

Admission to Ph.D. Programme in Zoology
DEPARTMENT OF ZOOLOGY
Calcutta University

Applications are invited for admission to Ph.D. programme in Zoology from candidates who have a Master's degree in Zoology or any other qualification considered equivalent thereto. The eligible candidates will take Research Eligibility Test as per the following schedule:

Date of admission test:	1 March, 2016 (Tuesday)
Date of interview:	9 March, 2016 (Wednesday)
Venue:	Dept. of Zoology, University of Calcutta, 35 Ballygunge Circular Road, Kolkata – 700 019.

The names of successful candidates (eligible for interview) will be displayed on the Notice Board of the Department on 7th March, 2016. No candidate will be intimated individually. The interview will be held on 9th March (11:30 a.m. onwards) at the Department of Zoology. Candidates who have qualified M. Phil. /NET/GATE in any branch of Life Sciences are exempted from the written examination and will need to appear at the interview only.

Application forms are to be downloaded from the C.U. website and filled in forms are to be submitted at the office of the Dept. of Zoology after payment of Rs.100/- (Rupees one hundred) only at the C.U. cash counter. The form and challan needs to be signed by the Head, Dept. of Zoology. Last date of submission of forms is **25 February, 2016 (Thursday)**.

Candidates may note the following:

- (A) The syllabus for the written examination is available in the website.
- (B) **Number of vacancies is 35 (Thirty five)**
- (C) The policy of reservation will apply in accordance with the power conferred by subsection (1) of section 8 of the W.B. State Higher Educational Institutions (Reservation in Admission) Act 2013 (West Ben Act X of 2013).

Head, Dept of Zoology
University of Calcutta

SYLLABUS
For
PhD entrance test in Zoology, University of Calcutta

1. 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. Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds).
- D. Conformation of nucleic acids (A-, B-, Z-, DNA), t-RNA, micro-RNA).
- E. Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins.

2. 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 families, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, transposons.
- D. **Cell division and cell cycle:** Mitosis and meiosis, their regulation, steps in cell cycle, 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, 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.
- D. **Control of gene expression at transcription and translation level:** Regulation of phages, viruses, prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression and gene silencing.

4. CELL COMMUNICATION AND CELL SIGNALING

- A. Host parasite interaction:** Recognition and entry processes of different pathogens like bacteria, viruses into animal cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, 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.
- C. 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.
- D. 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.
- E. 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; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.
- B. Embryonic stem cells :** Embryonic stem cells; Stem cell niches ; genetic equivalence and the cytoplasmic determinants.
- C. 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,
- D. Morphogenesis and organogenesis in animals:** axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis 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.
- E. Ageing and Senescence:** Mitochondrial control of ageing, insulin pathway control of ageing, Senescence and cell death.

6. 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, 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:** 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, central and peripheral nervous system, neural control of muscle tone and posture. 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. 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:** Heat transfer between animal and environment, Poikilothermy and Homeothermy, Physiological adjustment in extreme environmental conditions, acclimatization.
- H. Digestive system:** Digestion, absorption, energy balance, BMR.
- I. Endocrinology and reproduction:** Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, neuroendocrine regulation.
- J. Animal Behaviour :** Pheromones in colonial interactions, foraging and mating

7. INHERITANCE BIOLOGY

- A. Mendelian principles:** Dominance, segregation, independent assortment, deviation from Mendelian inheritance.
- 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, mapping by using somatic cell hybrids, development of mapping population in plants.
- E. Human genetics:** Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.
- F. Quantitative genetics:** Polygenic inheritance, heritability and its measurements, QTL mapping.

- G. Mutation:** Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal versus somatic mutants, insertional mutagenesis.
- H. Structural and numerical alterations of chromosomes:** Deletion, duplication, inversion, translocation, ploidy and their genetic implications.
- I. Recombination:** Homologous and non-homologous recombination, including transposition, site-specific recombination.

8. 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 the subcontinent, geographic origins and migrations of species; common Indian mammals, birds; seasonality and phenology of the subcontinent.
- D. Organisms of health and agricultural importance:** Common parasites and pathogens of humans, domestic animals and crops.

9. ECOLOGICAL PRINCIPLES

- A. Habitat and niche:** Concept of habitat and niche; niche width and overlap; fundamental and realized niche; 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 – demes and dispersal, interdemographic extinctions, age structured populations.
- C. Species interactions:** Types of interactions, interspecific competition, herbivory, carnivory, symbiosis.
- D. Community ecology:** Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
- E. Ecological succession:** Types; mechanisms; changes involved in succession; concept of climax.
- F. Ecosystem:** Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine).
- G. Biogeography:** Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.
- H. Applied ecology:** Environmental pollution, eutrophication, acid rains, global warming. Biodiversity – status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.
- I. 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.

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 unicellular eukaryotes; anaerobic metabolism, photosynthesis and aerobic metabolism.
- C. 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.
- D. 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.
- E. 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; 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.

11. APPLIED BIOLOGY:

- A.** Application of immunological principles (vaccines, diagnostics). Tissue and cell culture methods for animals.
- B.** Transgenic animals, hybridization & polyploidy in fish, Vermiculture & 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.
- F.** Drug delivery and targeting

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; expression of recombinant proteins using bacterial and animal 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 analysis, such as micro array based techniques; isolation, separation and analysis of carbohydrate and lipid molecules; RFLP, RAPD and AFLP techniques

- B. Histochemical and immunotechniques:** Antibody 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.
- C. Biophysical methods:** Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, structure determination using X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.
- D. 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.
- E. 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.
- F. Electrophysiological methods:** Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT.
- G. Methods in field biology:** Methods of estimating population density of animals, ranging patterns through direct, indirect and remote observations, sampling methods in the study of behavior, habitat characterization-ground and remote sensing methods.