

Sardar Patel University, Mandi (H.P.); Syllabus for Ph.D. (Zoology)  
Entrance Examination Session: 2024-25 Onwards

# SYLLABUS

[Entrance Examination]

Programme Branch

Ph.D. [Zoology]

Session:2024-25



Department of Zoology

Sardar Patel University, Mandi

Himachal Pradesh (INDIA), Pin-175001

## **SYLLABUS FOR PH.D.[ZOOLOGY] ENTRANCE EXAMINATION**

### **LIST OF COURSES**

<b>S. NO.</b>	<b>COURSE NAME</b>
1	Biosystematics and Taxonomy
2	Cell and Molecular Biology
3	Biochemistry and Metabolism
4	Tools and Techniques in Biological Sciences
5	Structure and Functions of Invertebrates and Vertebrates
6	Ecology and Environment
7	Cytogenetics and Evolution
8	Biostatistics and Bioinformatics
9	Animal Physiology
10	Protein Structure, Function and Evolution
11	Animal Behaviour
12	Developmental Biology
13	Immunology
14	Applied Zoology

## SYALLABI OF COURSES

S. NO.  
1

COURSE NAME  
BIOSYSTEMATICS AND TAXONOMY

**Trends in Biosystematics-concepts of different conventional and newer aspects**

Ecotaxonomy, Behavioural taxonomy, Cytotaxonomy  
Biochemical taxonomy, Numerical taxonomy

**Species concept and modes of speciation**

Typological species concept, Biological species concept  
Evolutionary species concept, Polytypic & monotypic species,  
subspecies, intraspecific groups, super species and other kind of species.

**Concept of zoological classification**

Theories of biological classification, Components of classification  
Phyletic Lineages, Linnaean hierarchy

**Taxonomic collections, methods & data recording**

Collection methods and data collection  
Preservation and curation  
Methods of identification and problems in identification  
Taxonomic characters and taxonomic keys  
Preparation of taxonomic publication and kinds of publication  
Ethics in publication

**Zoological Nomenclature**

International code of Zoological Nomenclature (ICZN)  
Operative principles and important rules of nomenclature  
Important Latin words & abbreviations and Linnaean Signs

S. NO.

2

COURSE NAME

CELL AND MOLECULAR BIOLOGY

### **Structural Organization of Plant and Animal Cell**

Cell wall: structure, function and biogenesis. Plasma membrane; structure, models, functions, principles of membrane transport; types of carrier proteins and active membrane transport ( $\text{Na}^+$  and  $\text{K}^+$  pump,  $\text{Ca}^{++}$  pump,  $\text{H}^+$  pump); Ion channel membranes. Epithelial and endothelial cells; structure, role comparison with gap junctions, role and functions of cadherins and selectins. Plant vacuole: Tonoplast membrane, ATPases storage organelles; lysosomes and functions of reticulum, Golgi apparatus, to Golgi and then to lysosomes; Molecular basis of endocytosis and exocytosis.

### **Chloroplast and mitochondria**

Structure, genome organization, gene expression, nucleochloroplastic interactions, biogenesis of mitochondria.

### **Nucleus**

Structure, nuclear pores, nucleosome organization, nucleolus.

### **The cytoskeleton**

Organization and role of microtubules and microfilaments, motor movements. Implications in flagellar and other movements.

### **Cell cycle and apoptosis**

Control mechanisms, role of cyclins, cyclin-dependent kinases, cytokinesis and cell plate formation, mechanisms of programmed cell death and its regulation.

### **Cell signaling through**

Protein tyrosine kinase receptors, JAK-STAT, cAMP, MAP kinase, NF- $\kappa$ B signaling pathways; insulin and Integrin signaling.

**Cancer** (progenitor cells, oncogenes, tumor suppressor genes) and therapeutic interventions of uncontrolled cell growth.

### **Gene expression**

Structure and types of DNA; replication, DNA damage and repair. Transcription, promoters and transcription factors, splicing, mRNA transport, rRNA biosynthesis, differences in prokaryotes and eukaryotes. RNA splicing: Nuclear splicing, spliceosome and small nuclear RNAs. Translation; structure of ribosome, mechanism of translation initiation, elongation and termination, structure and role of tRNA.

### **Regulation of gene expression**

In prokaryotes (Run off transcription, Britten-Davidson and Mated models of gene regulation) and eukaryotes.

### **Protein sorting**

Targeting of proteins to organelles.

**S. NO.**

3

**COURSE NAME**

BIOCHEMISTRY AND METABOLISM

**Biomolecules**

Carbohydrates – Monosaccharides, disaccharides and polysaccharides  
Proteins- Classification and structure, Amino acids classification and general characters. Lipids- classification and functions of lipids and fatty acids  
Nucleic acids – purines, pyrimidines, nucleotides, structure of DNA & RNA and types of RNA, Biosynthesis and degradation of purines and pyrimidines.

**Enzymes**

Nomenclature and classification of enzymes, vitamins as co-enzymes; Enzyme Kinetics – Michaelis –Menten equation. Determination of  $V_{max}$  and  $K_m$ , Factors affecting the enzyme activity. Enzyme inhibition – Competitive & non-competitive  
Mechanism of enzyme action – active sites, Chymotrypsin as a model, Regulation of enzyme activity, allosteric enzymes, PFK, ATC (Phosphofructokinase /Aspartate trans carbamylase)

**Bioenergetics**

Basic Principles of thermodynamics free energy, Enthalpy and Entropy. Redox Potential and electron transport. ATP- Production (Chemiosmotic model), high energy phosphates, Coupled reactions

**Metabolism**

Carbohydrate metabolism,- Glycolysis, Krebs cycle, pentose Phosphate pathway, Glycogenesis, Glycogenolysis, Gluconeogenesis, hexomonophosphate shunt. Protein metabolism – Transamination and deamination, incorporation of amino acids into TCA cycle, integration between urea cycle and TCA cycle. Lipid metabolism – fatty acid oxidation and biosynthesis, ketone bodies. Metabolic defects of carbohydrate and amino acid metabolism.

**Secondary Metabolites**

Biosynthesis and function of secondary metabolites phenolics, flavonoids, terpenoids, alkaloids, steroids. Importance of Acetyl Co.A and Shikimic acid in intermediary metabolism.

S. NO.	COURSE NAME
4	TOOLS AND TECHNIQUES IN BIOLOGICAL SCIENCES

### **Instrumentation in Biology**

Centrifugation: Principle and applications of Centrifugation; differential and sedimentation coefficient. Electrophoresis: Principle and applications of chromatography; adsorption, Ion exchange, gel permeation and affinity. Spectrophotometer: Principle, pH meter and applications of Spectrophotometer.

### **Microscopy and Histological techniques in Biology**

Microscopy: Principle, and applications of different types of microscopes Light, Phase Contrast, SEM & TEM. Microtome: Types and applications. Collection & fixation, embedding, sectioning, staining, Identification of different components. Tissue preparation for light microscopy.

Cryotechniques: History and applications of Cryotechniques, cryopreservation

### **Cell Culture and Tissue Culture Techniques in Biology**

Cell Culture System, and History of development of cell culture. Culture media preparation and cell harvesting methods. Commonly used Cell Lines and their Uses. Design and functioning of tissue culture laboratory.

### **Radiolabelling Techniques and Methods in Field Biology**

Detection and measurement of different types of radioisotopes normally used in biology, Molecular imaging of radioactive material Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations. Sampling methods in the study of behaviour, habitat characterization: ground and remote sensing methods

S. NO.	COURSE NAME
5	STRUCTURE AND FUNCTIONS OF INVERTEBRATES AND VERTEBRATES

### Structure and functions of Invertebrates

**Basic concept of coelom and its organisation:** Acoelomates, Pseudocoelomates, Coelomates: Protostomia and Deuterostoma.

**Locomotion:** Mechanism of flagellar and ciliary movement in Protozoa, Hydrostatic movement in Coelenterata, Annelida and Echinodermata

**Digestion:** Filter feeding in Annelids, Arthropoda, Mollusca and Echinodermata and digestion in lower metazoan

**Respiration:** Organs and mechanisms of respiration in Annelids, Arthropoda, Mollusca and Echinodermata.

**Excretion:** Organs and mechanisms of excretion in Annelids, Arthropoda, Mollusca and Echinodermata.

**Nervous System:** Basic concepts of nervous system in Annelids, Arthropoda (crustaceans and insects), Mollusca (cephalopods) and Echinodermata.

**Invertebrates Larvae:** Crustaceans larvae their types and evolutionary significance

### Structure and functions of Vertebrates

**Origin and Classification of Vertebrates:** Concept of Protochordata, Urochordata, Cephalochordata and Chordata

**Vertebrate Integument and its Derivatives:** Development, general structure and functions of skin and its derivatives, glands scales, horns, claws, nails, hoofs, feathers and hairs

**Circulatory System:** Origin and evolution of heart and aortic arches

**Skeletal System:** Form function, body size and skeletal elements of the body jaw

**Differential centrifugation in fractionating subcellular organelles according to their densities.** The density of an organelle is determined by both its mass and its shape. The sedimentation of an organelle will be dependent on its density relative to the density of the medium surrounding it (homogenization buffer containing 0.25 M sucrose in this experiment)

**Nervous system:** anatomy of the brain in relation to its functions, Nerves- Cranial, Peripheral and autonomous nervous systems Evolutionary histories, of horse, elephant and man

S. NO.

6

COURSE NAME  
ECOLOGY AND ENVIRONMENT

**Ecosystem organization**

Elucidate the flow of energy and matter in ecosystems, primary production, energy dynamics, litter fall, and decomposition, global biogeochemical cycles, minerals cycles in terrestrial and aquatic ecosystems.

**Population growth and dynamics**

Models of population growth (Stochastic and time lag), reproduction strategies, mating preference, spacing system, r and k selection, case studies in population dynamics.

**Predation**

Predators-Prey interaction, host parasite interaction, role of predation in nature.

**Competition and mutualism**

Types and theories of competition, commensalism and mutualism, plant-pollinator and animal-animal interactions. Niche theory.

**Biological diversity**

Concepts and levels, role of biodiversity in ecosystem functions and stability, speciation and extinction, IUCN, categories of threat, distribution and global patterns, terrestrial biodiversity hotspots.

**Environmental pollution**

Types, sources, effects on plant and animal ecosystems, greenhouse gases, ozone layer and ozone hole, consequences of climatic change.

**Ecological management**

Concepts, sustainable development, sustainability indicators, degraded ecosystem and their regeneration with special reference to waste lands, forests and aquatic ecosystems

S. NO.	COURSE NAME
7	CYTOGENETICS AND EVOLUTION

**Chromosome Organization**

Structure of chromosomes, DNA packaging. Structure of chromosomes, Mitose taphase chromosomes, centromere, kinetochore, telomere and importance. Heterochromatin and euchromatin. Chromosome banding Polytene and lampbrush chromosomes

**Sex chromosomes**

Sex determination and dosage compensation in Drosophila and human

**Mendelian and non-Mendelian Inheritance**

Mendelian inheritance and its modification, Maternal effect, Epigenetic inheritance, Extranuclear inheritance

**Variation in chromosome structure and number**

**Brief description of gene expression**

Genetic code, Transcription and translation, Regulation of gene expression

**Gene mutation and DNA repair**

Consequences of mutations, Occurrence and causes of gene mutation  
DNA repair

**Quantitative genetics**

Quantitative traits, Polygenic inheritance, Heritability

**Population genetics and evolution**

Genes in populations, The Hardy-Weinberg Equilibrium, Factors that changes allele frequencies in populations. Origin and evolution of species, Biological species concept, Anagenesis and cladogenesis, Allopatric, parapatric and sympatric speciation, Gradualism and punctuated equilibrium, Neo-Darwinism

**Molecular evolution**

Experimental approaches used to compare species at molecular level  
Phylogenetic trees, Molecular drive-a cohesive mode of species evolution  
Neutral theory of molecular evolution



S. NO.  
8

COURSE NAME  
BIostatISTICS AND BIOINFORMATICS

**Introduction to Biostatistics**

Definition and scope, Probability, Discrete and continuous variables, Presentation of Data. Measures of central tendency: Mean, median, mode, Standard deviation

**Biostatistics Software**

Analysis of variance, Correlation and regression. Sampling: techniques, Errors, Framing Hypothesis, Level of Significance, Hypothesis testing, Student's t test, Chi Square test

**Introduction to Bioinformatics**

Introduction to bioinformatics, genomics and proteomics databases, Nucleic acid sequence database. Genbank, UCSC, ENSEMBL, EMBL, DDBJ, protein sequence databases: Swiss- PROT, PDB, BLAST, BLAST vs FASTA, Bioinformatics & drug discovery, Introduction to computational genomics and proteomics

S. NO.	COURSE NAME
9	ANIMAL PHYSIOLOGY

### **Nutrition and Digestion**

Digestion and absorption of proteins, fats and carbohydrates, Vitamins, minerals and their role, Coordination and control of digestion

### **Body fluids**

Structure and functions of bloods vessels, Pressure, blood flow, resistance and interrelationship, Vascular distensibility and vascular compliance, Different types of body fluids, their importance and regulation

### **Respiration**

Transport of O<sub>2</sub> and CO<sub>2</sub>, Capacities & volumes of lungs, Distribution and physiology of respiratory pigments, Carbon monoxide poisoning, Buffer systems, Respiratory

### **Excretion**

Regulation of acid base balance, respiratory Quotient  
Functional anatomy of mammalian kidney and its renal unit, Ultrafiltration, absorption and secretion mechanisms in urine formation, Role of antidiuretic hormone and aldosterone. Kidney in acid base balance

### **Muscular System**

Ultrastructure of a skeletal muscle, Differences between skeletal, cardiac and, smooth muscle, Mechanism of contraction of skeletal muscle, Biochemistry of actomyosin ATPase reaction

### **Endocrine System**

Structural and functional organization of pituitary gland, Hormones secreted by thyroid, parathyroid, adrenal gland, pancreas and their functions. Feedback inhibition Hormones and metabolism

### **Reproductive physiology**

Histophysiology of mammalian gonads (Testis, Ovary), Hormones secreted by gonads,

### **Environment Physiology**

Basic concept of stress and strain, Adaptation, acclimation and acclimatization  
Adaptation to high altitude and deep diving

S. NO.	COURSE NAME
10	PROTEIN STRUCTURE, FUNCTION AND EVOLUTION

### **Chemical Nature of polypeptide:**

Various types of amino acids and their side chains, nature of amino acids, L and D amino acids in nature and their importance, non-ribosomal peptides, Extracellular matrix and proteoglycans, Glycoproteins and their role in cellular processes, Super molecular assembly involving proteins, nucleic acid and lipids using examples of multi-enzyme complex.

### **Structure of Protein**

Functional and Structural Proteins, Regular conformations of polypeptides:  $\alpha$ -helices and  $\beta$ -sheets, Secondary, tertiary and quaternary structure of proteins, Forces which decide protein structure, Ramachandran Plot, Structural motif and functional domains, Protein folding, Protein Families, Protein data bases, convergent and divergent evolution of protein structure

### **Overview of Protein Signaling; Membrane and Intracellular Receptors, Receptor-ligand interaction, Protein mediated signaling in animal and bacterial system (G-proteins, Tyrosine kinase, Serine/threonine kinase, histidine/aspartate kinases, arginine kinase). Role of ten major modifications in protein structure and function. Small G-proteins in cell signaling.**

Membrane and intracellular receptors, Receptor-ligand interaction, Protein mediated signaling in animal and bacterial system (G-proteins, Tyrosine kinase, Serine/threonine kinase, histidine/aspartate kinases, arginine kinase). Role of ten major modifications in protein structure and function. Small G-proteins in cell signaling.

### **Protein half-life and Protein Degradation**

Protein as source of Energy, Protein denaturation, genetic disorder affecting functional proteins, Diseases by protein aggregation and Prion, Protein Separation techniques. Techniques for protein identification.

S. NO.	COURSE NAME
11	ANIMAL BEHAVIOUR

**Introduction**

Definition, historical out line, patterns of behaviour, objectives of behaviour, mechanism of behaviour. Reflexes- reflex action, types of reflexes, characteristics of reflexes and complex behaviour. Orientation primary and

**Eusociaelictoy ndary orientation**

Social organization in honey bee, various type of communications, production of new queen and hive, swarming, honey bee as super organism. Fixed action pattern: mechanism, deprivation experiment, controversies. Learning and instincts: conditioning, habituation, sensitization, reasoning.

**Innate releasing mechanisms**

Key stimuli, open and closed IRM, mimetic releaser, code breakers. Homeostasis and behaviour, motivational conflict and decision making. Hormones and pheromones influencing behaviour of animals.

**Altruism**

Reciprocal altruism, group selection, kin selection and inclusive fitness, cooperation, alarm call. Parental care, Sexual selection: intra sexual selection (male rivalry), inter-sexual selection (female choice).

S. NO.  
12

COURSE NAME  
DEVELOPMENTAL BIOLOGY

**Introduction development Biology**

Scope, Science of developmental biology and its applications, Differentiation of germ cells into sperm or egg.

**Gametogenesis and Fertilization**

Gametogenesis, fertilization, and early development: Production of gametes, embryo sac development, zygote formation, cleavage, blastula formation, embryonic fields, gastrulation, and formation of germ layers in animals;

**Creation of Morphogenetic Uniformity**

(Cleavage patterns of cleavage: holoblastic, spiral holoblastic, Rotational holoblastic and meroblastic), Concept of fate maps (Chick, frog)

**Basic Concepts in Development**

Potency, induction, specification, Determination and Determination, Stem cells, imprinting, Mutants and transgenics in analysis of development

**Morphogenesis and organogenesis in animals**

Cell aggregation and differentiation, axes and pattern formation 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.

**Placenta**

Development of placenta, different types, Placental hormones and their functions/importance

**Cell Programming**

Programmed Cell Death, Ageing, Senescence

**Multiple ovulation and Embryo transfer technology**

Superovulation, In-vitro fertilization and In Vitro oocyte maturation, Cryopreservation and Embryo transfer technology

S. NO.  
13

COURSE NAME  
IMMUNOLOGY

**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, T cell-mediated effector functions, inflammation, hypersensitivity autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines. **Host parasite interaction** Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.

S. NO.  
14

COURSE NAME  
APPLIED ZOOLOGY

### **Apiculture, Sericulture and Lac Culture**

Introduction to apicultural and related practices, Hive products, Bee pasturage, apiculture and crop pollination, Pests, diseases and effect of pesticides on honeybees Beekeeping industry in India with special reference to Himachal Pradesh. Silkworm and its strains, rearing of silkworms, sericulture and its components, silk reeling, Pests, and diseases of silk moth Non-mulberry sericulture: Tasar, Muga and Eri culture, Sericulture industry in India. Lac culture: Introduction, history, life cycle, distribution and

### **Crop Pesticides and their Management**

Biology and control of following insect pests of agricultural importance: Termites, Rice weevils, castor hairy caterpillar, codling moth, mango mealy bug, Cotton white fly, citrus psylla, aphids and cabbage Caterpillar. Biology and control of some important Phytoparasitic nematodes: *Anguina*, *Xiphinema* sp, *Meloidogyne* sp & *Heterodera* sp., Principles and practices of pest control, Methods of pest control- Chemical Biological, Microbial, integrated control, Pheromonal and Hormonal control, Chemosterilants and genetic control

### **Animal Husbandry and Dairy farming**

Animal Husbandry: Purpose, scope & management, Dairy Animals, Breeds & Economic importance of Cow, Buffalo, Goat and Sheep, Modern methods of breeding for improvement of Dairy animals, Poultry: Breeds & economic importance Transgenic Animals, Vermicomposting and its significance

### **Pisciculture**

Major cultivable fish species for pisciculture, a knowledge of inland water bodies suitable for culture in India. General information about the fishes of Himachal Pradesh, Culture of Indian major carps & exotic carps, Fish hatcheries and their management

Preparation and management of Indian major carp culture ponds-nursery, rearing and production ponds, monoculture and composite culture. Fresh water, brackish and marine fisheries, induced breeding & its techniques in pisciculture. Fish enemies and their control, fish diseases and their control, importance of fish culture, fishing gears and fish preservation

### **Wildlife and its Management**

Introduction and importance of wildlife, Status of wildlife in India with special reference to Himachal Pradesh, Endangered and endemic faunal species of India Objectives of wildlife conservation and its strategies.