72. BIOCHEMISTRY / ENVIRONMENTAL SCIENCE /FORENSICSCIENCE / GENETICS/MICROBIOLOGY (BCESFSG&M)

PART – A: CHEMISTRY (40 Marks)

BCESFSG&M

Part-A (40 Marks)

Coordination Compounds, Applications of Coordination Compounds, Organ metallic Chemistry, Metal Carbonyls and Related Compounds, Boranes and Carboranes, Inorganic Reaction Mechanisms, Bioinorganic Chemistry, Hard and Soft Acids and Bases (HSAB). Carboxylic Acids and Derivatives, synthesis Based on Carbanions, Nitro Hydrocarbons, Amines, Cyanides and Isocyanides, Heterocyclic Compounds, Carbohydrates, Amino Acids and Proteins, Pericyclic Reactions, Synthetic Strategies, Asymmetric Synthesis. Electrochemistry and Emf, Chemical Kinetics, Thermodynamics. Photochemistry, Molecular Spectroscopy, Proton Magnetic Resonance Spectroscopy, Mass Spectroscopy.

S-Block Elements, P-Block Elements, Chemistry of Zero Group Elements, Chemistry of d-Block Elements, Chemistry of f-Block Elements, General Principles of Inorganic Qualitative Analysis, Symmetry of molecules, Non-Aqueous Solvents, Chemical Bonding, Molecular Orbital Theory, Theory of Quantitative Analysis, Theories of Bonding in Metals. Structural Theory in Organic Chemistry, Acyclic Hydrocarbons, alicyclic Hydrocarbons, aromatic Hydrocarbons, Arenes and Polynuclear Aromatic Hydrocarbons, Halogen Compounds, Alcohols, Phenols, Ethers and Epoxides, Carbonyl Compounds, Conformational Analysis, Stereochemistry of Carbon Compounds. Atomic Structure and Elementary Quantum Mechanics, Gaseous State, Liquid State, Solutions, Dilute Solutions and Colligative Properties, Solid State Chemistry, Phase Rule, Colloids and Surface Chemistry, adsorption, Material Science, Nano materials, Evaluation of Analytical Data.

PART – B (60 Marks)

SECTION – I: PHYSICS

Mechanics

1. Vector Analysis: Scalar and vector fields, gradient of a scalar field and its physical significance. Divergence and curl of a vector field and related problems. Vector integration, line, surface and volume integrals. Stokes, Gauss and Greens theorems- simple applications:

2. Mechanics of Particles: Laws of motion, motion of variable mass system, motion of a rocket, multi-stage rocket, conservation of energy and momentum. Collisions in two and three dimensions, concept of impact parameter, scattering cross-section,

3. Mechanics of rigid bodies: Definition of Rigid body, rotational kinematic relations, equation of motion for a rotating body, angular momentum and inertial tensor. Euler's equation, precession of a top, Gyroscope,

4. Central Forces: Central forces – definition and examples, conservative nature of central forces, conservative force as a negative gradient of potential energy, equation of motion under a central force, gravitational potential and gravitational field, motion under inverse square law, derivation of Kepler's laws, Coriolis force and its expressions.

5. Special theory of relativity: Galilean relativity, absolute frames, Michelson-Morley experiment, Postulates of special theory of relativity. Lorentz transformation, time dilation, length contraction, addition of velocities, mass-energy relation. Concept of four vector formalism.

Waves and Oscillations

1. Fundamentals of vibrations: Simple harmonic oscillator, and solution of the differential equation– Physical characteristics of SHM, torsion pendulum, - measurements of rigidity modulus, compound pendulum, measurement of 'g', combination of two mutually perpendicular simple harmonic vibrations of same frequency and different frequencies, Lissajous figures

2. Damped and forced oscillations: Damped harmonic oscillator, solution of the differential equation of damped oscillator. Energy considerations, comparison with undamped harmonic oscillator, logarithmic decrement, relaxation time, quality factor, differential equation of forced oscillator and its solution, amplitude resonance, velocity resonance. Coupled Oscillators.

3. Vibrating Strings: Transverse wave propagation along a stretched string, general solution of wave equation and its significance, modes of vibration of stretched string clamped at ends, overtones, energy transport, transverse impedance

4. Vibrations of bars: Longitudinal vibrations in bars- wave equation and its general solution. Special cases (i) bar fixed at both ends ii) bar fixed at the midpoint iii) bar free at both ends iv) bar fixed at one end. Transverse vibrations in a bar- wave equation and its general solution. Boundary conditions, clamped free bar, free-free bar, bar supported at both ends, Tuning fork.

Thermodynamics

1. Kinetic theory of gases: Introduction-Deduction of Maxwell‟s law of distribution of molecular speeds, Transport Phenomena-Viscosity of gases-thermal conductivity-diffusion of gases.

2. Thermodynamics: Basics of thermodynamics-Kelvin‟s and Claussius statements – Thermodynamic scale of temperature – Entropy, physical significance – Change in entropy in reversible and irreversible processes – Entropy and disorder – Entropy of universe – Temperature- Entropy (T-S) diagram – Change of entropy of a perfect gas-change of entropy when ice changes into steam.

3. Thermodynamic potentials and Maxwell's equations: hermodynamic potentials-Derivation of Maxwell‟s thermodynamic relations-Clausius-Clayperon‟s equation-Derivation for ratio of specific heats – Derivation for difference of two specific heats for perfect gas.Joule Kelvin effect – expression for Joule Kelvin coefficient for perfect and Vanderwaal‟s gas.

4. Low temperature Physics: Joule Kelvin effect – liquefaction of gas using porous plug experiment. Joule expansion – Distinction between adiabatic and Joule Thomson expansion – Expression for Joule Thomson cooling – Liquefaction of helium, Kapitza‟s method – Adiabatic demagnetization – Production of low temperatures – Principle of refrigeration, vapour compression type.

5. Quantum theory of radiation: Black body-Ferry‟s black body – distribution of energy in the spectrum of Black body – Wein‟s displacement law, Wein‟s law, Rayleigh-Jean‟s law – Quantum theory of radiation - Planck‟s law – deduction of Wein‟s distribution law, Rayleigh-Jeans law, Stefan‟s law from Planck‟s law. Measurement of radiation using pyrometers – Disappearing filament optical pyrometer – experimental determination – Angstrom pyroheliometer - determination of solar constant, effective temperature of sun.

6. Statistical Mechanics: Introduction, postulates of statistical mechanics. Phase space, concept of ensembles and some known ensembles ,classical and quantum statistics and their differences, concept of probability, Maxwell-Boltzmann‟s distribution law -Molecular energies in an ideal gas- Maxwell-Boltzmann‟s velocity distribution law, Bose-Einstein Distribution law, Fermi- Dirac Distribution law, comparison of three distribution laws,

Application of B-E distribution to Photons-planks radiation formula, Application of Fermi-Dirac statistics to white dwarfs and Neutron stars.

OPTICS

1 Interference: Principle of superposition – coherence – temporal coherence and spatial coherence – conditions for Interference of light

Interference by division of wave front: Fresnel‟s biprism – determination of wave length of light. Determination of thickness of a transparent material using Biprism – change of phase on reflection – Lloyd‟s mirror experiment.

Interference by division of amplitude: Oblique incidence of a plane wave on a thin film due to reflected and transmitted light (Cosine law) – Colours of thin films – Non reflecting films – interference by a plane parallel film illuminated by a point source – Interference by a film with two non-parallel reflecting surfaces (Wedge shaped film) – Determination of diameter of wire-Newton‟s rings in reflected light with and without contact between lens and glass plate, Newton‟s rings in transmitted light (Haidinger Fringes) – Determination of wave length of monochromatic light – Michelson Interferometer – types of fringes – Determination of wavelength of monochromatic light, Difference in wavelength of sodium D_1,D_2 lines and thickness of a thin transparent plate.

2 Diffraction: Introduction – Distinction between Fresnel and Fraunhoffer diffraction Fraunhoffer diffraction:- Diffraction due to single slit and circular aperture – Limit of resolution – Fraunhoffer diffraction due to double slit – Fraunhoffer diffraction pattern with N slits (diffraction grating) Resolving Power of grating – Determination of wave length of light in normal and oblique incidence methods using diffraction grating. Fresnel diffraction-Fresnel‟s half period zones – area of the half period zones –zone plate – Comparison of zone plate with convex lens – Phase reversal zone plate – diffraction at a straight edge – difference between interference and diffraction.

3 Polarization: Polarized light : Methods of Polarization, Polarization by reflection, refraction, Double refraction, selective absorption , scattering of light – Brewsters law – Malus law – Nicol prism polarizer and analyzer – Refraction of plane wave incident on negative and positive crystals (Huygen‟s explanation) – Quarter wave plate, Half wave plate – Babinet‟s compensator – Optical activity, analysis of light by Laurent‟s half shade polarimeter.

4 Aberrations and Fiber Optics: Introduction – Monochromatic aberrations, spherical aberration, methods of minimizing spherical aberration, coma, astigmatism and curvature of field, distortion. Chromatic aberration – the achromatic doublet – Removal of chromatic aberration of a separated doublet. Fiber Optics : Introduction – Optical fibers – Principles of fiber communication – Step and graded index fibers – Rays and modes in an optical fiber – Fiber material – Types of optical fibers and advantages of fiber communication.

Electromagnetism, Electrostatics:

Electric Field:- Concept of electric field lines and electric flux, Gauss‟s law (Integral and differential forms), application to linear, plane and spherical charge distributions. Conservative nature of electric field E, irrotational field. Electric Potential:- Concept of electric potential, relation between electric potential and electric field, potential energy of a system of charges. Energy density in an electric field. Calculation of potential from electric field for a spherical charge distribution.

Magnetostatics

Concept of magnetic field B and magnetic flux, Biot-Savart‟s law, B due to a straight current carrying conductor. Force on a point charge in a magnetic field. Properties of B, curl and divergence of B, solenoidal field. Integral form of Ampere‟s law, applications of Ampere‟s law: field due to straight, circular and solenoidal currents. Energy stored in

magnetic field. Magnetic energy in terms of current and inductance. Magnetic force between two current carrying conductors. Magnetic field intensity. Ballistic Galvanometer:- Torque on a current loop in a uniform magnetic field, working principle of B.G., current and charge sensitivity, electromagnetic damping, critical damping resistance.

Electromagnetic Induction

Faraday‟s laws of induction (differential and integral form), Lenz‟s law, self and mutual Induction. Continuity equation, modification of Ampere‟s law, displacement current, Maxwellequations

Electromagnetic waves

Maxwell‟s equations in vacuum and dielectric medium, boundary conditions, plane wave equation: transverse nature of EM waves, velocity of light in vacuum and in medium, polarization, reflection and transmission. Polarization of EM waves, Brewster‟s angle, description of linear, circular and elliptical polarization.

MODERN PHYSICS

Atomic Spectra and Models Inadequacy of classical physics:

Brief Review of Black body Radiation , Photoelectric effect, Compton effect, dual nature of radiation, wave nature of particles. Atomic spectra, Line spectra of hydrogen atom, Ritz Rydberg combination principle. Alpha Particle Scattering, Rutherford Scattering Formula, Rutherford Model of atom and its limitations, Bohr‟s model of H atom, explanation of atomic spectra, correction for finite mass of the nucleus, Bohr correspondence principle, limitations of Bohr model, discrete energy exchange by atom, Frank Hertz Expt. Sommerfeld's Modification of Bohr‟s Theory. Wave Particle Duality de Broglie hypothesis, Experimental confirmation of matter wave, Davisson Germer Experiment, velocity of de Broglie wave, wave particle duality, Complementarity. Superposition of two waves, phase velocity and group velocity , wave packets ,Gaussian Wave Packet , spatial distribution of wave packet, Localization of wave packet in time. Time development of a wave Packet; Wave Particle Duality, Complementarity . Heisenberg Uncertainty Principle, Illustration of the Principle through thought Experiments of Gamma ray microscope and electron diffraction through a slit. Time independent and time dependent Schrodinger wave equation. Estimation of ground state energy of harmonic oscillator and hydrogen atom, non-existence of electron in the nucleus. Uncertainty and Complementarities. Nuclear Physics Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers. Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions), Classification of Elementary Particles.

SECTION – II: BOTANY

Microbial Diversity of Lower Plants:
Brief account of Archaebacteria, Actinomycetes. **Viruses**: Structure, replication and transmission; plant diseases caused by viruses and their control with reference to Tobacco Mosaic and Rice Tungro. **Bacteria**: Structure, nutrition, reproduction and economic importance. An outline of plant diseases of important crop plants caused by bacteria and their control with reference to Angular leaf spot of cotton and Bacterial blight of Rice. General account of Mycoplasma with reference to Little leaf of brinjal and Papaya leaf curl. **Cyanobacteria**: General characters, cell structure, thallus organisation and their significance as biofertilizers with special reference to Oscillatoria, Nostoc and Anabaena. **Lichens**: Structure and reproduction; ecological and economic importance. **Algae:** General characters, structure, reproduction and classification of algae (Fritsch) and thallus organization in algae. Structure and reproduction of Volvox, Oedogonium, Chara, Ectocarpus, and Polysiphonia. Economic importance of algae in Agriculture and Industry. **Fungi:** General characters and classification of fungi (Ainsworth). Structure and reproduction of the Albugo, Mucor, Saccharomyces, Penicillium, Puccinia & Cercospora. Economic importance of fungi in relation to mycorrhizae and mushrooms. General account of mushroom cultivation.

Bryophytes, Pteridophytes, Gymnosperms and Paleobotany:
Bryophytes: General characters and classification. Structure, reproduction, life cycle and systematic position of Marchantia, Anthoceros and Polytrichum. Evolution of Sporophyte in Bryophytes. **Pteridophytes**: General characters and classification (Sporne's). Structure, reproduction, life cycle and systematic position of Rhynia, Lycopodium, Equisetum and Marsilea. Stelar evolution, heterospory and seed habit in Pteridophytes. **Gymnosperms**: General characters, structure, reproduction and classification (Sporne's). Distribution and economic importance of Gymnosperms. Morphology of vegetative and reproductive parts, systematic position and life cycle of Pinus and Gnetum. **Palaeobotany**: Introduction, Fossils and fossilization ; Importance of fossils. Geological time scale. General account on Bennettitales.
Taxonomy of Angiosperms: Principles of plant systematics, Types of classification: Artificial, Natural and Phylogenetic; Systems of classification: Salient features and comparative account of Bentham & Hooker and Engler & Prantle. An introduction to Angiosperm Phylogeny Group (APG). **Current concepts in Angiosperm Taxonomy**: Embryology in relation to taxonomy, Cytotaxonomy, Chemotaxonomy and Numerical Taxonomy. Nomenclature and Taxonomic resources: An introduction to ICBN, Vienna code - a brief account. Herbarium: Concept, techniques and applications. Systematic study and economic importance of plants belonging to the families; Annonaceae, Capparidaceae, Rutaceae, Fabaceae (Faboideae/papilionoideae, Caesalpinioideae, Mimosoideae), Cucurbitaceae, Apiaceae, Asteraceae, Asclepiadaceae, Lamiaceae, Amaranthaceae, Euphorbiaceae, Monocotyledons: Orchidaceae and Poaceae.

Medicinal Botany:
Ethnomedicine: Scope, interdisciplinary nature, distinction of Ethnomedicine from Folklore medicine. Outlines of Ayurveda, Sidda, Unani and Homeopathic systems of traditional medicine. Role of AYUSH, NMPB, CIMAP and CDRI. Plants in primary health care: Common medicinal plants – *Tinospora cordifolia*), *Ocimum sanctum*, *Piper longum, Terminalia chebula, Aloe vera, Curcuma longa.* Evaluation of crude drugs. Traditional medicine vs Modern medicine. Study of selected plant examples used in traditional medicine as resource (active principles, structure, usage and pharmacological action of modern medicine: Aswagandha, Sarpagandha, Nela usiri, Amla and Brahmi (Bacopa monnieri). **Pharmacognosy**: Introduction and scope. Adulteration of plant crude drugs and methods of identification - some examples. Indian Pharmacopoeia. **Plant crude drugs**: Types, methods of collection, processing and storage practices.
Plant Anatomy
Meristems: Types, histological organization of shoot and root apices and theories. Tissues and Tissue Systems: Simple, complex and special tissues. Leaf: Ontogeny, diversity of internal structure; stomata and epidermal outgrowths. Stem and root anatomy: Vascular cambium - Formation and

function. Anomalous secondary growth of Stem - Achyranthes, Boerhaavia, Bignonia, Dracaena; Root– Beta vulgaris. Wood structure: General account. Study of local timbers – Teak, Rosewood, Red sanders, Nallamaddi, and Neem.

Embryology

History and importance of Embryology. Anther structure, Microsporogenesis and development of male gametophyte. Ovule structure and types; Megasporogenesis; types and development of female gametophyte.

Palynology

Pollination - Types; Pollen - pistil interaction. Fertilization. Endosperm - Development and types. Embryo - development and types; Polyembryony and Apomixis - an outline. Palynology- Pollen morphology, NPC system and application of Palynology.

Cell Biology

Principles of Microscopy: Light Microscope and Electron Microscope. Plant cell envelops: Ultra structure of cell wall, molecular organization of cell membranes. Nucleus: Ultra structure, Nucleic acids - Structure of DNA, types and functions of RNA. Chromosomes: Morphology, organization of DNA in a chromosome, Euchromatin and Heterochromatin, Karyotype. Special types of chromosomes: Lampbrush and Polytene chromosomes. Extra nuclear genome: Mitochondrial DNA and Plastid DNA, Plasmids. Cell division: Cell and its regulation; mitosis, meiosis and their significance.

Genetics

Mendelism: Laws of inheritance. Genetic interactions - Epistasis, Complementary, Supplementary and inhibitory genes. Linkage: A brief account and theories of Linkage. Crossing over: Mechanism and

theories of crossing over. Genetic maps: Construction of genetic maps with Two point and Three point test cross data. Mutations: Chromosomal aberrations - structural and numerical changes; Gene mutations, Transposable elements. Gene Organization- Structure of gene, Genetic code, Process of DNA Replication with Polymerase enzyme. Mechanism of transcription in Prokaryotes and Eukaryotes. Regulation of gene expression in prokaryotes (Lac and Trp. Operons).

Plant Physiology

Plant-Water Relations: Importance of water to plant life, physical properties of water, diffusion, imbibition, osmosis; water, osmotic and pressure potentials; absorption, transport of water, Ascent of sap; Transpiration; Stomatal structure and movements. **Mineral Nutrition**: Essential macro and micro mineral nutrients and their role; symptoms of mineral deficiency. **Translocation of organic substances**: Mechanism of phloem transport. **Enzymes**: Nomenclature, Characteristics, Classification, Mechanism and regulation of enzyme action, factors regulating enzyme activity. **Photosynthesis**: Photosynthetic pigments, absorption and action spectra; Red drop and Emerson enhancement effect; concept of two photosystems; mechanism of photosynthetic electron transport and evolution of oxygen; Factors effecting Photosynthesis, Photophosphorylation. Carbon assimilation pathways: C3, C4 and CAM.

Nitrogen Metabolism: Biological nitrogen fixation, nitrate reduction, ammonia assimilation, (GS-GOGAT, transamination). **Respiration**: Aerobic and Anaerobic; Glycolysis, Krebs cycle; electron transport system,

mechanism of oxidative phosphorylation, pentose phosphate pathway. **Growth and Development**: Physiological effects of phytohormones–Auxins, gibberellins, cytokinins, ABA, ethylene and Brassinosteroids. Physiology of flowering and photoperiodism. Role of Phytochrome in flowering.

Stress physiology: Concept of water, salt and temperature stresses and plant responses.

SECTION – III: ZOOLOGY

Physiology and Biochemistry:

Digestion Digestion definition and extra and intracellular digestion. Digestion of Carbohydrates, Proteins, Lipids and Cellulose. Absorption and Assimilation of digested food; role of Gastrointestinal hormones in digestion **Respiration** Definition of Respiration and Respiratory mechanisms-External, Internal and cellular. Respiratory Pigments; Transport of oxygen, Oxygen dissociation curves. Bohr's effect. Transport of CO_2 – Chloride shift; Regulation of respiration – nervous and chemical **Circulation** Types of circulation - Open and Closed circulation Structure of Mammalian Heart, Types of hearts – Neurogenic and Myogenic; Heart function -Conduction and regulation of heart beat. Regulation of Heart rate – Tachycardia and Bradycardia; Blood Clotting mechanism. **Excretion** Classification of Animals on the basis of excretory products- Ammonotelic, Uricotelic, Ureotelic, Structure and function of Nephron. Urine formation, Counter current mechanism.

Physiology

Muscle Contraction: Types of Muscles, Ultra structure of skeletal muscle fibre, Sliding Filament theory, muscle contraction mechanism and energetics. **Nerve Impulse** Structure of Neuron, Nerve impulse - Resting potential and Action potential and Conduction of Nerve impulse, Synapse, types of synapses and Synaptic transmission. **Endocrine System** Endocrine glands - Structure, secretions and functions of Pituitary, Thyroid, Parathyroid, Adrenal glands and Pancreas, Hormone action and concept of Secondary messengers, Male and Female Hormones, Hormonal control of Menstrual cycle in humans.

Physiology and Biochemistry:

Homeostasis and Enzymes Concept of Homeostasis. Mechanism of Homeostasis. Osmoregulation - Water and ionic regulation by freshwater, brackish water and marine animals, Enzymes: Definition, Classification, Inhibition and Regulation. **Biomolecules and Metabolism** Carbohydrates**:** Classification and function of Carbohydrates, Carbohydrate metabolism - Glycolysis, Krebs cycle, , Electron transport and oxidative phosphorylation. Proteins**:** Classification of proteins based on functions and Chemical nature, Protein Metabolism - Transamination, Deamination and Urea Cycle, Lipids**:** Classification of Lipids, Lipid Metabolism - Fatty acid synthesis and Fatty acid oxidation.

Immunology and Animal Biotechnology:

Immunology – Basic concepts; antigens and antibodies Basic concepts of immunology. Cells of immune system, Primary and secondary Organs of immune system, Types of Immunity – Innate and acquired, Basic properties of antigens, Structure, function and types of an antibody. B and T cell epitopes, haptens, adjuvants. Antigen-antibody reactions, T-Cell and B-Cell activation, Monoclonal antibodies and their production. **Working of an Immune system; Immune system in health and disease** Structure and functions of major histocompatibility complex. Basic properties and functions of Cytokines, Interferons and complement proteins, Humoral and Cell mediated immunity. Types of hyper sensitivity. Concepts of autoimmunity and immunodeficiency. Introduction to Vaccines and types of Vaccines. **Animal Biotechnology and Genetically modified organisms** Concept and Scope of Animal Biotechnology. Cloning vectors - Plasmids, Cosmids, Lambda bacteriophage, YAC Cloning-Cloning methods (Cell, Animal and Gene cloning) Animal Cell culture **-** Equipment and materials for

animal cell culture; applications of cell culture techniques Recombinant DNA technology and its applications, Transgenesis – Methods of Transgenesis. Production of Transgenic animals and Application of Transgenic animals in Biotechnology. Stem cells –types and their applications.

Animal Diversity – Invertebrates

Brief history of Invertebrates: Kingdom Animalia, Brief history of Invertebrates. **Protozoa** General characters Classification up to classes with examples, Type study – *Elphidium,* Life cycle of *Plasmodium.* Locomotion, Reproduction and Diseases. **Porifera** General characters, Classification of Porifera up to classes with examples, Type study – *Sycon,* Canal system in sponges and Spicules. **Cnidaria** General characters, Classification of Cnidaria up to classes with examples, Type study – *Obelia,* Polymorphism in hydrozoa, Corals and coral reef formation. **Platyhelminthes** General characters Classification of Platyhelminthes up to classes with examples, Type study-*Schistosoma.* **Nemathelminthes** General characters Classification of Nemathelminthes up to classes with examples Type study-*Dracunculus,* Parasitic Adaptations in Helminthes.

Annelida General characters, Classification of Annelida up to classes with examples Type study - *Hirudinaria granulosa.* Evolutionary significance of Coelome and Coelomoducts and metamerism. **Arthropoda** General characters, Classification of Arthropoda up to classes with examples, Type study – Prawn, Crustacean larvae, Insect metamorphosis, *Peripatus* - Structure and affinities. **Mollusca** General characters, Classification of Mollusca up to classes with examples, Type study – *Pila*, Pearl formation, Torsion and detorsion in gastropods. **Echinodermata** General characters, Classification of Echinodermata up to classes with examples, Water vascular system in star fish, Echinoderm larvae and their significance. **Hemichordata** General characters, Classification of Hemichordata up to classes with examples, *Balanoglossus* - Structure and affinities.

Ecology, Zoogeography and Animal Behavior:

Ecology-I: Ecosystem structure and functions. Types of Ecosystems –Aquatic and Terrestrial. Biogeochemical cycles - Nitrogen, Carbon, Phosphorus and Water. Energy flow in ecosystem. Food chain, food web and ecological pyramids. Animal Associations - Mutualism, commensalism, parasitism, competition, predation.

Ecology – II: Concept of Species, Population dynamics and Growth curves. Community Structure and dynamics and Ecological Succession. Ecological Adaptations. Environmental Pollution – Sources, Effect and Control measures of Air, Water, Soil and Noise Pollution. Wildlife conservation - National parks and Sanctuaries of India, Endangered species. Biodiversity and hotspots of Biodiversity in India.

Zoogeography: Zoogeographical regions – Palaearctic, Nearctic, Neotropical, Oriental, Australian and Ethiopian regions - their Climatic and faunal peculiarities, Wallace line, Discontinuous distribution Continental Drift. **Animal Behaviour** Types of Behaviour- Innate and Acquired, Instinctive and Motivated behavior, Taxes, Reflexes, Tropisms, Biological rhythms and types of rhythms, trial and error learning, Imprinting, habituation, Classical conditioning, Instrumental conditioning, Social behavior, Communication, Pheromones, Biological rhythms, Biological clocks, Circadian rhythms.

Animal Diversity- Vertebrates and Developmental Biology:

Urochordata, Cephalochordata, Cyclostomata: Salient features of Urochordata, Retrogressive, metamorphosis and its significance in Urochordata, Salient features and affinities of Cephalochordata General characters of Cyclostomata, Comparison of the *Petromyzon* and *Myxine,* General characters and classification of Chordata upto orders with examples. **Pisces** General characters of Fishes, Classification of fishes up to order level with examples, *Scoliodon* – Respiratory, Circulatory and Nervous system. Types of Scales and types of Fins

Amphibia General characters of Amphibians, Classification of Amphibians up to orders with examples. *Rana tigrina*-Respiratory, Circulatory and Nervous system. Parental care in amphibian; neoteny and paedogenesis.

Reptilia: General characters of Reptilia, Classification of Reptilia up to orders with examples, *Calotes* – Respiratory system, Circulatory and Nervous system. Temporal fossae in reptiles and its evolutionary importance, Distinguished characters of Poisonous and Non poisonous snakes. Rhynchocephalia. **Aves** General characters of Aves, Classification of Aves up to orders with examples. *Columba livia* -, Digestive system, Circulatory systems, Respiratory system and Nervous, system. Migration in Birds, Flight adaptation in Birds, **Mammalia** General characters of Mammalia, Classification of Mammalia up to orders with examples Rabbit –Digestive, Respiratory, Circulatory and Nervous system. Dentition in mammals. Aquatic adaptations in Mammals. **Developmental Biology and Embryology** Gametogenesis (Spermatogenesis and Oogenesis) Fertilization, Types of eggs, Types of cleavages, Development of Frog up to formation of primary germ layers Formation of Foetal membrane in chick embryo and their functions, Types and functions of Placenta in mammals, Regeneration in Turbellaria and Lizards.

Cell Biology, Genetics & Evolution:

1. **Cell Biology** Ultrastructure of animal cell, Structure and functions of plasma membrane proteins. Structure and functions of cell organelles –Endoplasmic reticulum, Golgi body, Ribosomes, Lysosomes, centrosomes, Mitochondria and Nucleus Chromosomes – Structure, types, giant chromosomes, Cell Division - Mitosis, Meiosis. **2. Molecular Biology** DNA (Deoxyribo Nucleic Acid) – Structure, RNA (Ribo Nucleic Acid) - Structure, types, DNA Replication, Protein Synthesis – Transcription and Translation, Gene Expression – Genetic Code; operon concept, Molecular Biology Techniques- Polymerase Chain Reaction, Electrophoresis **3. Genetics** Mendals laws of Inheritance and Non-Medelian Inheritance, Linkage and Crossing over, Sex determination and sex-linked inheritance, Chromosomal Mutations- Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy. Gene mutations- Induced versus Spontaneous mutations. Inborn errors of metabolism. **4. Evolution** Theories of evolution – Lamarckism and Neo-Lamarckism, Darwinism and Neo-Darwinism, Modern synthetic theory. Evidences of Evolution and Hardy Weinberg Law. Forces of Evolution – mutation, gene flow, genetic drift, and natural selection. Isolation – Pre-mating and post mating isolating mechanisms, Speciation: Methods of speciation-Allopatric and sympatric.

SECTION – IV: BIOCHEMISTRY

Elementary aspects of cell structure–function, tissues and body fluids. 2. Chemistry, physiological role and metabolism of biomolecules like carbohydrates, amino-acids, proteins, Lipids & nucleic acids. 3. Basic aspects of nutrition, endocrinology & Physiology, clinical biochemistry, enzymology, biological oxidations, photosynthesis. 4. Physiological role of vitamins and minerals. 5. Basic aspects of immunology. 6. Replication, transcription and protein synthesis. 7. Fundamental aspects of microbiology. 8. Elementary aspects of r-DNA technology and genetic engineering. 9. Principles, methodology and applications of various biochemical techniques used in biochemistry.

SECTION – V: GENETICS

CLASSICAL GENETICS

Mendelian Inheritance & extensions: Terminology and definitions –phenotypes, genotype, locus, allele, homozygotes, heterozygotes, Johanssen's pure line concept, filial generations, reciprocal cross, back cross, test cross; Law of segregation- Law of Independent Assortment, Extension to mendelian segregation patterns: Co-dominance, Incomplete dominance, Lethals, gene interaction-Epistasis-paramutation-Environmental effects on gene expression-Penetrance-Expressivity, Multiple alleles, and Pseudoalleles**;** Features of Quantitative Inheritance, Multifactorial inheritance, Extrachromosomal inheritance, Sex linked inheritance: X—linked and Y-linked traits, Sex chromosome inactivation –dosage compensation, Gynandromorph; **Linkage and gene mapping:** Cytological proof of crossing over, Phases of linkage, test cross, recombination frequency, gene mapping, determination of map distances based on two and three point test crosses, coincidence, interference, Tetrad analysis –Neurospora, Mitotic crossing over-Drosophila**; Organellar inheritance:** Non-Mendelian inheritance, Chloroplast and Mitochondrial inheritance, Chloroplast and Mitochondrial genomes

CYTOGENETICS

Eukaryotic Cell cycle -Phases of cell cycle G0, G1,S, G2, Genes that determine the cell cycle – cyclins, CDK proteins, role of p53 in cell cycle, Mitosis –stages, significance of mitosis, Meiosis I & II- Stages, formation of synaptonemal complex, crossing over, chiasma formation, significance of meiosis**; Chromosome structure, chromatin organization and variation:** Chromosome morphology-size and shape; Euchromatin and Heterochromatin-constitutive and facultative heterochromatin, Components of chromatin, histones & non-histones, Packing of DNA into chromatin –Nucleosome and higher order organization, Specialized Chromosomes –Lampbrush chromosomes, Polytene Chromosomes, Super numerary chromosomes, Chromosome Variation-Structural and Numerical aberrations; **Cell communication and signaling:** Basics of cell signaling – paracrine, endocrine, autocrine, tight junctions and gap junctions, Secondary messengers -cAMP, phosphotidyl inositol, Ca+2and IP3, G-protein coupled receptors and Tyrosine Kinase receptors**; Dysregulation of Cell cycle:** Necrosis, senescence, programmed cell death (apoptosis- intrinsic and extrinsic factors), Cancer

MOLECULAR GENETICS

Nucleic acids: DNA as the genetic material and experimental evidences, RNA as genetic material, Chemistry of Nucleic acids, Forms of DNA and types of RNA, Models and methods of DNA replication, Mechanism of DNA replication and enzymes involved**; Gene expression and regulation in prokaryotes and eukaryotes:** Structure of prokaryotic and eukaryotic gene, Transcription and Translation mechanisms, Genetic code and properties, Operon concept- lac operon & glucose effect, tryptophan operon, Post-transcriptional and Post-translational modifications in eukaryotes**; Mutations and repair mechanisms:** Mutations-spontaneous and induced mutations, Types of mutations, DNA damage & repair mechanisms, Diseases caused due to mutation-sickle cell anaemia and cystic fibrosis

MICROBIAL GENETICS & GENETIC ENGINEERING

Bacterial recombination and mapping: Bacteria- structure, Transformation and gene mapping, Conjugation and gene mapping High frequency recombination, interrupted mating experiment; **Genetics of bacteriophages:** Structure and classification of bacteriophages, Lytic cycle, Lysogeny, Generalized and specialized transductions**;** Enzymes used in molecular cloning, Vectors used in cloning, Genomic and cDNA libraries, Blotting techniques and PCR, Screening for detection of cloned genes, **Applications of genetic engineering-** Gene products in medicine, DNA based vaccines, Subunit vaccines, Attenuated vaccines, genetically engineered microorganisms for bioremediation, phytoremediation, Transgenic plants, Transgenic animals, Molecular pharming, Industrial products

BIOSTATISTICS & BIOINFORMATICS

Measures of central tendency and measures of dispersion, Grouped data and graphical methods, Probability, Binomial, Poisson and Normal distributions, t-test, z-test, chi-square test**;** Computer and Internet Basics, Biological databases, DNA Sequence and Protein sequence databases, Sequence retrieval from Genbank, ENA, Swissprot

POPULATION GENETICS & EVOLUTION

Allele frequencies and genotype frequencies at a locus, Hardy-Weinberg Law, Linkage disequilibrium, Snyder's ratios; Selection–fitness, patterns of natural selection, general selection equation, equilibrium under selection, Selection favoring heterozygote, selection against heterozygote, complete elimination of recessive gene; Mutation–mutation models, influence of mutation on allele frequency & autozygosity, balance between forward & backward mutation, interaction of mutation with selection; Genetic load, Gene flow, Wahlund effect, Inbreeding, construction of pedigrees inbreeding coefficient and inbreeding depression; Genetic Drift -Bottle neck effect, Founder effect, effective population size, consequences of a decreasing population size; Origins of genomes - Acquisition of new genes by gene duplication and from other species, Origin of non-coding DNA, transposable elements and introns, Molecular phylogenetics, Molecular Evolution, Molecular clock

SECTION – VI: MICROBIOLOGY

Scope and importance of Microbiology. Spontaneous generation-biogenesis theory; Germ theory of diseases; Recent developments of Microbiology. Principles of microscopy. Principles of staining. Culture media. Sterilization methods. Isolation of pure cultures, maintenance and preservation of microbial cultures. Morphology and ultra structure of typical eubacterial cell. Bacterial classification. Discovery and nature of viruses. TMV, HIV, T4 and lambda phages. Cultivation and assay of phages, plant and animal viruses. Nutritional types of bacteria. Bacterial growth. Respiration. Fermentation. Antibiotics. DNA and RNA structures and their role as genetic materials. Transcription and translation. *Lac* operon. Bacterial plasmids and transposons. DNA damage and repair mechanisms. Mutations. Gene transfer mechanisms in bacteria. Recombinant DNA technology. Types of immunity. Organs of immune system. Cells of immune system. Antigens. Antibodies. Antigen-antibody reactions. Normal flora of human body. Infection, Disease, Defense mechanisms. Bacterial toxins, virulence and attenuation. Airborne diseases, Food water borne diseases and Blood borne diseases. General principles of diagnostic microbiology. Elements of chemotherapy-therapeutic drugs. Drug resistance. Microorganisms in relation to plant growth. Biological nitrogen fixation, Biofertilizers. Microorganisms of the environment (soil, water and air). Microbial interactions. Microbiology of potable and polluted waters. Microorganisms of food spoilage and their sources. General account of food .preservation. Microorganisms as food – SCP, edible mushrooms. Screening and isolation of industrially useful microbes, strain improvement and fermentation. Fermentor. Immobiolization Industrial production of Alcohols, Glutamic acid, Citric acid, vitamin B12, Enzymes, and Antibiotics. Biomolecules: Carbohydrates, aminoacids, proteins, Biochemical techniques.