Code No: 49

SUBJECT : ZOOLOGY
SYLLABUS

Unit 1.

ANIMAL DIVERSITY AND PHYLOGENY

- Concepts of species and hierarchical taxa, biological nomenclature.
- Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs and systems. Organization of Coelom, Symmetry and Metamerism.
- Protozoa: Human Parasitic Protozoana – Entamoeba histolytica and Plasmodium vivax, Canal systems in Porifera, Polymorphism and Metagenesis in Coelentrates, Types of Corals and Coral reefs, Human Parasitic Helmith worms – Liverfluke and Ascatis, Adaptive Radiation in Polychaetes.
- Economic importance of Insects, Torsion in Gastropods, Invertebrate larval forms and their evolutionary significance. Structure, affinities and life history of Minor Phyla – Ctenophora, Rotifera, Chaetognatha, Onychophora, Siphunculida, Entoprocta, Ectoprocta and Phoronida.
- Origin and outline classification of Chordata: Phylogeny, evolutionary significance and interrelationships of Hemichordata, Urochordata, and Cephalochordata and their relation with other deuterosomes.
- Origin, Evolution and general characters of Agnatha (Ostracoderms and Cyclostomes). The early Gnathostomes (Placoderms). General characters and classification of fishes. Adaptive Radiation in Bony fishes. Origin, Evolution and adaptive radiation of Amphibia.
- Origin and evolution of Reptiles, Skulls of reptiles and its importance in biosystematics. Outline classification of Reptiles, Mesozoic world of Reptiles and their extinction. Poisonous and Non-poisonous snakes.
- Origin and evolution of birds. Origin of flight and flight adaptations in birds. Origin of mammals. Primitive mammals – Prototheria, Metatheria and Eutherian Mammals. Aquatic adaptation in Aves and Mammals.
- Structure and functions of integument and its derivatives (glands, scales, feathers and hairs). Comparative account of jaw suspension, girdles and limbs. Comparative study of Heart in Vertebrates.

Unit 2.

CELLULAR ORGANIZATION

- Membrane structure and function: Structure of cell membrane and models, membrane transport- diffusion, osmosis, active transport, membrane pumps, ion channels, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes. Cell membrane synthesis.
- Structural organization and function of intracellular organelles: Nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, ribosomes, peroxisomes, structure and functions of cytoskeleton and its role in motility.
- Organization of genes and chromosomes: Conformation of nucleic acids (helix (A, B, Z), tRNA, mRNA, rRNA, micro-RNA). Operon, unique and repetitive DNA, structure of chromatin and chromosomes, heterochromatin, euchromatin and Giant chromosomes.
- Cell division and cell cycle, regulation and control of cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, Significances of Mitosis and Meiosis, Mitotic Apparatus.
- DNA replication, repair and recombination: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination.
- RNA synthesis and processing: transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins.

- Control of gene expression at transcription and translation level: Regulating the expression of prokaryotic and eukaryotic genes – *lac* and *trp*operon, role of chromatin in gene expression and gene silencing.
- Cellular communication: General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix and integrins.
- Cell signaling Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways.
- Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, therapeutic interventions of uncontrolled cell growth.
- Programmed cell death (Apoptosis), aging and senescence.

Unit 3.

DEVELOPMENTAL BIOLOGY AND IMMUNOLOGY

- Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals, embryo sac development and zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers and embryogenesis.
- Morphogenesis and organogenesis: Ecodermal, Mesodermal and Endodermal derivatives, Organogenesis – vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates, Development of Amphibians, Aves and Mammals. Post embryonic development- larval formation, metamorphosis.
- Human Reproduction: Reproductive organs, Menstrual cycle, Human Fertilisation process, infertility and assisted reproductive technology, Birth control methods. Twins, Human Syndromes
- Immunology: Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, General properties, structure and function of antibody molecules, generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions. Primary and Secondary Lymphoid organs: MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell- mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, acquired immune-deficiencies, vaccines and immunization schedule.

Unit 4.

ANIMAL PHYSIOLOGY

- Digestive system: Nutrients – Vitamins and Minerals. Balance Diet, BMR, Digestion and absorption.
- Blood and circulation: Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity and haemostasis.
- Cardiovascular System: Structure of Human Heart, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation. Blood vessels – Arteries, Veins and Lymphatic vessels.
- Respiratory system: Respiratory Structure – Insects, Fish and Human beings, respiratory pigments, Comparison of respiration in different species, transport of gases, exchange of gases, neural and chemical regulation of respiration.
- Nervous system: Central Nervous system, Peripheral and Autonomic nervous system. Structure of Neuron, types, transmission of nerve impulses, action potential, Synapse, neurotransmitters, Neuroanatomy of the brain and spinal cord and Reflex action.
- Receptors: Photoreceptors, mechanoreceptors and Gustatoreceptors. Echolocation, Bioluminescence, Colouration, and colour change. Lateral line system in fishes.
- Excretory system: Ammonotelism Uricotelism and Ureotelism process, structure of kidney, and Nephron, Mechanism of urine formation, Counter-current principle, micturition, regulation of water balance, electrolyte balance, acid-base balance.

- Thermoregulation and Stress Adaptations: Thermoregulation in homeotherms, poikilotherms – acclimation and acclimatization, physical, chemical and neural regulation of body temperature. Adaptation to high altitudes, Deep Sea adaptation.
- Endocrinology: Endocrine glands, basic mechanism of hormone action, hormones and diseases, neuroendocrine regulation. Invertebrate hormones.

Unit 5.

INHERITANCE BIOLOGY

- Mendelian principles: Dominance, segregation, independent assortment.
- Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests.
- Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.
- Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids.
- Cytoplasmic Inheritance: Inheritance of Mitochondrial, genes, maternal inheritance, shell coiling in *Limnaea*. Extra nuclear inheritance by endosymbionts- Kappa particles in *Paramecium.*
- Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sexduction, mapping genes by interrupted mating.
- Human genetics: Pedigree analysis, LOD score for linkage testing, karyotypes, genetic disorders.
- Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.
- Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.
- Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.
- Recombination: Homologous and non-homologous recombination including transposition.

Unit 6.

ECOLOGICAL PRINCIPLES

- The Environment: Physical environment, biotic environment, biotic and abiotic interactions. Concept of habitat and niche, niche width and overlap, fundamental and realized niche.
- Population Ecology: Characteristics of a population, population growth curves, population regulation, life history strategies (*r* and *K* selection), concept of metapopulation, demes and dispersal, interdemic extinctions, age structured populations.
- Species Interactions: Types of interactions, interspecific and Intra specific, Symbiosis, Mutualism, Parasitism, Commensalism, competition, herbivory, carnivory, pollination, symbiosis.
- Community Ecology: Nature of communities, community structure and attributes, levels of species diversity and its measurement, edge effect and ecotone.
- Ecological Succession: Types, mechanisms, changes involved in succession, concept of climax.
- Ecosystem Ecology: Ecosystem structure, ecosystem function, energy flow and mineral cycling (C,N,P), primary production and decomposition, structure and function of some Indian ecosystems, terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).
- Biodiversity: Definition, types, Hotspots, Flagship species, keystone species, Biodiversity concerns.
- Biodiversity conservation: *In situ* and *ex situ* conservation, concept of protected areas, National parks, sanctuaries, Red data book, Gene bank, threatened and endangered species. Salient features of Wildlife Protection Act, 1972 and Biological Diversity Act, 2002. Threats to survival and conservation strategies for elephant, tiger, Olive Ridley sea turtle, White rumped Vulture and Gangetic Dolphin.

- Environmental issues: Urbanisation, deforestation, habitat loss, remote sensing and GIS in conservation.
- E–wastes and its erradication.
- Environmental Summits: Conventions, Climate change conventions, Environmental laws and Acts.
- Environmental Exploitation: Exploitation and depletion of natural resources.
- Pollution: definition, types, sources, effects. Global warming, climate change, glacial melting and rising sea levels, floods, droughts and desertification, Creating buffer zones, sustainable development, carbon sequestration, carbon sink, carbon foot print, carbon credit, carbon trading and carbon budget.
- Clean energy sources: solar, wind, hydel, biofuel, hydrogen as fuel
- Effluent management: Hazardous and biomedical waste management.
- Emission standards : BS6, AQI, WQI.
- Clean potable water: Desalination, rain water harvesting, conserving water bodies.

Unit 7.

MOLECULES AND THEIR INTERACTIONS

- Structure of atoms, molecules and chemical bonds. Structure of water molecule.
- Composition, structure and function of biomolecules: carbohydrates, lipids, proteins, nucleic acids and vitamins.
- Stabilizing interactions: Van der Waals, electrostatic, hydrogen bonding, hydrophobic interactions, etc.
- Principles of biophysical chemistry: pH, buffer, reaction kinetics, thermodynamics, colligative properties.
- Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.
- Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes and coenzymes.
- Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.

Unit 8.

EVOLUTION AND BEHAVIOUR

- Emergence of evolutionary thoughts: Lamarck, Darwin–concepts of variation, adaptation, struggle, fitness and natural selection, Spontaneity of mutations, the evolutionary synthesis.
- Origin of cells and unicellular evolution: Origin of basic biological molecules, Abiotic synthesis of organic monomers and polymers, Concept of Oparin and Haldane, Urey-Miller Experiment(1953), The first cell, Evolution of prokaryotes, Origin of eukaryotic cells.
- Paleontology and Evolutionary History: The evolutionary time scale, Major events in the evolutionary time scale, Stages in primate evolution. Evolution of Man.
- Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks, Molecular tools in phylogeny, classification and identification, Protein and nucleotide sequence analysis, origin of new genes and proteins, Gene duplication and divergence.
- Population genetics : Populations, Gene pool, Gene frequency, Hardy-Weinberg Law, concepts and rate of change in gene frequency through natural selection, migration and random genetic drift, Adaptive radiation, Isolating mechanisms, Speciation, Allopatric and Sympatric, Convergent evolution, Sexual selection, Co-evolution.
- Brain, Behavior and Evolution: Approaches and methods in the study of behavior, Proximate and ultimate causation, Altruism and evolution-Group selection, Kin selection, Reciprocal altruism, Neural basis of learning, memory, cognition, sleep and arousal, Biological clocks, Development of behavior, Social communication, Social dominance, Use of space and territoriality, Mating systems, Parental investment and Reproductive success, Parental care, Aggressive behavior, Habitat selection and optimality in foraging, Migration, orientation and navigation, Domestication and behavioral changes.

Unit 9.

BIOTECHNOLOGY

- Recombinant DNA technology: Molecular tools, host cells, Isolation and purification of nucleic acids, Cloning vectors, methods of gene transfer. Gene cloning Strategies, Blotting techniques, PCR, gene libraries, screening strategies, DNA sequencing methods, Protein sequencing methods, methods for analysis of gene expression at RNA and protein level, large scale expression- micro array based techniques. Isolation, separation and analysis of carbohydrate and lipid molecules RFLP, RAPD and AFLP techniques. Human Genome project.
- Biotechnology in health care: Gene therapy, DNA in the diagnosis of genetic diseases. DNA finger printing.
- Pharmaceutical Products of DNA Technology: Human protein replacements and therapeutic agents for human diseases. Recombinant vaccines, production of monoclonal antibodies.
- Microbial Fermentation Technology – Production of low and high molecular weight compounds.
- Enzyme technology: Commercial production of enzymes, immobilization of enzymes and cells- therapeutic applications, Biosensors.
- Animal cell culture methods and Applications, Transgenic animals.
- Biodegradation and Bioremediation.
- IPR, Patenting, Trade Mark, Copy rights. GMOs and GM foods–Pros and Cons. Microbial warfare, Microbial weapons, bioterrorism.

Unit 10.

METHODS IN BIOLOGY

- Histochemical and Immuno techniques: Antibody generation, Detection of molecules using ELISA, RIA, immunoprecipitation, flow cytometry and immune fluorescence microscopy, detection of molecules in living cells, *in situ* localization by techniques such as FISH and GISH.
- Biophysical Method: Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.
- Statistical Methods: Measures of central tendency and dispersal, probability distributions (Binomial, Poisson and normal), Sampling distribution, Difference between parametric and non-parametric statistics, Levels of significance, Regression and Correlation, t-test, Analysis of variance, chi square test.
- Radiolabeling techniques: Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.
- Microscopic techniques: Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM, image processing methods in microscopy.
- Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI and CAT.

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