

Ph.D. entrance test in Zoology, University of Calcutta

Total marks: 50; Short answer type questions; Time: 1 hr.

SYLLABUS

1. DIVERSITY OF LIFE FORMS

- A. **Principles and methods of taxonomy:** Concepts of species and hierarchical taxa, biological nomenclature, classical and quantitative methods of taxonomy of animals.
- B. **Outline classification of animals and microorganisms:** Important criteria used for classification in each taxon, evolutionary relationships among taxa.
- C. **Natural history of Indian subcontinent:** Major habitat types of subcontinent, geographic origins and migrations of species; common Indian mammals, birds.

2. SYSTEM ANATOMY & PHYSIOLOGY

- A. **Blood and circulation:** Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis, haemopoiesis.
- B. **Cardiovascular System:** Comparative anatomy of heart structure, Heart and circulation in foetal and neonatal mammal, cardiac cycle and blood pressure.
- C. **Respiratory system:** Respiratory pigments in animals, Comparison of respiration in different nonchordate species, Ventilatory mechanisms in chordates, transport of gases, exchange of gases, waste elimination.
- D. **Nervous system:** Neurons, action potential, gross neuroanatomy of the brain and spinal cord, Neurotransmitters, neurohormones and neuromodulators.
- E. **Sensory system :** Receptor system and sensory perception in insects, Phototransduction in compound and vertebrate eye.
- F. **Excretory system:** Excretory structure and functions in Annelids and Insects. Ultrastructure of kidney, Juxtaglomerular apparatus, urine formation.
- G. **Thermoregulation:** Heat transfer between animal and environment, Poikilothermy and Homeothermy, Physiological adjustment in extreme environmental conditions, acclimatization.
- H. **Digestive system:** Digestion, absorption; Types and mode of feeding in Protozoa, insects and molluscs, filter feeding in protochordates.
- I. **Endocrinology and reproduction:** Endocrine glands, reproductive processes, neuroendocrine regulation.

3. EVOLUTION AND BEHAVIOUR

- A. **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 and

modifications; isolating mechanisms; speciation; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution.

- B. **Brain, Behavior and Evolution:** Approaches and methods in study of behavior; proximate and ultimate causation; altruism and evolution-group selection, kin selection, reciprocal altruism; biological clocks; development of behavior; mate selection and mating strategies; parental investment and reproductive success; parental care; aggressive behavior; habitat selection and optimality in foraging; migration, orientation and navigation.

4. ECOLOGICAL PRINCIPLES

- A. **Habitat and niche:** Niche width and overlap; resource partitioning; character displacement.
- B. **Population ecology:** Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation.
- C. **Species interactions:** Types of interactions, interspecific competition, herbivory and carnivory.
- D. **Community ecology:** Levels of species diversity and its measurement; edges and ecotones; theory of island biogeography.
- E. **Ecosystem:** Energy flow and mineral cycling (CNP); productivity and its measurements; structure and function of some Indian ecosystems (tropical rainforest, mangroves and wetlands).
- F. **Applied ecology:** Environmental pollution, eutrophication, acid rains, global warming. Biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.
- G. **Conservation biology:** Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves). Reasons for wildlife depletion in India. Stochastic perturbations- environmental, Demographic, spatial and genetic stochasticity, Minimum viable populations & recovery strategies for threatened species.

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; 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; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis.
- C. **Morphogenesis and organogenesis in animals:** axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis eye lens induction, limb development and regeneration in vertebrates; post embryonic development-larval formation, metamorphosis.

6. INHERITANCE BIOLOGY

- A. **Concept of gene:** Allele, multiple alleles, pseudoallele, complementation tests.
- B. **Mendelian principles and applications:** Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, sex linkage, sex limited and sex influenced characters.
- C. **Gene mapping methods:** Linkage maps, mapping with molecular markers, mapping by using somatic cell hybrids.
- D. **Human genetics:** Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders (Thalassemia and Haemophilia).
- E. **Mutation:** Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal versus somatic mutants, insertional mutagenesis.
- F. **Structural and numerical alterations of chromosomes:** Deletion, duplication, inversion, translocation, ploidy and their genetic implications.
- G. **Recombination:** Homologous and non-homologous recombination, including transposition, site-specific recombination.

7. CELLULAR ORGANIZATION

- A. **Membrane structure and function:** Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.
- B. **Structural organization and function of intracellular organelles:** nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes.
- C. **Organization of genes and chromosomes:** Operon, interrupted genes, gene heterochromatin, euchromatin, transposons.
- D. **Cell division and cell cycle:** Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle.

8. FUNDAMENTAL PROCESSES

- A. **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.
- B. **RNA synthesis and processing:** Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, 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, translational proof-reading, translational inhibitors, post-translational modification of proteins.

9. MOLECULES AND THEIR INTERACTION

- A. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).
- B. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.
- C. Metabolism of carbohydrates, lipids, amino acids.

10. CELL COMMUNICATION AND CELL SIGNALING

- A. **Host parasite interaction:** Recognition and entry processes of different pathogens like bacteria, viruses and parasites, pathogen-induced diseases in animals.
- B. **Cell signaling:** Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways and apoptosis.
- C. **Cellular communication:** General principles of cell communication, cell adhesion, gap junctions, extra cellular matrix.
- 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.

11. APPLIED BIOLOGY:

- A. Parasites and pests.
- B. Transgenic animals, hybridization and polyploidy in fish, Vermiculture and vermicomposting, raceways culture of fish.
- C. Genomics and its application to health and agriculture, including gene therapy.
- D. Bioremediation and phytoremediation.
- E. Bioassay and Biosensors in ecotoxicological screening.