

Entrance Examination Syllabus for 5-Year Integrated M.Sc. course in Molecular Biology

Duration of Entrance Examination: 1 Hr

Pattern: 50 multiple choice questions of 1 mark each

Biology -30, Chemistry-10, Physics -5 and Mathematics -5 questions

PART A: BIOLOGY

UNIT I:

CELL: STRUCTURE AND FUNCTION:

Cell and its three major parts: Cell Membrane, cytoplasm, nucleus - Cell theory and the cell as the basic unit of life - Structure of the Prokaryotic and eukaryotic cell - Plant cell and animal cell (brief) - Cell Organelles: Cell envelope, cell membrane, cell wall structure and function: mitochondria, Golgi bodies/dictyosomes, endoplasmic reticulum, ribosomes, lysosomes, vacuoles, plastids, microbodies - Cytoskeleton, cilia, flagella, centrioles (Ultra structure and function) - Nucleus: nuclear membrane, chromatin, nucleolus - Chemical constituents of living cells - Biomolecules: Structure and functions of carbohydrates, proteins, fats, lipids and nucleic acids - Enzymes: types, properties, function and enzyme action - Cell division: Cell cycle, significance of, and differences between Mitosis and Meiosis

UNIT II:

PLANT PHYSIOLOGY:

Movement of water, food, nutrients and gases - Absorption of water, gases and nutrients - Cell to Cell transport - Diffusion, facilitated diffusion, active transport - Plant-Water Relations - Imbibition, water potential, osmosis, plasmolysis - Long Distance Transport - Apoplast, symplast, root pressure, transpiration pull - Transportation and Guttation - Opening and closing of stomata - Role of K^+ ions - Uptake of mineral and their translocation - Transportation through xylem and phloem - Plants and mineral nutrition - Essential minerals, macro- and micronutrients and their role - Deficiency symptoms - Mineral toxicity - Elementary idea of Hydroponics as a Method to study mineral nutrition - Nitrogen metabolism: Nitrogen cycle, biological nitrogen fixation - Plants Respiration - Exchange of gases - Cellular respiration: glycolysis, fermentation (anaerobic) - Energy Relation: Number of ATP molecules generated - Amphibiotic pathways - Respiratory quotient of nutrients - Photosynthesis - Autotrophic nutrition - Site of photosynthesis - Photosynthetic pigments (Elementary idea) - Photosynthetic and biosynthetic phases of photosynthesis - Cyclic and non-cyclic photophosphorylation - Chemiosmotic hypothesis - Photorespiration - C_3 and C_4 pathways - Factors affecting photosynthesis - Law of Limiting Factors. Plant Growth and Development - Phases of plant growth and plant growth rate - Condition of Growth - Differentiation, dedifferentiation and redifferentiation - Sequence of developmental process in a plant cell - Growth regulators: auxin, gibberellin, cytokinin, ethylene, ABA - Photo morphogenesis including brief account of Phytochrome (Elementary Idea) - Seed germination - Seed dormancy - Vernalisation - Photoperiodism

UNIT III:

HUMAN PHYSIOLOGY:

Digestion and Absorption - Human alimentary canal and Digestive glands - Role of digestive enzymes and gastrointestinal hormones - Peristalsis - Digestion, absorption and assimilation of proteins, carbohydrates and fats - Calorific value of proteins, carbohydrates and fats - Egestion - Nutritional and digestive disorders – P E M, indigestion, constipation, vomiting, jaundice Breathing and Respiration - Respiratory organs in animals (Recall only) - Respiratory system in humans - Mechanism of Breathing and its regulation in humans - Exchange of gases, transport of gases and regulation of respiration in humans - Respiratory volumes - Disorders related to respiration – Asthma, Emphysema, Occupational Respiratory disorders Body fluids and Circulation - Composition of blood, Blood groups, Coagulation of blood - Composition of Lymph and function - Human circulatory system - Structure of human heart and blood vessels - Cardiac cycle, Cardiac output, ECG - Double circulation - Regulation of cardiac activity - Disorders of circulatory system – Hypertension, Coronary artery disease, Angina pectoris, heart failure Excretory products and their elimination - Modes of excretion – Ammonotelism, ureotelism, uricotelism - Human excretory system-structure and function - Urine formation, Osmoregulation - Regulation of kidney function, Renin-angiotensin, Antinatriuretic factor, ADH and Diabetes insipidus - Role of other organs in excretion - Disorders – Uraemia, Renal failure, Renal calculi, Nephritis - Dialysis and artificial kidney Locomotion and Movement - Types of movement – ciliary, flagellar, muscular - Skeletal muscle _ contractile proteins and muscle contraction - Skeletal system and its functions. (to be dealt with the relevant practical of practical syllabus) - Joints - Disorders of muscular and skeletal system – Myasthenia gravis, Tetany, Muscular dystrophy, Arthritis, Osteoporosis Gout

Unit IV:

NEURAL CONTROL AND COORDINATION:

Neural and nerves - Nervous system in humans - Central Nervous system, Peripheral Nervous system and Visceral Nervous system - Generation and conduction of nerve impulse - Reflex action - Sensory Perception - Elementary structure and function of eye and ear and general idea of other sense organs Chemical coordination and regulation - Endocrine glands and hormones - Human endocrine system – Hypothalamus, Pituitary, Pineal, Thyroid, Parathyroid, Adrenal, Pancreas, Gonads - Mechanism of hormone action (Elementary Idea) - Role of hormones as messengers and regulators - Hypo- and hyperactivity and related disorders, (Common disorders eg. Dwarfism, Acromegaly, Cretinism, goiter, exophthalmic goitre, diabetes, Addison's disease)

Unit V:

GENETICS AND EVOLUTION:

Heredity and variation - Mendelian Inheritance - Deviations from Mendelism, incomplete dominance Co-dominance, Multiple alleles and Inheritance of blood group, pleiotropy. - Elementary idea of Polygenic Inheritance - Chromosome theory of inheritance - Chromosomes and genes.

Sex determination - In humans, birds, honey bee. - Linkage and crossing over. - Sex linked inheritance-Hemophilia, Color blindness.

Medellin disorders in humans - Chromosomal disorders in humans. - Down's syndrome, Turner's and Klinefelter's syndromes.

Search for genetic material and DNA as genetic material. - Structure of DNA and RNA - DNA packaging - DNA replication - Central dogma - Transcription, genetic code, translation. - Gene expression and regulation. - Genome and human genome project. - DNA finger printing.

EVOLUTION:

Origin of life, Biological evolution and evidences for biological evolution (Paleontological from comparative anatomy and embryology and molecular evidence) - Darwin's contribution /Modern Synthetic theory of Evolution - Hardy – Weinberg's principle. Mechanism of evolution – Variation (Mutation & Recombination) and Natural Selection with examples drift types of natural selection - Gene flow and genetic - Adaptive Radiation Human evolution

Unit VI:

ECOLOGY AND ENVIRONMENT:

Meaning of ecology, environment, habitat and niche - Organisms and environment.

Population and ecological adaptations - Population Interactions – mutualism, competition, predation, parasitism. - Population attributes – growth, birth rate and death rate, - Age distribution.

Ecosystems- Patterns, components, energy flow, nutrient cycling (carbon and phosphorous), decomposition and productivity - Pyramids of number, biomass, energy. - Ecological succession - Ecological Services: Carbon fixation, Pollination, Oxygen release

Biodiversity and its conservation - Threats to and need for biodiversity conservation. - Hotspots, endangered organisms, extinction, Red Data Book. - Biodiversity conservation- biosphere reserves, national parks and sanctuaries.

Environmental Issues - Air Pollution and its control - Water pollution and its control - Agrochemicals and their effects - Solid waste management - Radioactive waste management - Greenhouse effect and global warming - Ozone depletion, deforestation. - Any three case studies as success stories addressing environmental issues.

PART B. CHEMISTRY

Unit VII:

ATOMIC STRUCTURE:

Thomson's model, Rutherford's model, Bohr's model and their limitations. Concept of shells/sub shells, dual nature of matter and light, de Broglie's relationship, Heisenberg uncertainty principle, concept of orbitals, Quantum numbers and their significance, shapes of orbitals. Aufbau's principle, Pauli Exclusion Principle, Hund's rule, electronic configuration, stability of half filled and completely filled orbital.

Periodic table: Classification of Elements, periodicity, modern periodic law. Periodic trends of elements, atomic radii, ionic radii. Ionization energy, electron affinity and electro negativity.

Chemical Bonding: Ionic bond, covalent bond: bond parameters. Lewis structures, polar character of covalent bond, covalent character of ionic bond, valence bond theory, geometry of covalent molecules, VSEPR theory and hybridization. MOT of homo nuclear diatomic molecules, hydrogen bond.

Unit VIII:

ELECTROCHEMISTRY:

Redox reactions, conductance in electrolytic solutions, specific and molar conductivity variations with concentration, Kohlrausch's Law, electrolysis and laws of electrolysis (elementary idea), dry cell-electrolytic cells and Galvanic cells, lead accumulator, EMF of a cell, standard electrode potential. Nernst equation and its application to chemical cells, Relation between Gibbs energy change and emf of a cell, fuel cells, corrosion.

CO-ORDINATION COMPOUNDS:

Introduction, ligands, co-ordination number, colour, magnetic properties and shapes, IUPAC nomenclature. Bonding (Werner's theory, VBT and CFT); Structural and stereo isomerism, importance of co-ordination compounds (in qualitative inclusion of analysis, extraction of metals and biological systems).

BIOMOLECULES:

Carbohydrates-Classification and their importance, D-L configuration. Proteins: Elementary idea of α -amino acids and peptide bond. Polypeptides; proteins- primary, secondary and tertiary structure of proteins. Denaturation of proteins and enzymes. Lipids and hormones-classification and functions. Vitamins-Classification and functions. Nucleic Acids: DNA & RNA.

PART C: PHYSICS

Unit IX:

Laws of Motion, Intuitive concept of force. Inertia, Newton's first law of motion; momentum and Newton's second law of motion; impulse; Newton's third law of motion. Law of conservation of linear momentum and its applications. Equilibrium of concurrent forces. Static and kinetic friction, laws of friction, rolling friction. Dynamics of uniform circular motion: Centripetal force, examples of circular motion (vehicle on level circular road, vehicle on banked road)

Work, Energy and Power Scalar product of vectors. Work done by a constant force and a variable force; kinetic energy, work-energy theorem, power. Notion of potential energy, potential energy of a spring, conservative forces: conservation of mechanical energy (kinetic and potential energies); non-conservative forces: elastic and inelastic collisions in one and two dimensions.

OPTICS: RAY OPTICS (GEOMETRIC OPTICS):

Reflection of light, spherical mirrors, mirror formula. Refraction of light, total internal reflection and its applications, optical fibers, refraction at spherical surfaces, lenses, thin lens formula, lens-maker's formula. Newton's relation: Displacement method to find position of images (conjugate points) Magnification, power of a lens, combination of thin lenses in contact, combination of a lens and a mirror. Refraction and dispersion of light through a prism. Scattering of light-blue colour of the sky and reddish appearance of the sun at sunrise and sunset. Elementary idea of Raman Effect. Optical instruments: Human eye, image formation and accommodation, correction of eye defects (myopia, hypermetropia, presbyopia and astigmatism) using lenses. Microscopes and astronomical telescopes (reflecting and refracting) and their magnifying powers. Wave optics (Physical Optics): Wave front and Huygens principle, reflection and refraction of plane wave at a plane surface using wave fronts. Proof of laws of reflection and refraction using Huygens, principle interference. Young's double slit experiment and expression for fringe width, coherent sources and sustained interference of light.

Diffraction due to a single slit, width of central maximum. Resolving power of microscopes and astronomical telescopes. Polarization, plane polarized light; Brewster's law, uses of plane polarized light and polaroids.

Part D: MATHEMATICS

Unit X:

STRAIGHT LINES:

Brief recall of 2D from earlier classes. Slope of a line and angle between two lines. Various forms of equations of a line: parallel to axes, point-slope form, slope-intercept form, two point form, intercepts form and normal form. General equation of a line. Distance of a point from a line.

MATHEMATICAL REASONING:

Mathematically acceptable statements. Connecting words/ phrases - consolidating the understanding of "if and only if (necessary and sufficient) condition", "implies", "and/or", "implied by", "and", "or", "there exists" and their use through variety of examples related to real life and Mathematics. Validating the statements involving the connecting words difference between contradiction, converse and contra positive.

STATISTICS & PROBABILITY:

Measure of dispersion; mean deviation, variance and standard deviation of ungrouped/grouped data. Analysis of frequency distributions with equal means but different variances. 2. Probability: Random experiments: outcomes, sample spaces (set representation). Events: occurrence of events, 'not', 'and' and 'or' events, exhaustive events, mutually exclusive events Axiomatic (set theoretic) probability, connections with the theories of earlier classes. Probability of an event, probability of 'not', 'and' & 'or' events.

MODEL QUESTIONS OF ENTRANCE EXAM

1. Chemicals releases at the synaptic junction are
 - a) Hormones
 - b) Neurotransmitters
 - c) CSF
 - d) Enzymes
2. Occasionally a single gene may express more than one effect. This is called
 - a) Multiple allelism
 - b) Mosaicism
 - c) Pleiotropy
 - d) Polyploidy

Key Answers: 1. b 2. c