BIOLOGY

Diversity In the Living World:

The living world: The Diversity in the living world, Taxonomic categories,

Biological classification: Kingdoms (Monera, Protista, Fungi, Plantae, and Animalia), Viruses, Viroids and Lichens,

Plant kingdom: Algae, Bryophytes, Pteridophytes, Gymnosperms, Angiosperms,

Animal kingdom: Basis of classification of animals and Classification of Animals

Structural Organisation In Plants And Animals:

Morphology of flowering plants: The Root, The Stem, The Leaf, The Inflorescence, The Flower, The Fruit, The Seed, Semi-technical Description of a Typical, Flowering Plant, Description of Some Important Families,

Anatomy of flowering plants: The Tissue System, Anatomy of Dicotyledonous and Monocotyledonous Plants

Structural organisation in animals: Organ and Organ System, Amphibian-Frog

Cell: Structure And Functions:

Cell: the unit of life: A Cell, The Cell Theory, An Overview of Cell, Prokaryotic Cells, Eukaryotic Cells

Biomolecules: Analysis of Chemical Composition of organisms, Primary and Secondary Metabolites, Biomacromolecules, Proteins, Polysaccharides, Nucleic Acids, Structure of Proteins, Enzymes

Cell cycle and cell division: Cell Cycle, Mitosis and Meiosis and its significance

Plant Physiology:

Photosynthesis in higher plants: Photosynthesis, Early Experiments, Location of photosynthesis, Pigments involved in Photosynthesis, Light Reaction, The Electron Transport, Synthesis and utilization of ATP and NADPH, The C4 Pathway, Photorespiration, Factors Affecting Photosynthesis

Respiration in plants: Do Plants Breathe? Glycolysis, Fermentation, Aerobic Respiration, The Respiratory Balance Sheet, Krebs/Citric acid cycle, Respiratory Quotient

Plant growth and development: Growth, Differentiation, Dedifferentiation and Redifferentiation, Development, Plant Growth Regulators

Human Physiology:

Breathing and exchange of gases: Respiratory Organs, Mechanism of Breathing, Exchange of Gases, Transport of Gases, Regulation of Respiration, Disorders of Respiratory System

Body fluids and circulation: Tissue Fluids-Blood, Lymph, Circulatory Pathways, Double Circulation, Regulation of Cardiac Activity, Disorders of Circulatory System

Excretory products and their elimination: Human Excretory System, Urine Formation, Function of the Tubules, Mechanism of Concentration of the Filtrate, Regulation of Kidney Function, Micturition, Role of other Organs in Excretion, Disorders of the Excretory System

Locomotion and movement: Types of Movement, Muscle, Skeletal System, Joints, Disorders of Muscular and Skeletal System

Neural control and coordination: Neural System, Human Neural System, Neuron as Structural and Functional Unit of Neural System, Central Neural System

Chemical coordination and integration: Endocrine Glands and Hormones, Human Endocrine System, Hormones of Heart, Kidney and Gastrointestinal Tract, Mechanism of Hormone Action

Reproduction:

Sexual reproduction in flowering plants: Flower structure, Angiosperms, Pre-fertilisation: Structures and Events, Double Fertilisation, Post-fertilisation: Structures and Events, Apomixis and Polyembryony

Human reproduction: The Male Reproductive System, The Female Reproductive System, Gametogenesis, Menstrual Cycle, Fertilisation and Implantation, Pregnancy and Embryonic Development, Parturition and Lactation

Reproductive health: Reproductive Health – Problems and Strategies, Population Explosion and Birth Control, Medical Termination of Pregnancy, Sexually Transmitted Diseases, Infertility

Genetics And Evolution:

Principles of inheritance and variation: Mendel's Laws of Inheritance, Inheritance of One Gene, Inheritance of Two Genes, Sex Determination, Mutation, Genetic Disorders

Molecular basis of inheritance: The DNA, The Search for Genetic Material, RNA World, Replication, Transcription, Genetic Code, Translation, Regulation of Gene Expression, Human Genome Project, DNA Fingerprinting

Evolution: Origin of Life, Evolution of Life Forms – A Theory, Evidence for Evolution, Adaptive Radiation, Biological Evolution, Mechanism of Evolution, Hardy – Weinberg Principle, Evolution, Origin and Evolution of Man

Biology In Human Welfare:

Human health and disease: Common Diseases in Humans, Immunity, AIDS, Cancer, Drugs and Alcohol Abuse

Microbes in human welfare: Microbes in Household Products, Microbes in Industrial Products, Microbes in Sewage Treatment, Microbes in Production of Biogas, Microbes as Biocontrol Agents, Microbes as Biofertilisers

Biotechnology:

Biotechnology: principles and processes: Principles of Biotechnology, Tools of Recombinant DNA Technology, Processes of Recombinant DNA Technology

Biotechnology and its application: Biotechnological Applications in Agriculture and Medicine, Transgenic Animals, Ethical Issues

Ecology:

Organisms and populations: Populations, Logistic growth, Population interactions
Ecosystem: Ecosystem–Structure and Function, Productivity, Decomposition, Energy Flow, Ecological Pyramids

Biodiversity and conservation: Biodiversity and Biodiversity conservation

CHEMISTRY

Some Basic Concepts of Chemistry: Matter and its nature, Dalton's atomic theory: Concept of atom, molecule, element, and compound, Laws of chemical combination, Atomic and molecular masses, mole concept, molar mass, percentage composition, empirical and molecular formulae, Chemical equations, and stoichiometry

Structure of the Atom: Discovery of Sub-atomic Particles, Atomic Models, Developments Leading to the Bohr's Model of Atom, Bohr's Model for Hydrogen Atom, Towards Quantum Mechanical Model of the Atom, Quantum Mechanical Model of Atom

Classification of Elements and Periodicity in Properties: Genesis of Periodic Classification, Modern Periodic Law and the Present Form of the Periodic Table, Electronic Configurations of Elements and the Periodic Table, Electronic Configurations and Types of Elements: *s-, p-, d-, f-* Blocks, Periodic Trends in Properties of Elements

Chemical Bonding and Molecular Structure: Kössel-Lewis Approach to Chemical Bonding, Ionic or Electrovalent Bond, Bond Parameters, The Valence Shell Electron Pair Repulsion (VSEPR) Theory, Valence Bond Theory, Hybridisation, Molecular Orbital Theory, Bonding in Some Homonuclear Diatomic Molecules, Hydrogen Bonding

The d- & f-block elements: Position in the Periodic Table, Electronic Configurations of the *d*-Block Elements, General Properties of the Transition Elements (*d*-Block), Some Important Compounds of Transition Elements, The Lanthanoids, The Actinoids, Applications of *d*- and *f*-Block Elements

Coordination compounds: Werner's Theory of Coordination Compounds, Definitions of Some Important Terms Pertaining to Coordination Compounds, Nomenclature of Coordination Compounds, Isomerism in Coordination Compounds, Bonding in Coordination Compounds, Bonding in Metal Carbonyls, Importance and Applications of Coordination Compounds

Thermodynamics: Thermodynamic Terms, Measurement of ΔU and ΔH, Calorimetry, Enthalpy Change, ΔH of a Reaction – Reaction Enthalpy, Enthalpies for Different Types of Reactions, Spontaneity, Gibbs Energy Change and Equilibrium

Equilibrium: Equilibrium in Physical Processes, Equilibrium in Chemical Processes – Dynamic Equilibrium, Law of Chemical Equilibrium and Equilibrium Constant, Homogeneous Equilibria, Heterogeneous Equilibria, Applications of Equilibrium Constants, Relationship between Equilibrium Constant K, Reaction Quotient Q and Gibbs Energy G, Factors Affecting Equilibria, Ionic Equilibrium in Solution, Acids, Bases and Salts, Ionization of Acids and Bases, Buffer Solutions, Solubility Equilibria of Sparingly Soluble Salts

Redox Reactions: Classical Idea of Redox Reactions-Oxidation and Reduction Reactions, Redox Reactions in Terms of Electron Transfer Reactions, Oxidation Number, Redox Reactions and Electrode Processes

Solutions: Types of Solutions, Expressing Concentration of Solutions, Solubility, Vapour Pressure of Liquid Solutions, Ideal and Non-ideal Solutions, Colligative Properties and Determination of Molar Mass, Abnormal Molar Masses

Electrochemistry: Electrochemical Cells, Galvanic Cells, Nernst Equation, Conductance of Electrolytic Solutions, Electrolytic Cells and Electrolysis, Batteries, Fuel Cells, Corrosion

Chemical Kinetics: Rate of a Chemical Reaction, Factors Influencing Rate of a Reaction, Integrated Rate Equations, Temperature Dependence of the Rate of a Reaction, Collision Theory of Chemical Reactions

Organic Chemistry – Some Basic Principles and Techniques: General Introduction, Tetravalence of Carbon: Shapes of Organic Compounds, Structural Representations of Organic Compounds, Classification of Organic Compounds, Nomenclature of Organic Compounds, Isomerism, Fundamental Concepts in Organic Reaction Mechanism, Methods of Purification of Organic Compounds, Qualitative Analysis of Organic Compounds, Quantitative Analysis

Hydrocarbons: Classification, Alkanes, Alkenes, Alkynes, Aromatic Hydrocarbon, Carcinogenicity and Toxicity

Haloalkanes and haloarenes: Classification, Nomenclature, Nature of C–X Bond, Methods of Preparation of Haloalkanes, Preparation of Haloarenes, Physical Properties, Chemical Reactions, Polyhalogen Compounds

Alcohols, phenols, and ethers: Classification, Nomenclature, Structures of Functional Groups, Alcohols and Phenols, Some Commercially Important Alcohols, Ethers

Aldehydes, ketones, and carboxylic acids: Nomenclature and Structure of Carbonyl Group, Preparation of Aldehydes and Ketones, Physical Properties, Chemical Reactions, Uses of Aldehydes and Ketones, Nomenclature and Structure of Carboxyl Group, Methods of Preparation of Carboxylic Acids, Physical Properties, Chemical Reactions, Uses of Carboxylic Acids

Organic compounds containing nitrogen: Structure of Amines, Classification, Nomenclature, Preparation of Amines, Physical Properties, Chemical Reactions, Method of Preparation of Diazonium Salts, Physical Properties, Chemical Reactions, Importance of Diazonium Salts in Synthesis of Aromatic Compounds

Biomolecules: Carbohydrates, Proteins, Enzymes, Vitamins, Nucleic Acids, Hormones

MATHEMATICS

Sets and Logic

Set: Representing sets in different ways. Subsets. Different types of sets e.g. universal set, finite or infinite sets, intervals in real line. Various operations on sets. Properties of various operations on sets. Venn diagram. Ordered pairs. Cartesian products.

Relations & functions: Type of relations. Equivalence relation. Functions. Types of functions. Composition of functions, inverse of a function. Real valued functions: algebraic operations of real valued functions, different types of real valued functions (e.g. polynomial, rational, modules, signum, etc), graphical representation of real valued functions.

Basic counting techniques

Permutations and Combinations: Fundamental principles of counting. Factorial n. Permutations and combinations- derivation of formulae and their connections. Applications.

Binomial Theorem: Binomial theorem for positive integral indices. Pascal's triangle. General and middle term in binomial expansion. Applications.

Complex numbers, linear and quadratic equations

Complex Numbers: Motivation for complex numbers. Representation of complex numbers in the plane as a pair of real numbers and their representation of the form a+ib. Polar representation and the Argand plane. Algebra of complex numbers. Modulus and conjugate of a complex number. Statement of the Fundamental Theorem of Algebra.

Quadratic Equations: Quadratic equations and their solutions. Relation between roots and the coefficients of quadratic equations.

Linear Inequalities: Inequalities, Algebraic solution of linear inequalities in one variable and their graphical representation.

Trigonometric functions

Measures of angles and their conversions. Trigonometric functions, identities, and their geometric interpretations. Applications of trigonometric equations. Inverse trigonometric functions and properties. Graphs of trigonometric functions.

Vectors

Vectors and scalars. Magnitude and direction of a vector. Direction cosines/ ratios. Types of vectors. Position vector. Negative and components of a vector. Addition of vectors. Multiplication of a vector by a scalar. Position vector of a point dividing a line segment in the given ratio. Dot and cross products of vectors. Projection of a vector on another vector/ line.

Matrices & determinants

Matrices: Concept, notation, order, equality, transpose of a matrix, types of matrices, simple properties of addition, multiplication, scalar multiplication, and multiplication of matrices. Concept of elementary row and column operations. Invertible matrices and proof of the uniqueness of inverse, if it exists. Applications of matrices.

Determinants: Determinant of a square matrix (up to 3 X 3 matrices), properties of determinants, minors, cofactors, and applications of determinants in finding the area of a triangle. Adjoint and inverse of a square matrix. Applications of determinants.

Coordinate geometry

Cartesian system of rectangular coordinates in a plane. Shifting of origin.

Straight Lines: Slope of a line and angle between two lines. Various forms of equations of a line. General equation of a line. Distance of a point from a line.

Conic Sections: Sections of a cone: Circles, ellipse, parabola, hyperbola, a point, a straight line, and a pair of intersecting lines as a degenerated case of a conic section. Standard equations and simple properties of parabola, ellipse, and hyperbola. Standard equation of a circle, the general form of the equation of a circle.

Three-dimensional geometry

Coordinate axes and planes. Distance between points. Section formula. Direction cosines and direction ratios of a line. Various forms of the equation of a line. Angle between two lines and two planes. Shortest distance between two lines in three-dimensional space. Coplanar and skew line. Cartesian and vector equation of a plane. Distance of a point from a plane.

Sequences & series

Arithmetic and Geometric progressions. Sums of finite and infinite geometric series. Sums of finite terms in arithmetic series. Arithmetic mean (A.M.) and geometric mean (G.M.). Relation between A.M and G.M. Sums of first n-terms of the special series, for example, $\sum n$, $\sum n^2$ and $\sum n^3$.

Limit & continuity

Limits. Continuity. Algebraic properties of limits. Algebraic properties of continuous functions. Limits and continuity of real valued functions, polynomials, rational functions, trigonometric functions, exponential functions, and inverse functions.

Differentiation

Differentiation: Definition of derivative and relating it to slope of tangent of the curve. Derivative of sum, difference, product, and quotient of functions. Derivative of some standard functions e.g. polynomial, trigonometric, inverse trigonometric, exponential, and logarithmic functions. Derivative of composite functions via chain rule. Derivative of implicit functions and functions in parametric forms. Logarithmic derivative. Second order derivatives.

Application of Derivatives: Rate of change, increasing/decreasing functions, tangents and normals maxima and minima.

Integration

Integration: Integration as inverse process of differentiation. Integrals involving algebraic, trigonometric, exponential, and logarithmic functions. Integration of a variety of functions by substitution, by partial fractions, by parts and using trigonometric identities. Evaluation of integrals of some standard types. Fundamental theorem of calculus. Basic properties and evaluation of definite integrals.

Applications of Integration: Finding the area of region under simple curves. Finding the area of the region between two simple curves.

Differential equations

Definition, order, degree. Formation of a differential equation. Solution by separation of variables. Homogeneous differential equation of first order and degree. Solution of the equations dy/dx +P y=Q where P and Q are functions of x or constant and similarly for dx/dy +P x=Q where P and Q are functions of y or constant.

Statistics, Probability & Linear Programming

Statistics: Measure of dispersion; mean deviation, variance, and standard deviation of ungrouped/grouped data.

Probability: Random experiments: outcomes, sample spaces (set representation). Events: Occurrence of events, ‘not’, ‘and’ & ‘or’ events, exhaustive events, mutually exclusive events. Axiomatic (set theoretic) probability. Probability of an event, probability of ‘not’, ‘and’, & ‘or’ events. Multiplication theorem on probability. Conditional probability, independent events, total probability, Baye’s theorem.

PHYSICS

Units and Measurements: The international system of units; Significant figures; Dimensions of physical quantities; Dimensional formulae and dimensional equations; Dimensional analysis and its applications.

Motion in a Straight Line: Instantaneous velocity and speed; Acceleration; Kinematic equations for uniformly accelerated motion.

Motion in a Plane: Scalars and vectors; Multiplication of vectors by real numbers; Addition and subtraction of vectors – graphical method; Resolution of vectors; Vector addition – analytical method; Motion in a plane; Motion in a plane with constant acceleration; Projectile motion; Uniform circular motion.

Laws of Motion: The law of inertia; Newtons first law of motion; Newtons second law of motion; Newtons third law of motion; Conservation of momentum; Equilibrium of a particle; Common forces in mechanics; Circular motion.

Work, Energy and Power: Notions of work and kinetic energy: The work-energy theorem; Work; Kinetic energy; Work done by a variable force; The work-energy theorem for a variable force; The concept of potential energy; The conservation of mechanical energy; The potential energy of a spring; Power; Collisions.

System of Particles and Rotational Motion: Centre of mass; Motion of centre of mass; Linear momentum of a system of particles; Vector product of two vectors; Angular velocity and its relation with linear velocity; Torque and angular momentum; Equilibrium of a rigid body; Moment of inertia; Kinematics of rotational motion about a fixed axis; Dynamics of rotational motion about a fixed axis; Angular momentum in case of rotations about a fixed axis.

Gravitation: Kepler's laws; Universal law of gravitation; The gravitational constant; Acceleration due to gravity of the earth; Acceleration due to gravity below and above the surface of earth; Gravitational potential energy; Escape speed; Earth satellites; Energy of an orbiting satellite.

Mechanical Properties of Solids: Stress and strain; Hooke's law; Stress-strain curve; Elastic moduli; Applications of elastic behaviour of materials.

Mechanical Properties of Fluids: Pressure; Streamline flow; Bernoulli's principle; Viscosity; Surface tension.

Thermal Properties of Matter: Temperature and heat; Measurement of temperature; Ideal-gas equation and absolute temperature; Thermal expansion; Specific heat capacity; Calorimetry; Change of state; Heat transfer; Newton's law of cooling.

Thermodynamics: Thermal equilibrium; Zeroth law of thermodynamics; Heat, internal energy and work; First law of thermodynamics; Specific heat capacity; Thermodynamic state variables and equation of state; Thermodynamic processes; Second law of thermodynamics; Reversible and irreversible processes; Carnot engine.

Kinetic Theory: Molecular nature of matter; Behaviour of gases; Kinetic theory of an ideal gas; Law of equipartition of energy; Specific heat capacity; Mean free path.

Oscillations: Periodic and oscillatory motions; Simple harmonic motion; Simple harmonic motion and uniform circular motion; Velocity and acceleration in simple harmonic motion; Force law for simple harmonic motion; Energy in simple harmonic motion; The Simple Pendulum.

Waves: Transverse and longitudinal waves; Displacement relation in a progressive wave; The speed of a travelling wave; The principle of superposition of waves; Reflection of waves; Beats.

Electric Charges and Fields: Electric Charge; Conductors and insulators; Basic properties of electric charge; Coulomb's law; Forces between multiple charges; Electric field; Electric field lines; Electric flux; Electric dipole; Dipole in a uniform external field; Continuous charge distribution; Gauss's law; Applications of Gauss's law.

Electrostatic Potential and Capacitance: Electrostatic potential; Potential due to a point charge; Potential due to an electric dipole; Potential due to a system of charges; Equipotential surfaces; Potential energy of a system of charges; Potential energy in an external field; Electrostatics of conductors; Dielectrics and polarisation; Capacitors and capacitance; The parallel plate capacitor; Effect of dielectric on capacitance; Combination of capacitors; Energy stored in a capacitor.

Current Electricity: Electric current; Electric currents in conductors; Ohm's law; Drift of electrons and the origin of resistivity; Limitations of Ohms law; Resistivity of various materials; Temperature dependence of resistivity; Electrical energy, power; Cells, emf, internal resistance; Cells and resistors in series and in parallel; Kirchhoff's rules; Wheatstone bridge.

Moving Charges and Magnetism: Magnetic force; Motion in a magnetic field; Magnetic field due to a current element, Biot-Savart law; Magnetic field on the axis of a circular current loop; Ampere's circuital law; The solenoid; Force between two parallel currents, the Ampere; torque on current loop, magnetic dipole; The moving coil galvanometer.

Magnetism and Matter: The bar magnet; Magnetism and Gauss's law; Magnetisation and magnetic intensity; Magnetic properties of materials.

Electromagnetic Induction: The experiments of Faraday and Henry; Magnetic flux; Faraday's law of induction; Lenz's law and conservation of energy; Motional electromotive force; Inductance; AC generator.

Alternating Current: AC voltage applied to a resistor; Representation of AC current and voltage by rotating vectors – phasors; AC voltage applied to an inductor; AC voltage applied to a capacitor; AC voltage applied to a series LCR circuit; Power in AC circuit: the power factor; Transformers.

Electromagnetic Waves: Displacement current; Electromagnetic waves; Electromagnetic spectrum.

Ray Optics and Optical Instruments: Reflection of light by spherical mirrors; Refraction; Total internal reflection; Refraction at spherical surfaces and by lenses; Refraction through a prism; Optical instruments.

Wave Optics: Huygens principle; Refraction and reflection of plane waves using Huygens principle; Coherent and incoherent addition of waves; Interference of light waves and Young's experiment; Diffraction; Polarisation.

Dual Nature of Radiation and Matter: Electron emission; Photoelectric effect; Experimental study of photoelectric effect; Photoelectric effect and wave theory of light; Einstein's photoelectric equation: energy quantum of radiation; Particle nature of light: the photon; Wave nature of matter.

Atoms: Alpha-particle scattering and Rutherford's nuclear model of atom; Atomic spectra; Bohr model of the hydrogen atom; The line spectra of the hydrogen atom; De Broglie's explanation of Bohrs second postulate of quantisation.

Nuclei: Atomic masses and composition of nucleus; Size of the nucleus; Mass-energy and nuclear binding energy; Nuclear force; Radioactivity; Nuclear energy.

Semiconductor Electronics: Materials, Devices and Simple Circuits: Classification of metals, conductors, and semiconductors; Intrinsic semiconductor; Extrinsic semiconductor; p-n junction; Semiconductor diode; Application of junction diode as a rectifier.