superconductors-properties, materials, SQUIDS, Cryogenics.

Properties of liquids: Pressure in liquids, Pressure transmission: Pascal's law and its applications, Buoyancy: Archimedes principle and its applications. Surface tension, capillarity. Fluid flow: streamlines, Bernoulli's Equation- Applications, Viscosity, Viscometers. Properties of gases: Ideal gas, Kinetic theory of gases, gas laws, ideal gas equation.

4. Dielectrics and Magnetism

Properties of dielectrics, non-polar and polar dielectrics, Dielectric strength, Ferroelectrics, Piezoelectric, applications. Magnetic materials: Magnetism, magnetic materials, classification of magnetic materials, types of magnetic materials, soft magnetic materials, hard magnetic materials, applications.