

Syllabus in Zoology

UNITS

- I. Molecules and their Interaction**
 - II. Cell biology and Immunology**
 - III. Inheritance Biology and Biotechnology**
 - IV. Developmental Biology**
 - V. Biology of Non-chordates**
 - VI. Biology of Chordates**
 - VII. Physiology of Animal Systems**
 - VIII. Ecological Principles**
 - IX. Evolution and Behavior**
 - X. Methods in Biology**
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I. MOLECULES AND THEIR INTERACTION:

- a. **Molecules and chemical bonds**-Stabilizing interactions-Van-der Waals, electrostatic, hydrogen bonding, hydrophobic interactions etc.). Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties.
- b. **Biomolecules**- Composition, structure and function of carbohydrates, lipids, proteins, nucleic acids and vitamins.
- c. **Bioenergetics and metabolic pathways**-Glycolysis, TCA cycle, B-oxidation, High energy compounds. Oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.
- d. **Enzymes and enzyme kinetics**- Types, enzyme regulation, mechanism of enzyme catalysis, Allosteric enzymes, co-enzymes; isozymes and their importance.

II. CELL BIOLOGY AND IMMUNOLOGY

- a. **Structural organization and function of cellular organelles**-Structure and models of plasma membrane, transport mechanisms. Structure and function of nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, cytoskeleton and its role in motility.
- b. **Fundamental Processes**-Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle). DNA replication, DNA

damage / repair and recombination mechanisms. 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 poly-adenylation, structure and function of different types of RNA, RNA transport.

- c. **Protein synthesis and processing** - Ribosome, 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.
- d. **Organization of genes and chromosomes**-Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons. Cancer biology- Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.
- e. **Cell communication and cell signaling**-Hormones and their receptors interactions, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, Regulation of hematopoiesis, general principles of cell communication, cell adhesion and role of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.
- f. **Innate and adaptive immune system**- Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. Generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, 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 effectors functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiency, vaccines.

III. INHERITANCE BIOLOGY AND BIOTECHNOLOGY

- a. **Mendelian principles**-Dominance, segregation, independent assortment. Allele, multiple alleles, complementation tests, co-dominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.
- b. **Gene mapping methods**- Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids.

- c. **Extra chromosomal inheritance-** Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Microbial genetics - Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.
- d. **Human genetics-** Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Polygenic inheritance, heritability and its measurements, QTL mapping. Human Genome project.
- e. **Mutation** -Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.
- f. **Structural and numerical alterations of chromosomes-**Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Recombination - Homologous and non-homologous recombination including transposition.
- g. **Genetic Engineering:** Restriction enzymes, methylases, polymerases, reverse transcriptase, ligase, kinases and phosphatases, cloning vectors, plasmids, and artificial chromosomes. Expression vectors-classification, isolation, purification, salient features and advantages. Basic concepts of recombinant DNA technology and its application. Transgenic animals.

IV. DEVELOPMENTAL BIOLOGY

- a. **Basic concepts of development-**Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.
- b. **Gametogenesis, fertilization and early development-**Production of gametes, cell surface molecules in sperm-egg recognition in animals; early embryonic development-cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers.
- c. **Morphogenesis and organogenesis-**Cell aggregation and differentiation; organogenesis– post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination, programmed cell death, aging and senescence.
- d. **Development:** Early development of amphioxus, frog and chick.
- e. **Human reproduction:** Graffian follicle, ovulation, fertilization, blastocyst and implantation, gestation and lactation, menstrual cycle, placenta, role of male and female reproductive and placental hormones, methods of assisted fertility, cloning and sperm banks, family planning devices.

V. BIOLOGY OF NON-CHORDATES:

- a. **Principles of Animal classification.** Taxonomic procedures – Taxonomic collections, preservation, curation and process of identification. International Code of Zoological Nomenclature (ICZN).
 - b. General characters and Classification, Body plans and Symmetry-
Protozoa – Type study - Amoeba, Entamoeba, Trypanosoma, Euglena and Paramecium.
 Locomotion, Nutrition and Reproduction. Structure, life history and pathogenicity of *Plasmodium vivax*.
- Porifera**– Histology, Spicules, Canal system, Reproduction and larval forms.
Cnidaria – Type study Hydra, Obelia, Sea Anemone, Aurelia.
 Polymorphism in Cnidaria, Mesenteries in Sea Anemone. Structure of Corallite, Coral reefs, conditions necessary for coral growth, types and theories.
- c. **Platyhelminthes** – Structure and reproduction, Mode of infection, disease caused and control measures of *Taenia solium*, *Fasciola hepatica*, *Schistosoma hematobium*, *Ascaris*, *Wauchereria bancrofti* and *Ancylostoma*. Parasitic adaptations.
 - d. **Annelida** – Type study earthworm, Nereis and Leech -Externals, digestive system, respiratory system, circulatory system, excretory system and reproductive system.
 Tubiculous Annelida. Parasitic adaptations.
 - e. **Onychophora**- Peripatus – Salient features and Significance.
Arthropoda – Type study Cockroach, Prawn and Scorpion.
 Respiration, Circulation and Excretion. Larval forms, Metamorphosis and Endocrine control. Economic importance of Insects – Silkworm, Honeybees and Lac insects.
 Parasites – Bedbug, Head louse, Ticks, Mites, Mosquitoes.
 Pests – Weevil, Beetles, Locusts, Cockroach and Biological control.
Trilobita.
 - f. **Mollusca** – Type study Pila and Fresh water mussel. Types and Structure of Shells, Torsion in Gastropoda, respiration in Mollusca, Foot in Mollusca. Neopalina.
 - g. **Echinodermata** – Type study Star fish, Brittle star, Sea Urchin and Sea lily.
 Water vascular system in star fish and corona of sea urchin. Larval forms and evolutionary significance.
 - h. **Hemichordata**- Salient features and Phylogenetic significance.
 - i. **Minor Phyla**– organization and general characters of Chaetognatha, Ctenophore, Phoronida, Pogonophora.

VI. BIOLOGY OF CHORDATES:

- a. **General characters and classification of protochordates:**
 Cephalochordata– Amphioxus - Detailed study.
 Urochordata– Ascidia - Detailed study and retrogressive metamorphosis.
 Cyclostomata– Salient features, Petromyzon and Myxine, ammocoete larva and its significance.

- b. **Pisces** – General characters, distinctive features between Chondrichthyes and Osteichthyes, Scoliodon – Detailed study. Scales in fishes, Parental care in fishes. Dipnoi.
- c. **Amphibia**– Origin of Amphibia. Type study – Frog: Externals, digestive, respiratory, skeletal, nervous system, circulatory, excretory and reproductive system. Metamorphosis. Parental care.
- d. **Reptilia**- General characters and classification. Evolution of Arcades and Fossae and its significance, Chelonia, Rhynchocephalia, Crocodilia and Squamata. Poisonous and Non-poisonous snakes, snake venom – types and composition and importance. Poison apparatus.
- e. **Aves** - General characters and classification. Salient features of Archaeornithes and Neornithes. Paleognathae, Neognathae and Impennae. Palate in birds. Foot and beak in birds. Migration in birds.
- f. **Mammals** - General characters and classification. Prototheria, Metatheria, Eutheria –orders Cetacea, Chiroptera, Carnivora, Rodentia, Proboscidea, Artiodactyla. Perisodactyla and Primata. Dentition in Mammals. Type study – Rabbit: Externals, digestive, respiratory, circulatory and Urinogenital system.
- g. **Comparative anatomy of Vertebrates.**
Skeletal system – Skull, Vertebrae, Girdles and limb skeleton.
Circulatory system – Heart and aortic arches.
Comparative anatomy of Vertebrates.
Nervous system – Brain, Cranial nerves, Spinal nerves and Sense organs.
Urinogenital system – Evolution of Kidney and reproductive ducts.
- h. **Adaptations** – Aquatic, arboreal, Volant and desert adaptations. Coloration and mimicry.
- i. **Zoogeography** – Zoogeographical realms – Major fauna and flora.
- j. **Economic Zoology**-Vermiculture, Apiculture, Sericulture, Aquaculture, Dairy and Poultry.

VII. PHYSIOLOGY OF ANIMAL SYSTEMS:

- a. **Histology of Mammalian organs** – Skin, Lung, Liver, Spleen, Pancreas, Stomach, Intestine, Kidney, Pituitary, Thyroid, Adrenal, Testis and Ovary. Hormones of Pituitary, Thyroid, Adrenal, Pancreas, Testis and Ovary and their role.
- b. **Digestive system**- Digestion, absorption, Ruminant digestion. Role of GI hormones, energy balance, BMR, digestive disorders.
- c. **Blood and circulation**- Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, hemoglobin, immunity,

haemostasis. Myogenic and neurogenic hearts, Systemic and pulmonary circulation, ECG, Echocardiogram and disorders of cardiac system.

- d. **Muscular System**-Types of Muscles. Ultra structure of skeletal muscle, contractile and regulatory proteins. Mechanism of Muscle contraction. Neuromuscular junction and relaxation. Rigor Mortis, Muscle fatigue, Muscular dystrophies.
- e. **Respiratory system**- Comparison of respiration in different species, anatomical considerations, transport and exchange of gases, neural and chemical regulation of respiration, disorders of respiratory system.
- f. **Nervous system**- Neurons and glial cells, action potential, synapse, neurotransmitters, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture, EEG and disorders of nervous system, neuropeptides. Sense organs- Olfaction, Vision, hearing and tactile response.
- g. **Excretory system** - Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance, kidney failure and dialysis.
- h. **Thermoregulation**- Comfort zone, body temperature-physical, chemical, neural regulation, acclimatization. Stress and adaptation- free radicals and harmful effects, antioxidants and their role.
- i. **Endocrinology and reproduction**- Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, gametogenesis, ovulation, neuroendocrine regulation.

VIII. ECOLOGICAL PRINCIPLES

- a. **Abiotic and biotic interactions**-habitat and niche, species interactions-competition, herbivory, carnivory, pollination, symbiosis.
- b. **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.
- c. **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, estuarine). Ecological succession-types; mechanisms; changes involved in succession; concept of climax.
- d. **Community Ecology**- Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
- e. **Biogeography**- Major terrestrial biomes; theory of island biogeography; bio-geographical zones of India.

- f. **Applied Ecology- Environmental pollution**-sources, effects and control of air, water soil and sound pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.
- g. **Current environmental issues**- Green house effect and global warming, acid rain, ozone layer depletion.
- h. **Conservation Biology**- Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

IX. EVOLUTION AND BEHAVIOUR

- a. **Lamarckism; Darwinism and Neo-Darwinism** –concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis.
- b. **Chemical evolution of life**- contribution of Oparin and Haldane, Miller's experiment; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; anaerobic metabolism, photosynthesis and aerobic metabolism.
- c. **Paleontology and Evolutionary history**- Evolutionary time scale; Eras, periods and epochs; stages; evolution of horse and Homo sapiens.
- d. **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.
- e. **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; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution.
- f. **Animal behavior**: Innate behavior- taxes, reflexes, instincts and motivation, learnt behavior- habituation, imprinting, conditioned reflexes and insight learning.
- g. **Brain, Behavior and Evolution**-Approaches and methods in 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.
- h. **Biological clocks**- Development of behavior; Social behavior in insects and monkeys; 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.

X. TECHNIQUES IN BIOLOGY-

- a. **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.
- b. **Statistical Methods**-Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance; Regression and Correlation; t-test; Analysis of variance; X² test; Basic introduction to Multivariate statistics etc.
- c. **Radio labeling 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.
- d. **Microscopic techniques**- Visualization of cells and sub cellular 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.
- e. **Electrophysiological methods**- Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT.
- f. **Histochemical and Immunotechniques**- Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, fluocytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.