

**Syllabus for the post of Assistant Professor (College Cadre) in the Subject
of Zoology (Advt. No.67/2024)**

1. Molecules and their Interaction Relevant to Biology
2. Cellular Organization
3. Fundamental Processes
4. Cell Communication and Cell Signaling
5. Developmental Biology
6. System Physiology– Animal
7. Inheritance Biology
8. Diversity of Life Forms
9. Ecological Principles
10. Evolution and Behavior
11. Applied Zoology
12. Methods in Biology


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1. MOLECULES AND THEIR INTERACTION RELEVANT TO BIOLOGY

- A. Structure of atoms, molecules and chemical bonds.
- B. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).
- C. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).
- D. Bioenergetics, glycolysis, oxidative phosphorylation.
- E. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes
- F. Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).
- G. Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).
- H. Stability of proteins and nucleic acids.
- I. Metabolism of carbohydrates, lipids, amino acids and nucleotides.

2 CELLULAR ORGANIZATION

A) Membrane structure and function

(Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membrane.

Structural organization and function of intracellular organelles

Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, vacuoles, structure & function of cytoskeleton and its role in motility, Structure and functions of Cilia and flagella

B) Organization of genes and chromosomes

Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons.

C) Cell division and cell cycle : Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.

3. FUNDAMENTAL PROCESSES

A) DNA replication, repair and recombination : Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication,


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extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination.

- B) **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, 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) **Control of gene expression at transcription and translation level** (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

4. Cell communication and cell signaling

- A) **Cell signaling** : Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways.
- B) **Cellular communication**: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.
- C) **Cancer**
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.
- D) **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 effector functions, inflammation, hypersensitivity and

autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines.

5. DEVELOPMENTAL BIOLOGY

- A) **Basic concepts of development:** Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; cytoplasmic determinants.
- B) **Gametogenesis, fertilization and early development:** Production of gametes, cell surface molecules in sperm-egg recognition in animals; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals.
- C) **Morphogenesis and organogenesis in animals :** Axes and pattern formation in *Drosophila*, Amphibia and Chick. Eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.
- D) **Programmed cell death, ageing and senescence.**

6. SYSTEM PHYSIOLOGY - ANIMAL

- A. **Blood and circulation** - Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis.
- B. **Cardiovascular System:** Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.
- C. **Respiratory system** - Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.
- D. **Nervous system** - Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture.


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- E. **Sense organs** - Vision, hearing and tactile response.
- F. **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.
- G. **Thermoregulation** - body temperature – physical, chemical, neural regulation, acclimatization.
- H. **Stress and adaptation**
- I. **Digestive system** - Digestion, absorption, energy balance, BMR.
- J. **Endocrinology and reproduction** - Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, gametogenesis, ovulation, neuroendocrine regulation.

7. INHERITANCE BIOLOGY

- A) **Mendelian principles** :Dominance, segregation, independent assortment.
- B) **Concept of gene** :Allele, multiple alleles, pseudoallele, complementation tests
- C) **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.
- D) **Gene mapping methods** :Linkage maps, tetrad analysis, mapping with molecular markers.
- E) **Extra chromosomal inheritance** :Inheritance of Mitochondrial genes and maternal inheritance.
- F) **Human genetics** :Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.
- G) **Quantitative genetics** :Polygenic inheritance, heritability and its measurements.
- H) **Mutation** :Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.

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- I) **Structural and numerical alterations of chromosomes** :Deletion, duplication, inversion, translocation, ploidy and their genetic implications.
- J) **Recombination** :Homologous and non-homologous recombination including transposition.

8 DIVERSITY OF ANIMALS

A. **Principles & methods of taxonomy:**

Concepts of species and hierarchical taxa, biological nomenclature, classical & quantitative methods of taxonomy of animals.

B. **Levels of structural organization:**

Unicellular, colonial and multicellular forms, Levels of organization of tissues, organs & systems, adaptive radiation, adaptive modifications.

C. **Classification of Animals:**

Classification of animals, Study of Non-Chordates and Chordates, Important criteria used for classification in each taxon.

D. **Natural history of Indian subcontinent:**

Major habitat types of the subcontinent, geographic origins and migrations of species. Common Indian mammals, birds.

E. **Organisms of health & agricultural importance:** Common parasites and pathogens of humans and crops.

F. **Organisms of conservation concern:**

Rare, endangered species, Conservation strategies.

9. ECOLOGICAL PRINCIPLES

The Environment: Physical environment; biotic environment; biotic and abiotic interactions.

Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.


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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 competition, herbivory, carnivory, pollination, symbiosis.

Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.

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).

Applied Ecology: Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.

Conservation Biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

10. **EVOLUTION AND BEHAVIOUR**

A. **Emergence of evolutionary thoughts**

Lamarck; Darwin—concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis.

B. **Origin of cells and unicellular evolution:**

Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellulareukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.


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C. Paleontology and Evolutionary History:

Approaches and methods in study of behavior; Altruism and evolution-Group selection, Kin selection, Reciprocal altruism; Neural basis. The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major group of animals; Stages in primate evolution including *Homo sapiens*.

D. Molecular 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. The Mechanisms:

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 behaviour; Convergent evolution; Sexual selection; Co-evolution.

F. Brain, Behavior and Evolution:

Concept 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; Migration, orientation and navigation; Domestication and behavioral changes.


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11. **APPLIED ZOOLOGY:**

- A. Application of immunological principles, vaccines, diagnostics. Tissue and cell culture methods for animals.
- B. Transgenic animals, molecular approaches to diagnosis and strain identification.
- C. Genomics and its application to health and agriculture, including gene therapy.
- D. Bioresource and uses of biodiversity.
- E. Breeding in animals- Methods and Techniques.
- F. Integrated Pest Management, Sericulture, Apiculture and Aquaculture
- G. Bioremediation

12. **METHODS IN BIOLOGY**

A. **Molecular Biology and Recombinant DNA methods:**

Isolation and purification of RNA , DNA (genomic and plasmid) and proteins, different separation methods.

Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, Isoelectric focusing gels.

Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Isolation of specific nucleic acid sequences

Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors.

Protein sequencing methods, detection of post translation modification of proteins.

DNA sequencing methods, strategies for genome sequencing.

Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques

Isolation, separation and analysis of carbohydrate and lipid molecules RFLP, RAPD and AFLP techniques, ELISA, western blot, FISH and GISH.


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D 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; z-test and Analysis of variance.

E. Microscopic techniques:

Light and electron microscopy (SEM and TEM)


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