Paper II
Zoology
(Subjective)

Pre Ph.D. Admission Test, 2019

ZOOLOGY

PAPER – II
(Subjective)

Full Mark 100

Time: 2 hrs.

Questions are to be set in **Three** groups representing all the units. **Group A** will consist of a total of ***eight*** short answers type questions (***Five*** to be answered each of **six marks**, in approximately **150** words). **Group B** will consist of a total of ***seven*** questions (***Four*** to be answered each of **ten marks**, in approximately **200** words). **Group C** will consists of a total of ***four*** questions (***Two*** to be answered each of **fifteen marks**, in approximately **500** words).

UNIT - 1

Functional Biology:

- Organization of coelom and its significance
- Patterns of feeding and digestion in invertebrates and vertebrates
- Respiratory pigments
- Organs and Mechanism of Respiration in Invertebrates: Gills, Lungs and Trachea
- Organs and of Mechanism of Respiration in Vertebrates: Gills, ARO and Lungs
- Principles of gaseous exchange and Fick's modified equation
- Transport of gases in blood and body fluid
- Regulation of respiration (Neural and chemical control)
- Respiratory adaptations at higher altitude and in diving mammals
- Patterns of nitrogenous excretion in different phylogenetic groups
- Organs of excretion: Coelomoducts, nephridia, Malpighian tubules and kidney
- Mechanism of osmoregulation and excretion in aquatic (freshwater and marine) and terrestrial animals
- Mechanism of acid-base balance
- Thermoregulation in vertebrates
- Mechanism of energetic of muscle contraction (Skeletal)
- Physiology of electrical and synaptical transmitters in neurons
- Neurotransmitters and their functions
- Acoustico-lateral system and electroreception in aquatic vertebrates

UNIT – 2

Cell Biology:

Bio membrane:

- Molecular composition, arrangement and functional consequences
- Models of bio-membrane
- Transport across bio-membrane: diffusion, active transport and membrane pumps (P-type pump, V- type pump and ABC transporter)

- Cotransport by symporters and antiporters

Cytoskeleton:
- Microtubules and microfilaments: structure and dynamics
- Role of Kinesin and Dynein in intracellular transport
- Axonal-transport and cell movement (with respect to non-muscle motility)

DNA replication:
- Outline of prokaryotic replication
- Replication features of single stranded phages
- Mechanism and machinery of replication in eukaryotes
- DNA damage and repair mechanisms

Transcription:
- Outline mechanism of prokaryotic transcription
- Organization of eukaryotic transcription machinery
- General and specific transcription factors
- Regulatory elements & DNA binding domains of transcription apparatus
- Processing of primary transcript & RNA editing in eukaryotes

Translation:
- Genetic code: Codon assignment and features
- Outline of Prokaryotic translation
- Eukaryotes translation: machinery (Ribosome & t RNA)
- Eukaryotes translation: mechanism (initiation, elongation and termination)

Intra cellular protein trafficking:
- Targeting proteins to ER: Signal hypothesis
- Co- and post - translational modifications of proteins
- Trafficking mechanisms: Vesicular transport, Protein sorting, Endocytosis and exocytosis

UNIT – 3

Genetics:

Organization of Chromosomes:
- Organization of prokaryotic chromosomes
- Organization of eukaryotic chromosome: Nucleosome as functional particle, 30 nm chromatin fiber, higher order structure of chromatin
- Organization of centromere and kinetochore, organization of telomere and its maintenance
- Heterochromatin: Types, organization, formation and significance
- Structural organization and functional significance of polytene and Lampbrush chromosomes.

Microbial genetics:
- Transformation, conjugation, transduction and sex-duction in bacteria
- Construction of linkage map in bacteria
- Molecular mechanism of recombination

Cell cycle:
- Stages and check points in cell cycle
- Genetics of cell cycle regulation: Role of cyclins and CDKs
- Molecular basis of cellular check points

Sex determination and dosage compensation:

- Genetic and Molecular basis of sex determination in *C. elegans*, *Drosophila* and human
- Genetic basis of dosage compensation in *C. elegans*, *Drosophila* and mammals

Techniques & Methods in genetics:

- DNA sequencing: Base destruction method, chain termination method and automated sequencing, Pyro- sequencing and whole genome short-gun sequencing
- DNA amplification: Polymerase chain reaction, its application and limitations.
- DNA finger printing: VNTR profiling, STR profiling (Autosomal & Y chromosome), mitochondrial DNA profiling and SNP profiling
- Genome expression analysis: Southern, Northern & Western blotting, Reverse Transcription PCR, DNA micro array

UNIT – 4

Biochemistry:

Bioenergetics:

- Laws of thermodynamics, internal energy, enthalpy, entropy
- Concept of free energy, redox potential, energy rich compounds
- Mitochondrial electron transport chain and oxidative phosphorylation

Biochemistry of Carbohydrates:

- Monosaccharides and Disaccharides, Types and properties
- Polysaccharides: Homopolysaccharide and Heteropolysaccharide
- Glycolysis, HMP shunt, Glyconeogenesis and Glycogenolysis

Biochemistry of proteins and lipids:

- Amino acid
- Primary, secondary, tertiary, quaternary and domain structures
- Stabilizing forces in protein structure
- Peptide conformation (Ramachandran plot, helices, turns and sheets)
- Biosynthesis of Urea
- Free fatty acids: Synthesis and importance
- β- Oxidation of long chain fatty acids

Enzyme Biochemistry:

- Enzyme: Classification and nomenclature
- Mechanism of enzyme action
- Kinetics of enzyme catalyzed reaction
- Non-genetic Regulation of enzyme activity: Feedback inhibition, Allosteric inhibition
- Free radicals, Antioxidants and detoxification

UNIT – 5

Endocrinology:

- Aims and scope of endocrinology
- Hormones as messengers

- Chemical nature and gross features of hormones
- Neuro-endocrine system and neurosecretion
- Hypothalemic control of endocrine system
- Hormones involved in reproduction: Seasonal breeders, Continuous breeders
- Hormonal regulation of reproductive cycle: Ovarian cycle, Menstrual cycle, Oestrus cycle
- Biosynthesis of steroid hormones
- Biosynthesis of amino acid derived hormones (T4, Epinephrine)
- Biosynthesis of simple peptide hormones, Pre and Prohormones

Hormone Receptors:

- β- adrenergic receptor
- Insulin receptor
- Steroid hormone receptor

General principles of hormone actions (signal transduction):

- Second messenger concept [G proteins, Nucleotides (cAMP, cGMP), Calcium, Calmodulin, Phospholipids]
- Lipid soluble hormones and intracellular receptor
- Lipid insoluble hormone and intracellular signaling

UNIT – 6

Immunobiology:

Immunity:

- Innate and Acquired Immunology:
  - Cell types of innate and adaptive immunity, Lymphocyte trafficking
  - Phagocytosis and inflammation
- Humoral immunity: β cell activation and differentiation, primary and secondary humoral response
- Cell mediated immunity: T - cell development and T-cell activation, CTL and NK cell mediated immunity

Nature of Antigens:

- Antigenicity and immunogenicity, and the factors influencing it.
- Characteristics of β and T cell epitopes and haptens
- Super antigen and its role in T cell activation
- Antigen processing and presentation
- MHC complex
- Structure and functions of Antibodies: Gross and fine structure, Classes and sub-classes, Antibody mediated effector functions and monoclonal antibodies

Antigen-antibody interaction and Complement system:

- Antibody affinity and antibody avidity
- Precipitation reactions
- Agglutination reactions
- Complement System: activation pathway, biological function and complement deficiencies
- ELISA
- Cytokines: Classification and function, Cytokines receptors.

Organization and expression of Ig genes:

- Organization of Ig genes
- Generation of antibody diversity
- BCR and Generation of T-cell receptor diversity

Immunology and Diseases:

- Hypersensitivity (Type I, II, III, IV).
- Auto-immunity
- Immune responses to infectious agents - bacterial, viral and parasitic infection (Protozoa and Helminth parasites).
- Immunodeficiencies

UNIT – 7

Ethology:

Basics of Animal Behaviour:

- Ethology - Definition, Branches, Significance
- Approaches and methods in the study of Behaviour
- Patterns of Behavior: Innate behavior - Kinases/Taxes, Simple reflex, Comparison of reflex and complex behaviors, Instinct and, Motivation, Learned behavior - Habituation, Imprinting, Conditioned reflex, Trial & error learning, Reasoning and Cognition

Social Behaviour:

- Social behaviour of insects (Honey bees, Ants and termites)
- Schooling in fish, Flocking in birds,
- Social organization of Primates
- Parental care in fishes
- Altruism: Reciprocal altruism, Inclusive fitness, group selection, and Kin- selection

Reproductive Behaviour:

- Evolution of sex and reproductive strategies
- Mating system
- Courtship & Parental Behaviours: Parental care and Parental Investment

Biological Rhythms:

- Circadian, Circannual, Lunar, Tidal and Epicycles
- Navigation including orientation
- Migration of Fishes and Birds

Control of Behaviour:

- Neural control of behaviour
- Hormones and Behavior
- Ecological aspects of behavior: Habitat selection, Optimal foraging theory, and Aggressive behavior

UNIT – 8

Gamete and Developmental Biology:

Gamete Biology:

- Cellular basis of spermatogenesis and Biochemistry of semen
- Ovarian follicular growth and differentiation
- Oogenesis and vitellogenesis

- Ovulation and ovum transport
- Molecular events during fertilization
- (a) Multiple ovulation and Embryo transfer technology:
  - *In vitro* oocyte maturation
  - Super ovulation
  - *In vitro*-fertilization
- (b) Assisted Reproduction technologies:
  - Collection and preservation of gametes

Developmental Biology: ICST, GIFT, ZIFT and Immuno-contraception

Basic concept of development:

- Potency, commitment, specification, induction, competence, determination and differentiation
- Morphogenetic gradients, cell fate and cell lineages, genomic equivalence and cytoplasmic determinants

Differentiation, morphogenesis and organogenesis:

- Cell differentiation: Role of cytoplasm and nucleus
- Gene amplification and rearrangement during development
- Axes and pattern formation in *Drosophila*
- Limb development and regeneration in vertebrates

Stem cell Biology:

- Definition and characteristics of stem cell
- Type of stem cell (embryonic, adult and cancer stem cell)
- Nuclear reprogramming of induced pluripotent stem cell, test for pluripotency
- Potential application of stem cells, therapeutic cloning

UNIT – 9

Environmental Science:

Concept and Dynamics of ecosystem:

- Abiotic factors and Biotic factors.
- Energy flow: (a) Lindemann's rule of trophic dynamics, (b) Energy flow models
- Biogeochemical cycles: Nitrogen, carbon, sulphur and phosphorous cycle
- Hydrological cycles

Principles pertaining to limiting factors:

- Liebig's Law of minimum, Shelford's Law of tolerance
- Concept &Law of limiting factors
- Factors compensation and ecotypes

Population Growth, Predation and Regulation:

- Demography: Life tables, Generation time, Net reproductive rate, Reproductive value
- Population growth: Exponential growth, Verhulst-Pearl logisitic growth model.
- Population regulation extrinsic and intrinsic mechanisms
- Concept of niche, niche width and overlap, fundamental and realized niche, resource partitioning character displacement

Global Environmental Issues:

- Climate Change

- Carbon Footprint
- Water Security - conservation of surface and ground water
- Wildlife conservation: Causes of extinction, National and International efforts for conservation (CITIES, IUCN, CBD), National parks and sanctuaries, Biosphere reserves, Wildlife protection Acts

Pollution Biology:

- Pollutants, their sources and classification
- Causes, effects and control of Water and Air Pollution
- Biomagnification and Eutrophication
- Thermal and Radioactive pollution
- Emerging pollutants: POPs, Pharmaceuticals
- Bio-indicators as index of pollution and their significance

UNIT – 10

Biosystematics and Evolution

Biosystematics:

- Definition & basic concept of Biosystematics and taxonomy, its importance and application in biology
- Hierarchy of categories, outline of classification of animals, important criteria used for classification up to classes in each phylum
- Species concept : Biological and phylogenetic, sub-species and other infra-specific categories, evolutionary relationship among taxa
- International code of Zoological nomenclature (ICZN): operative principles, and important rules, Zoological nomenclature and scientific names of various taxa
- Trends in taxonomy : chemo-taxonomy, cyto-taxonomy and molecular taxonomy

Evolution:

Pattern of genetic variation and natural selection:

- Genetic polymorphisms, variation in chromosome structure, protein structure and nucleotide sequences
- Concept of Natural Selection (Darwinian and Neo- Darwinian), mode of its operation: stabilizing, directional and disruptive modes of Natural Selection

Molecular evolution:

- Variation in the evolution of protein and DNA sequences
- Molecular phylogenies
- Rates of molecular evolution and molecular clock
- Neutral theory of molecular evolution
- Origin of new genes and evolution of multi gene family

Mechanism of speciation:

- Patterns and mechanisms of reproductive isolation and its role in evolution
- Models of speciation : sympatric and allopatric

Population genetics:

- Concept of Gene pool, allele frequency and genotype frequency
- Hardy-Weinberg principle of genetic equilibrium and its mathematical derivation

- Detailed account of destabilizing forces of genetic equilibrium: Natural selection, Mutation, Migration, Meiotic drive, and Genetic Drift

UNIT – 11

Tools and Techniques:

Analytical instruments:

- Principles and uses of analytical instruments: pH meter, colorimeter, Spectrophotometer, Ultra-centrifuge.
- Microscopy: Principles of light, Transmission Electron, Scanning Electron, Fluorescence, Phase-contrast and Confocal Microscopes, Photomicrography.

Separation techniques:

- Electrophoresis: SDS PAGE, Agarose gel electrophoresis;
- Chromatography: Column, GLC, HPLC
- Organelle separation by centrifugation
- Cell separation by flow cytometry and density gradient centrifugation

Immunological techniques:

- Radio- immunoassay (RIA)
- Enzyme-linked Immunosorbent assay (ELISA)

Principles of Histology and Histochemistry:

- General principles of fixation and types of fixatives
- General principles of staining and types of dyes
- General principles of histochemistry: Carbohydrate, Protein, Lipid, Nucleic acids, Enzymes

Biostatistics:

- Basic concepts in Biostatistics (sampling design, data collection and scaling techniques)
- Mean: Arithmetic, Geometric & Harmonic Mean
- Standard Deviation
- Standard Error
- Analysis of Variance (ANOVA)
- Correlation (Karl Pearson and Rank's correlation)
- Regression
- Rules of probability: Binomial, Poission and Normal probability distributions
- Test of Significance: Chi-square test, Student's t-test