Department of Zoology

(DST-FIST Funded)

School of Biosciences and Biotechnology
Baba Ghulam Shah Badshah University
Rajouri (J&K)-185234

Syllabus & Sample Questions of Entrance Test for Admission to Ph. D programme in Zoology-2023

Section-I

1. Animal Diversity and Taxonomy

- Diversity and classification of animals; theories of classification, phonetic and cladistic approaches to classification, classification and phylogeny.
- Zoogeography – concepts and importance, Zoogeographical regions of India and their characteristic fauna.
- Variation and taxonomy: continuous and discontinuous variation; intra- and inter-population, and intra- and inter-specific variation; developmental, environmental and genetic variation.
- Museums- concept, procedures and role; zoos and Zoological Parks- concept and role; major Indian museums and zoos; Zoological Survey of India (ZSI) - brief history, organization and role.
- Molecular taxonomy: modern trends, achievements made in animal taxonomy using different molecular markers.
- International Code of Zoological Nomenclature (ICZN) – objectives, brief history, operative principles, criteria of publication and availability.
- Species concept; taxonomic, biological, evolutionary and phylogenetic species concept
- Levels of structural organization: Unicellular, colonial and multicellular forms, levels of organization of tissues, organs & systems, comparative anatomy, adaptive radiation, adaptive modifications.
- Outline classification of animals & microorganisms: Important criteria used for classification in each taxon, classification of animals and microorganisms, evolutionary relationships among taxa.

2. Viruses and Bacteria

- General characteristics; origin and nature; ultrastructure; chemical nature; virus like agents: virions, viroids, prions- structure and importance.
- Classification of viruses and basis of classification.
- Isolation and purification of viruses, viral life cycle with special reference to HIV, TMV and M13; mechanism of viral nucleic acid replication; differences between DNA and RNA viruses.
- Viral transmission (general account) with emphasis on transmission through cell sap in plants and blood in humans.
- Bacterial classification and its basis; International Code of Nomenclature for Bacteria- salient features.

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- Archaebacteria, cynobacteria and eubacteria: diversity of form, ultra structure of cell and cell wall.
- Modes of bacterial reproduction and recombination: asexual and sexual: conjugation, transformation and transduction.

3. Invertebrates: Structure and Function

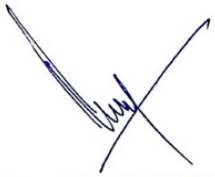
- Organization of coelom: Acoelomates, pseudocoelomates, protostomia and deurerostomia.
- Locomotion: Flagellar and ciliary movement.
- Nutrition in protozoa.
- Filter feeding in polychaetes, mollusca and echinodermata.
- Organs of respiration: Gills, lungs and trachea.
- Organs of excretion: Coelom, coelomoducts, nephredia malphigian tubules.
- Excretion and osmoregulation in invertebrates

4. Vertebrates: Structure and Function

- Origin and concepts of protochordates, affitinities of protochordates
- Vertebrate integument and its derivatives.
- Blood composition and function, evolution of heart, evolution of aortic arches, single circulation and double circulation.
- Internal and external respiration
- Evolution of urinogenital system in vertebrates
- Comparative anatomy of brain and spinal cord.
- Sense organ: Mechanoreceptors, photoreceptors, phonoreceptors.

5. Cell Organisation and Function

- Cell theory, structural organization and function of intracellular organelles (nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, structure & function of cytoskeleton and its role in motility, extracellular matrix).
- Cell division and cell cycle (mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle).
- Protein sorting, protein targeting, glycosylation, cellular signalling, hormones,
- Membrane composition, structure and function, structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, transport across membranes, membrane pumps, mechanism of sorting and regulation of intracellular transport, membrane permeability, electrical properties of membranes, molecular assembly of biomembranes, membrane pores, membrane receptors, endocytosis and cell signalling.
- Organization of genes and chromosomes; structure of chromatin and chromosomes, heterochromatin, euchromatin and telomeres.

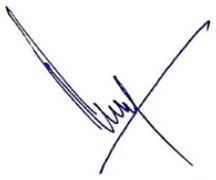


6. Fundamental Processes

- 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, structure and function of different types of RNA, RNA transport.
- 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 and gene silencing.

7. System Physiology – Animal

- Blood and circulation: Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis.
- 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.
- Respiratory system: Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.
- 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.
- Sense organs: Vision, hearing and tactile response.
- 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.
- Thermoregulation: Comfort zone, body temperature; physical, chemical, neural regulation, acclimatization.
- Digestive system: Digestion, absorption, energy balance, BMR.
- Endocrinology and reproduction: Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, gametogenesis, ovulation, neuroendocrine regulation.



8. 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.
- Extra chromosomal inheritance: Inheritance of mitochondrial 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.
- 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.

9. Developmental Biology

- 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.
- 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.
- Organogenesis in animals: Cell aggregation and differentiation in *Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*, 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.

- Programmed cell death, aging and senescence

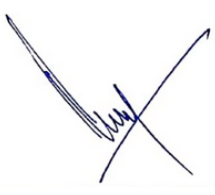
10. Immune System

- Cells and molecules involved in innate and adaptive immunity, haematopoiesis 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.
- Immune modulation, the complement system, toll-like receptors, cell-mediated effector functions.
- Inflammation, cytokines, hypersensitivity and autoimmunity, immune response during bacterial, parasitic and viral infections, microbial pathogenicity, principles of diagnostics, immunodeficiencies, vaccines, tumor antigens and cancer immunotherapy.

11. 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.
- 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.
- Conservation Biology: Principles of conservation, major conservation strategies, Indian case studies on conservation/management strategy (Project Tiger, Biosphere Reserves), threatened animal species.

12. Evolution and Behaviour



- Emergence of evolutionary thoughts: Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; 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; experiment of Miller (1953); the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; anaerobic metabolism, photosynthesis and aerobic metabolism.
- Palaeontology and Evolutionary History: The evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale; origins of unicellular and multi cellular organisms; major groups of plants and animals; stages in primate evolution including Homo.
- 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.
- 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; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution.
- Brain, Behaviour and Evolution: Approaches and methods in study of behaviour; 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 behaviour; social communication; social dominance; use of space and territoriality; mating systems, parental investment and reproductive success; parental care; aggressive behaviour; habitat selection and optimality in foraging; migration, orientation and navigation; domestication and behavioural changes.

SECTION II

1. Survey, documentation, techniques and identification

- Methods of survey: introduction, planning, types, advantages and disadvantages.
- Traditional approaches: sampling methods, RRA (Rapid Rural Appraisal), PRA (Participatory Rural Appraisal).
- Geographical Information System (GIS): introduction. Scope, history, components, functions, advantages and limitations.
- Remote sensing: concepts and its applications in resource management.
- Bio-repository: concept and scope.

2. Molecules and their Interaction

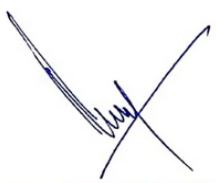
- Structure of atoms, molecules and chemical bonds.
- Composition, structure, metabolism and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).
- Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).
- Principles 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
- Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).
- Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).
- Stability of proteins and nucleic acids.

3. Microscopy and its Applications

- Principles and application of light, bright field, phase contrast, fluorescence, scanning and transmission electron microscopy
- Different fixation and staining techniques for EM, freeze-etech and freeze fracture methods for EM, live cell imaging and its applications.

4. Chromatography and Centrifugation

- Types of chromatography; thin layer, column and gas chromatography and high performance liquid chromatography (HPLC).



- Principles and application of gel filtration, ion exchange and affinity chromatography.
- Centrifugation- principles of working, types of centrifuges, differential and density gradient centrifugation.

5. **Electrophoresis and Spectroscopy**

- Principle of electrophoresis, different types of electrophoresis, support media (agarose and polyacrylamide gel).
- SDS-PAGE, IEF, 2D electrophoresis, detection, estimation and recovery of protein from gels.
- Agarose electrophoresis of DNA, DNA sequencing gels, pulse field gel electrophoresis (PFGE), electrophoresis of RNA.
- Principles of spectroscopy and its application in biological research, Mass spectroscopy- LC-MS, GC-MS and MALDI-TOF.

6. **Molecular Biology and Recombinant DNA Methods**

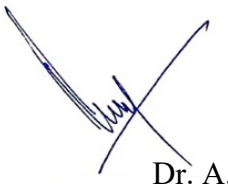
- Isolation and purification of RNA , DNA (genomic and plasmid) and proteins,
- Different separation methods, analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, Isoelectric focusing gels.
- Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems.
- Expression of recombinant proteins using bacterial, animal and plant vectors. Isolation of specific nucleic acid sequences.
- Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors, In vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms.
- 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

7. **Histochemical and Immunological Techniques**

- Monoclonal and polyclonal antibodies generation.
- Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy
- Detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.

8. Statistical Methods

- Statistical application- mean, median, mode, mean deviation and standard deviation, chi square test, z test, t test, two sample t test and paired t test.
- Primary and secondary data, pictorial representation of data, Frequency distribution, classification of data.
- Histograms, frequency polygons, cumulative frequency curves, polygraphs and limitation of graph, 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; analysis of variance; X^2 test, basic introduction to Muetrovariate statistics, etc.



Dr. A. A. Shah
Head
Deaprtment of Zoology

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Sample Questions

1. The largest zoogeographical region of India is

A. Deccan Plateau
B. Gangetic Plain
C. Western Ghat
D. Himalayan zone

2. The three germ layers, namely ectoderm, endoderm and mesoderm are found in

A. All the chordates only
B. All the chordates except the protochordates
C. All the chordates and higher invertebrates
D. Higher chordates and higher invertebrates.

3. If 3 Na^+ ions pumped out of cell and 2 K^+ pumped in to cell then number of ATP molecules hydrolyzed are

A. 1
B. 2
C. 3
D. 4

4. Two amino acids of the standard 20, contain sulphur atoms. They are

A. cysteine and serine
B. cysteine and threonine
C. methionine and cysteine
D. methionine and serine.

5. In electrophoresis, DNA will migrate towards

A. cathode or positive electrode
B. anode or negative electrode
C. cathode or negative electrode
D. anode or positive electrode.

6. Which of the following statement is true

A. a vector should have an origin of replication
B. a vector should have selectable markers
C. a vector should have unique restriction sites
D. all of these

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