B.Sc. - Zoology

I Semester:
- Paper I: Lower Non-Chordata
- Paper II: Higher Non-Chordata
- Paper III: Cell Biology
- Practical: Related to the Syllabus of first semester

II Semester:
- Paper I: Molecular Biology, Elementary Biotechnology and Biological Techniques
- Paper II: Taxonomy, Evolution and Elementary Palaeontology
- Paper III: Genetics
- Practical: Related to the Syllabus of second semester

III Semester:
- Paper I: Lower Chordata
- Paper II: Higher Chordata
- Paper III: Ecology and Environmental Biology
- Practical: Related to the Syllabus of third semester

IV Semester:
- Paper I: Developmental Biology
- Paper II: Applied Zoology
- Paper III: Elementary Entomology and Applied Ichthyology
- Practical: Related to the Syllabus of fourth semester

V Semester:
- Paper I: Microbiology
- Paper II: Animal Behaviour
- Paper III: Toxicology and Histology
- Practical: Related to the Syllabus of fifth semester

VI Semester:
- Paper I: Biological Chemistry and Basic Mammalian Endocrinology
- Paper II: Animal Physiology
- Paper III: Bioinformatics and Biostatistics
- Practical: Related to the Syllabus of sixth semester

B.Sc. Zoology: Semester- I

Paper I: Lower Non-Chordata
Salient features and outline classification (upto orders) of various Lower Non-chordate Phyla and related type study and topics as covered under respective Phyla.

Protozoa: *Paramecium* with particular reference to locomotion, nutrition, osmoregulation and reproduction. Taxonomy, morphology (including adaptations), life cycle, pathogenicity and control measures of *Trypanosoma, Leishmania, Giardia, Plasmodium, Entamoeba histolytica*.

Porifera: *Sycon* with reference to structure, reproduction and development. Canal system, and affinities of Porifera.


Helminthes: Taxonomy, morphology (including adaptations), life cycle, pathogenicity and control measures of *Fasiola, Ancylostoma, Schistosoma, Ascaris, Filaria* (including periodicity). Parasitic adaptations in Helminthes.

**Paper II: Higher Non-Chordata**

Salient features and outline classification (upto orders) of various Higher Non-chordate Phyla and related type study and topics as covered under respective Phyla.


**Paper III: Cell Biology**

Prokaryotic and Eukaryotic cells; Ultrastructure of eukaryotic cell; Plasma membrane (Ultrastructure, chemical composition, models of plasma membrane; Specialisations of plasma membrane, functions of plasma membrane).

Structure and functions of following cell organelles: (a) Mitochondria (b) Ribosomes (c) Lysosomes (d) Centrioles (e) Golgi Complex (f) Endoplasmic reticulum. Structure and functions of Nucleus and nucleolus.

Cell division – (a) Cell cycle (b) Mitosis (Process of mitosis, mitotic poisons and significance of mitosis), (c) Meiosis (Process of meiosis, structure and functions of synaptonemal complex, significance of meiosis). An idea of cell transformation and cancer.

Eukaryotic chromosomes - Structure, chemical composition, classification and uninemic and multinemic concept of chromosome structure. Structure and functions of polytene and lampbrush chromosomes. Dosage compensation in *Drosophila* and man; Barr body.

**B.Sc. Zoology: Semester-I, Practical’s**
A complete record of laboratory work will be maintained by every student. The practical work will consist of the following:

1. Study of living animals: *Amoeba, paramecium, Euglena, Hydra*, and rectal ciliates
2. Study of Nervous-system/General anatomy with the help of charts/models and simulation of *Earthworm, Prawn, Pila, Unio*.
4. Study of permanent slides/museum specimens/models belonging to following phyla
   - **Protozoa**: Amoeba, Paramecium, Euglena, Ceratium and Noctiluca.
   - **Porifera**: T.S. and L.S. of Sycon, Euplectella, Hyalonema and Spongilla.
   - **Coelenterata**: Medusa of Obelia, larval stages of Aurelia, Physalia, Porpita, Vellela, Tubipora, Millepora, Aurelia, Gorgonium, Pennatula, Alcyonium, Adamsia.
   - **Annelida**: T.S. of eartworm and Nereis through different body regions. Neries Heteronereis, Arenicola, Chaetopterus,
   - **Arthropoda**: Mouth parts of insects, Pupa and larva of modquito Daphnia Cyclops and larval stages of Crustaceans. Crab, hermit crab, Lepas, Balanus, Astaxus, Squilla, millipede, mantis, cricket, stic insect, waterbug, beetle, locust, moth and butterfly, scorpion, spider, kingcrab and peripatus.
   - **Mollusca**: Various larval stages, T.S. of Unio through gills; Chiton, Doris, Aplysia, Aeolis, Dentalium, Octopus, Loligo, Sepia, Nautilus, Teredo, Osteria, Pecten.
   - **Echiodermata**: Various larval stages, T.S. of arm of starfish; Echinus, Ophiothrix, Holothuria, Asteria, Antedon.

Study of following with the help of permanent slides/ museum specimens/ models/ Pictures for spotting

5. **Study of Parasites**:
   - (a) **Protozoa**: Plasmodium, Moncystis, Trypanosoma, Leishmania, Entamoeba, Giardia.
   - (b) **Helminthes**: Fasciola, Taenia, Ascaris, Schistosoma and filarial including larval stages.
   - (c) **Annelida**: Leeches
   - (d) **Arthropod**: Sacculina, lice, flea, bedbug, tick and mites.
   - (e) Life Cycle of the following:-
Entamoeba
T. Solium
A. Lumbricoides
F. hepatica
Schistosoma

6. Cytology experiments:
(b) Study of mitosis and meiosis using available material
(c) Study of permanent slides showing stages of cell division, giant chromosome, mitochondria, Golgi body etc.

B.Sc. Zoology: Semester- II

Paper I: Molecular Biology, Elementary Biotechnology and Biological Techniques

Molecular Biology:

Elementary Biotechnology:
Origin and definition, scope and importance, Restriction enzymes and cloning techniques used in recombinant DNA technology, DNA fingerprinting. Biochips. A Brief knowledge of PCR and its significance.

Biological Techniques:
Introductory knowledge of the application of following biological techniques:
(a) Photometry (Beer Lambert’s law)
(b) Chromatography
(c) Electrophoresis
(d) Microscopy (Phase contrast, TEM, SEM & Fluorescence)
Paper II: Taxonomy, Evolution and Elementary Palaeontology

Taxonomy:


Evolution:


Paper III: Genetics

Mendel’s life, Pre-Mendelian experiments, symbols and terminologies, Laws of dominance, segregation and independent assortment.

Linkage: Coupling and repulsion hypothesis, Morgan’s view of linkage, kinds of linkage, chromosome theory of linkage.

Crossing over: Somatic and germinal crossing over, kinds of crossing over, theories of the mechanism of crossing over, significance.


Sex linked inheritance: Inheritance of X-linked gene (Colour blindness and haemophilia in man), Sex linkage in Drosophila.

Mutation: Historical background, chromosomal mutation (Chromosomal aberrations), gene mutations and their interpretation.
B.Sc. Zoology: Semester-II, Practical’s

A complete record of laboratory work will be maintained by every student. The practical work will consist of the following:

1. **Biotechnology**
   a. Laminar flow
   b. Autoclave
   c. Elisa reader
   d. PCR machine
   e. Refrigerated centrifuge
   f. Transilluminator

2. **Genetics**
   (i) Experiments on Mendelian and non-Mendelian inheritance.
   (ii) Study of mutants of Drosophila.

3. **Biological Techniques**
   Instruments and techniques regarding:
   (i) Photometry
   (ii) Chromatography
   (iii) Electrophoresis
   (iv) Radioimmunoassay

4. **Taxonomy and Evolution**
   (a) Animal collection techniques:
   (b) Appliances such as cyanide bottle, aspirator, insect nets, fishing nets, Berlese funnel, spreading board.
   (c) Kinds and use of keys.
   (d) Study of evolution of man with the help of Model/chart.
5. **Elementary Palaeontology:** Study of different Era/Periods of Geological Time scale based on charts & models.

**B.Sc. Zoology : Semester-III**

**Paper I: Lower Chordata**

Salient features and outline classification (up to order) of various Lower chordate groups as covered under respective taxonomic groups.

Protochordata: Salient features of body organisation and systematic position of *Balanoglossus* and *Amphioxus* as a type and its affinities.
Agnatha: External features of *Petromyzon*.


**Paper II: Higher Chordata**

Salient features and outline classification (up to order) of various Higher chordate groups as covered under respective taxonomic groups.


Paper III: Ecology and Environmental Biology

Ecology:
Definition of ecology and its relation to humanity.

The environment: Abiotic factors, biotic factors, edaphic factors.
Concept of ecosystem with reference to pond ecosystem. Energy flow in ecosystem. Pyramids of number, biomass and energy. Food chain- grazing and detritus, Food web and trophic levels. Introduction to the laws of limiting factors (Liebig’s law of minimum and Shelford’s law of tolerance).


Population: Definition and characteristics: density, natality, mortality, migration, emigration and immigration, growth and growth-curves. Dispersion and aggregation. Negative and positive interactions including commensalism, mutualism, predation, competition and parasitism.

Environmental Biology:
Biodiversity: Conservation and management of biodiversity. Brief introduction to the concept of protected areas- Sanctuary, National Parks and Biosphere Reserves.

India’s wild life habitats (Ecology and distribution of fauna Pressure on India’s wild life resources). Adaptations of animals to desert and aquatic life.

Pollution and its control: Air, Water, Soil pollution, Green house effect, Climate change, Acid rain, Ozone layer depletion, Bio-accumulation, Biomagnifications. Control measures to various pollutions.
B.Sc. Zoology: Semester-III, Practical

A complete record of laboratory work will be maintained by every student. The practical work will consist of the following:

**Lower and Higher Chordate diversity:**

**Protochordata:** Study of permanent slides of *Amphioxus* and *Balanoglossus* passing through different body regions, *Doliolum, Salpa, Oikopleura*. Museum specimens of *Herdmania, Ciona* and *Balanoglossus*.

**Cyclostomata:** Museum specimens of *Petromyzon* and *Myxine*.

**Fishes:** Dissections only with the help of Simulations, charts/models of general anatomy, afferent and efferent branchial arteries, cranial nerves and internal ear of *Scoliodon*. Preparation of permanent slides of ampulla of Lorenzini, placoid, Cycloid and ctenoid scales. Study of permanent slides of shark T.S. passing through different body regions and different kinds of scales of fish. Museum specimens of *Sphyrna, Pristis, Torpedo, Trygon, Acipenser, Polypterus, Hippocampus, Exocoetus, Anguilla, Echeneis, Diodon, Protopterus, Synaptura and Chimaera*.

**Amphibia:** Dissections only with the help of Simulations, charts/models of cranial nerves, hyoid apparatus, brain and columella of frog. Study of museum specimen of *Salamandra, Proteus, Amphiuma, Nectures, Siren, Ambyostoma, Axolotl larva*. *Rhacophorus, Alytes, Hyla, Pipa* and *Bufo*. Study of skeleton of frog and permanent histological slides of Amphibia.

**Reptilia:** Study of the skeleton of Varanus. Study of museum specimen of following: *Varanus, Heloderma, Hemidactylus, Phrynosoma, Chameleon, Draco, Calotes, Cobra, Pit-viper, Pitless-viper, Rattle snake, Krait, Dhaman, Typhlops and marine snake; Alligator, Crocodile, Gavialis, Turtle and tortoise*.

**Aves:** Permanent preparation of filoplume and down feather. Study of the skeleton of fowl. Study of museum specimens of *Psittacula, Corvus, Pavo, Bubo*, and model of Archaeopteryx.

**Mammalia:** Dissection only with the help of Simulations, charts/models of the general anatomy and blood vascular system of a mammal. Study of permanent slides of mammals. Study of the skeleton of rabbit. Study of the museum specimens of *Tachyglossus* and *Ornithorynchus* (models) *Pangolin, Funambulus, Pteropus*, Hedgehog and Loris.
Ecology:
I. Estimation of the pH of water/soil sample.
II. Determination of dissolved oxygen and carbon dioxide in water sample.
III. Study of adaptations in animals inhabiting different ecological environments.

Environment Biology:
I. Study of wild animals with the help of stuffed preparations/models/charts/photographs.
II. Study of indicator organisms of different kinds of water pollution.
III. Simple experiments on the effect of environmental pollution on animals.

B.Sc. Zoology: Semester-IV

Paper I: Developmental Biology

Gametogenesis: Spermatogenesis and Oogenesis including structure, differentiation and longevity of gametes. Chemical and metabolic events during gamete formation. Types of eggs.

Fertilization: Significance of fertilization, approximation of gametes, Capacitation, Acrosome reaction, formation of fertilization membrane, egg activation, Blockage to polyspermy.

Cleavage: Patterns, control of cleavage patterns, chemical changes during cleavage, totipotency.

Blastulation and Gastrulation: A complete study in frog and chick; Fate maps, their formation and significance.

Foetal membranes: Their formation and functions in chick.

Retrogressive metamorphosis: As exhibited by an ascidian.
Regeneration: Morphallaxis and Epimorphosis, Blastema and its significance, mechanisms as exhibited by invertebrates (Hydra and Planaria) and Vertebrates (Limb regeneration in Amphibia).

Embryonic Induction: Origin, structure and significance of primary organizer, Nature of inductive signal.

**Paper II: Applied Zoology**

Elementary knowledge of:
(a) Aquaculture
(b) Sericulture
(c) Apiculture
(d) Lac culture
(e) Pearl culture
(f) Piggery

Bionomics and control measures of the common pests of fruits (Papilio demoleus and Quadraspidotus perniciosus), Vegetables (Thrips tabaci and Aulacophora foveicollis) and stored grains (Callosobruchus chinensis and Trogoderma granarium). Polyphagous insect (Locust and Termites).

Pest management, including insect pest control and integrated pest management.
A note on Bioethics

**Paper III: Elementary Entomology and Applied Ichthyology**

**Elementary Entomology:**
Classification of insects up to orders: Brief knowledge of general characters of following insect orders- Thysanura, Collembola, Orthoptera, Isoptera, Thysanoptera, Heteroptera, Homoptera, Coleoptera, Lepidoptera, Hymenoptera and Diptera and Methods of their collection and preservation.

**Applied Ichthyology:**
Classification of fishes up to orders.
Induced breeding.
Indigenous and exotic fishes.
Migration in fishes.

**B.Sc. Zoology: Semester-IV, Practical**

**Developmental biology:**
Study of the permanent slides of the chick embryos (whole mounts) and those showing the embryology of frog.

**Applied Zoology:**
Specimens / slides of Apis, silk moth, Lac insect, phytoparasitic nematodes, major carps. Study of life cycles and control measures of insects of economic impotence (Stored grains pests, pest of fruits and vegetables); and study of structural organization of Bee hive. Picture of commercially important varieties of poultry and cattle.

**Elementary Entomology and Applied Ichthyology:**
Salient features and outline classification (up to order) of various insect groups as covered under respective taxonomic groups.
Salient features and outline classification (up to order) of various fishes as covered under respective taxonomic groups.
B.Sc. Zoology: Semester-V

Paper I: Microbiology

Introduction to microbiology: kinds of microbes, Typical structure of a bacterium, Gram positive and Gram negative bacteria and virus.

Microbes of medical importance: Bacteriophages, Mycobacterium, Rickettsia, Actinomycetes and Mycoplasma.

A brief knowledge of AIDS.

Environmental use of microorganisms: Nutrient cycle, Metal recovery, petroleum recovery, pest control, waste water treatment and Bioremediation.

Industrial microbiology- Food production, dairy products, fermented food, alcoholic beverages, microbial spoilage, food preservation. A brief knowledge of Antibiotics.

Paper II: Animal Behaviour

Patterns of behaviour:

Stereotype innate behaviour: Kinases, Taxes and Reflexes. Concepts of (i) Fixed action patterns (ii) Sign or key stimulus or releasers and (iii) Innate releasing mechanism, Instinctive behaviour.

Learned behaviour: Habituation, Conditioned reflexes, Selective learning, Insight learning, Imprinting, Song learning in birds.
Communication: Chemical, Visual, Auditory, Electric and tactile, Dance language of honey bees, Biological clocks.

Bird migration with particular reference to the mechanisms of navigation.

Introduction to Socio-biology: Social structure in primates

**Paper III: Toxicology and Histology**

**Toxicology:**

Introduction and brief history of toxicology: General principles of toxicology, Brief history, Environmental toxicology (kinds and sources of toxic agents - animal toxins, plant toxins, pesticides, metals and food additives). Metabolism of toxic substances.

Dose response relationship: Frequency and cumulative responses, determination of TLₘ values, LC₅₀, margin of safety, threshold limits.

Analytical toxicology: Toxic response of blood, organ function tests, teratogenic, reproductive and carcinogenic tests.

**Histology:**

Histology: Structure of epithelium, connective tissue, cartilage, bone, smooth., striped and cardiac muscles, and nervous tissue as studied under light microscope.

Histological structure of gonads, liver, lung, pancreas and kidney in mammals.
B.Sc. Zoology: Semester-V, Practical

Microbiology:

(i) Cleaning of glassware and sterilization
(ii) Preparation of liquid and solid media for cultivation of bacteria
(iii) Preparation of media for the culture of fungi.
(iv) Isolation of microorganisms from soil.
(v) Gram staining of bacteria
(vi) Micrometry of microorganisms

Animal behaviour:

Study of different kinds of behaviour with the help of photographs.

Toxicology:

Calculation of LC$_{50}$ with the help of data provided. Study of behavioural responses (in fish, insects or any other locally available animal) to some important toxicants.

Histology:

Study of the permanent slides of cartilage, bone, epithelium, connective tissue, nervous tissue, blood, striped and unstriped muscles, liver, kidney, lungs, pancreas, pituitary, thyroid, and adrenal of mammals. Preparation of smooth and striped muscles.
B.Sc. Zoology: Semester-VI

Paper I: Biological Chemistry and Basic Mammalian Endocrinology

Biological Chemistry:

Introduction to biological molecules: Proteins, Amino acids, Carbohydrates, Lipids, Vitamins and Enzymes- their structure, classification and significance. Metabolism of Carbohydrates.

Endocrinology:
General characteristics of endocrine system, mechanisms of hormone action (cellular and sub cellular). A brief knowledge of the structure and hormonal functions of the glands namely, Pituitary, Thyroid, Pancreas, Adrenal, Testis and Ovary. Elementary knowledge of the etiology of Dwarfism, gigantism, acromegaly, diabetes insipidus, Goitre, Cretinism, Myxoedema, Diabetes mellitus and Addison’s disease.

Paper II: Animal Physiology

Nutrition: Food constituents, intracellular and extracellular digestion, Digestion and absorption of carbohydrate, fat and protein.

Respiration: Pulmonary ventilation, respiratory pigments, gaseous transport and control of respiration.

Excretion: Concept of ammonotelic, ureotelic and guanotelic animals, urine formation in mammals.

Nervous system: Resting and action potential of nerves, synapse and transmission of nerve impulse.

Muscular system: Muscle contraction and its Mechanism. A brief idea of tetanus and fatigue.

**Paper III: Bioinformatics and Biostatistics**

**Bioinformatics:**

Elementary knowledge of computer: Organisation of computer, input and output devices, elementary idea of software, hardware and programming languages.

Use of computers in biological sciences: Sequence, structure and strain databases and their use.

**Biostatistics:**

Biostatics as a tool in research, Data collection- Random and non-random sampling, data tabulation and data presentation (Graph, Histogram, Scatter diagram), Concept of mean, mode, median and of standard deviation and standard error.
B.Sc. Zoology: Semester-VI, Practicals

Physiology / Biochemistry:
   (i) Preparation of haemin crystals from human blood
   (ii) Determination of clotting and bleeding time
   (iii) Counting of RBCs in human blood
   (iv) Counting of WBCs in human blood
   (v) Determination of haemoglobin percentage in human blood
   (vi) Qualitative identification of carbohydrate, protein and lipid.
   (vii) Analysis of urine for identification of sugar, albumin, ketone bodies, etc.
   (viii) Study of the action of salivary amylase on starch.

Endocrinology: Study of endocrine glands and related disorders with the help of slides/photographs/charts/models.

Biostatistics:
   (i) Calculation regarding mean, median, SD and SE from given data.
   (ii) Preparation of histogram and pie diagram with the help of data provided.

Bioinformatics: Brief knowledge of computer and its application.
B.Sc. ZOOLOGY

SEMESTER – I

EXERCISES AND DISTRIBUTION OF MARKS IN PRACTICAL EXAMINATION

The duration of practical will be 3½ hours and distribution of marks will be as following:-

**Time: 3½**

1. Study of Nervous-system/General anatomy
2. Identification of spots:
   (Specimens: 10 and slides: 05)
3. Permanent preparation
4. Exercise on life-cycle of parasites
5. Cytology Experiments
6. Viva - Voce
7. Sessional Records (Internal Assessment)

B.Sc. ZOOLOGY

SEMESTER – II

EXERCISES AND DISTRIBUTION OF MARKS IN PRACTICAL EXAMINATION

The duration of practical will be 3½ hours and distribution of marks will be as following:-

**Time: 3½**

1. Identification of spots.
   (Application and function of instruments related to Biotechnology)
2. Biological techniques
3. Experiments on Mendelian and non-Mendelian incheritance:
   (Exercises based on Genetics)
4. Exercises based on Taxonomy and Evolution
5. Exercise on Palaeontology
6. Viva - Voce
7. Sessional Records (Internal Assessment)

B.Sc. ZOOLOGY
SEMESTER – III
EXERCISES AND DISTRIBUTION OF MARKS IN PRACTICAL EXAMINATION

The duration of practical will be 3½ hours and distribution of marks will be as following:-

**Time: 3½**

1. Study of Nervous-system/General anatomy
2. Identification of spots.
   (Specimens: 05, slides: 0 2 and bones: 03)
3. Permanent preparation
4. Ecology experiments
5. Experiment on environmental biology/ Wildlife
6. Viva - Voce
7. Sessional Records (Internal Assessment)

B.Sc. ZOOLOGY
SEMESTER – IV
EXERCISES AND DISTRIBUTION OF MARKS IN PRACTICAL EXAMINATION
The duration of practical will be 3½ hours and distribution of marks will be as following:-

Time: 3½
1. Study of Developmental biology
2. Study of Applied Zoology
3. Study of Elementary Entomology
4. Study of Applied Ichthyology
5. Viva - Voce
6. Sessional Records (Internal Assessment)

B.Sc. ZOOLOGY
SEMESTER – V
EXERCISES AND DISTRIBUTION OF MARKS IN PRACTICAL EXAMINATION
The duration of practical will be 3½ hours and distribution of marks will be as following:-

Time: 3½
1. Microbiology Experiments
2. Study of Animal behaviour
3. Study of Toxicology
4. Study of Histology
5. Viva - Voce
6. Sessional Records (Internal Assessment)

B.Sc. ZOOLOGY
SEMESTER – VI

EXERCISES AND DISTRIBUTION OF MARKS IN PRACTICAL EXAMINATION

The duration of practical will be 3½ hours and distribution of marks will be as following:-

**Time: 3½**

1. Experiment on Physiology
2. Experiment on Biochemistry
3. Endocrinology
4. Exercise on Biostatistics
5. Bioinformatics
6. Viva - Voce
7. Sessional Records (Internal Assessment)