FACULTY OF SCIENCE

SYLLABI

FOR

B.Sc. (Honors) in Zoology (Semester System)
Under the Framework of Honors School System

Choice Based Credit System (CBCS)
1st to VIth Semester

Department of Zoology,
Panjab University, Chandigarh

EXAMINATIONS 2018-19
PREAMBLE

The Department of Zoology is one of the oldest and well-established departments in North India, which has completed more than 100 years of teaching and research. It was shifted from Hoshiarpur to present campus at Chandigarh in July 1960. The department has many landmarks as its teaching and research activities changed from classical to the most recent ones in Zoology, and remained at the forefront both nationally and internationally. Based on the performance of teaching and research potentials of the staff members, UGC had recognized the Department for Special Assistance Programme (SAP) in 1985 and extended it for two terms. Under the COSIST Programme, a grant of Rs. 42.5 lakhs was sanctioned for a five year term (1996-2001). 3rd Phase of SAP started from 2001-2006 with financial aid of Rs. 65.75 lakhs. On completion of the 3rd Phase of SAP, UGC review committee upgraded the department for CAS (Centre of Advance Study) in Biodiversity: Cell and Molecular Biology, with the financial assistance of Rs. 78.25 lakhs from 2007-2012. In 2013 the department was recognized by the DST under its FIST programme and sanctioned a grant of 1.10 crores for 5 years. In 2015 the department has received grant of Rs. 161.55 lacs + 2 Project Fellows under Phase II CAS Programme.

The Department is well equipped with teaching and research laboratories. There are three laboratories for under-graduate students and two for post-graduate students where course practicals are conducted. There are six specialized laboratories for research students (M.Sc., M.Phil & Ph.D.) which are maintained as per the specific needs of the research areas including Cell and Animal Physiology, Aquatic Biology, Cytogenetics, Entomology & Parasitology. There is a central sophisticated instruments laboratory equipped with advanced instruments such as Real-time PCR, Flow Cytometer, 2D Gel Electrophoresis system, HPLC, Nanodrop etc along with other basic research instruments.

The Department also has a well equipped computer lab., which are open for use by students and staff. The Department has a seminar room with modern audio visual facility and interactive class-room.

Library

The department library is well stocked with highly informative 10,000 textbooks and reference books having general information related to the subject of Zoology. The library also receives good scientific research journals of national and international repute for the benefit of research scholars and the faculty. New books and journals are regularly added and updated.

Museum

The department has two state of art museums with a wealth of 3000 specimens belonging to different animal phyla.
## COURSE STRUCTURE

Choice Based Credit System (CBCS) 1st Year
(SEMESTER I & SEMESTER VI)

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<thead>
<tr>
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<tbody>
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<td>C1</td>
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<tr>
<td>AECC1</td>
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<tr>
<td>C-GE1</td>
<td>BZO-C-GE1: Animal Diversity</td>
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<td>BZO-C5: Diversity of Chordates</td>
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<td>C7</td>
<td>BZO-C7: Fundamentals of Biochemistry</td>
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<tr>
<td>SEC*</td>
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<tr>
<td>C-GE3</td>
<td>BZO-C-GE3: Insect Vector and Diseases</td>
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<tr>
<td>C11</td>
<td>BZO-C11: Molecular Biology</td>
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<td>C12</td>
<td>BZO-C12: Principles of Genetics</td>
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<td>DSE**</td>
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C: Core Courses; GE: General Elective; AECC: Ability Enhancement Compulsory Courses; SEC: Skill Enhancement Courses; DSE: Discipline Specific Elective
*SKILL ENHANCEMENT COURSES (any one per semester in semesters 3-4)

1. BZO-SEC1: Apiculture
2. BZO-SEC2: Aquarium Fish Keeping
3. BZO-SEC3: Medical Diagnostics
4. BZO-SEC4: Research Methodology

**DISCIPLINE SPECIFIC ELECTIVE COURSES (any two per semester in semesters 5-6)

1. BZO-DSE1: Endocrinology
2. BZO-DSE2: Reproductive Biology
3. BZO-DSE3: Wild Life Conservation and Management
4. BZO-DSE4: Animal Biotechnology
5. BZO-DSE5: Fish and Fisheries
6. BZO-DSE6: Parasitology
7. BZO-DSE7: Immunology
8. BZO-DSE8: Biology of Insecta

GENERAL ELECTIVE SUBJECTS (Offered by Zoology Department) for students of other departments

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<tr>
<th>CODE</th>
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<th>PRE-REQUISITE</th>
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<tbody>
<tr>
<td>BZO-C-GE1:</td>
<td>Animal Diversity</td>
<td>10+2 Biology</td>
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<tr>
<td>BZO-C-GE2</td>
<td>Human Physiology</td>
<td>10+2 Biology</td>
</tr>
<tr>
<td>BZO-C-GE3</td>
<td>Insect Vector and Diseases</td>
<td>10+2 Biology</td>
</tr>
<tr>
<td>BZO-C-GE4</td>
<td>Aquatic Biology</td>
<td>10+2 Biology</td>
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Note: A Department will run a particular Skill Enhancement Course, Discipline Specific Elective Course and General Elective Course only if the minimum number of students opting for that course is 10

Outlines for Semester II will be same as for Semester I
B.Sc. (Honors) in Zoology (Semester System)
Under the Framework of Honors School System

Choice Based Credit System (CBCS)

SEMESTER I
OUTLINES OF TESTS

OBJECTIVE OF THE COURSE

To teach the various concepts of Zoology and their applications, the syllabus pertaining to B.Sc. (Honors) Zoology (3 Year course & 6 Semesters) in the subject of Zoology under Honors School Framework has been upgraded as per provision of the UGC module for CHOICE BASED CREDIT SYSTEM and demand of the academic environment. The syllabus contents are duly arranged UNIT wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills according to UGC.

Semester I

CORE COURSE (ZOOLOGY)

Theory Papers:
Core Course-1 (BZO-C1): Non-Chordates I 100 Marks (4 credits)
Core Course-2 (BZO-C2): Principles of Ecology 100 Marks (4 credits)

Practicals:
Core Course-1 Practical (BZO-C1 Lab): Non-Chordates I 50 Marks (2 credits)
Core Course-2 Practical (BZO-C2 Lab): Principles of Ecology 50 Marks (2 credits)

GENERAL ELECTIVE (ZOOLOGY)

Theory Papers:
Each student from other disciplines may opt any two of the general electives offered by the Science Departments of Panjab University.
General Elective -1 (BZO-C-GE1) 100 Marks (4 credits)

Practicals:
General Elective -1 Practical (BZO-C-GE1 Lab) 50 Marks (2 credits)

ABILITY ENHANCEMENT COMPULSORY COURSE FOR CHEMISTRY STUDENTS

Each student of Zoology Department has to opt one Ability Enhancement Compulsory Course of the following:

Theory Papers:
Each student of Zoology Department has to opt one Ability Enhancement Compulsory Course (AECC) of the following:
1. English Communication (BZO-AECC1) 50 Marks (2 credits)

650 Total Marks (26 Total credits)
B.Sc (Hons.) Zoology

GENERIC ELECTIVE

1. Course under these will be offered only if a minimum of 10 students opt for the same
2. Students of Zoology will opt for GE from course offered by other Departments under CBCS programme.

EVALUATION

1. There shall be one Mid Term Examination of 20% of the total marks (20 or 10 marks) in each semester.
2. End-semester examination will be of 80% of the total marks (80 or 40 marks).
3. If a subject has practical component, each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practicals of 20% marks (10 marks). The final examination will be of 80% marks (40 marks).

Pattern of end-semester question paper

(i) Nine questions in all with equal weightage (16 or 8 marks). The candidate will be asked to attempt five questions.
(ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.
(iii) The remaining eight questions will be in Four UNITs, each unit comprising of two questions.
(iv) Students will attempt one question from each UNIT and the compulsory question.

Computation of Semester Grade Point Average (SGPA)

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<td>4+2=6</td>
<td>X=(Marks%/10)</td>
<td>6 × X</td>
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SGPA=Total Credit point in the semester/total credits

Grade and Grade Points:

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<td>9</td>
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<td>6</td>
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CORE COURSES (ZOOLOGY)
SEMESTER I
B. Sc (Hons.) Zoology

Semester I

BZO-C1: Non-Chordates I: Protists to Pseudocoelomates
THEORY

Total Lectures: 60                                                                                                        Credits: 4

Objectives:
• To enable the students to develop an appreciation for the biodiversity of invertebrate species.
• To impart knowledge about co-existence of different forms of living organisms ranging from unicellular to multicellular animals.

UNIT 1: Protista, Parazoa and Metazoa (15 hrs)
General characteristics and classification up to classes*
Study of Euglena, Amoeba and Paramecium
Life cycle and pathogenicity of Plasmodium vivax and Entamoeba histolytica
Locomotion and reproduction in Protista
Evolution of symmetry and segmentation of Metazoa

UNIT 2: Porifera and Ctenophora (15 hrs)
Porifera: General characteristics and classification up to classes of phylum Porifera*. Canal system and spicules in sponges.
Ctenophora: General characteristics and evolutionary significance of phylum Ctenophora.

UNIT 3: Cnidaria (15 hrs)
Cnidaria: General characteristics and classification up to classes of phylum Cnidaria*. Metagenesis in Obelia, polymorphism in Cnidaria, corals and coral reefs.

UNIT 4: Platyhelminthes & Nemathelminthes (15 hrs)
Platyhelminthes: General characteristics and classification up to classes*. Life cycle and pathogenicity of Fasciola hepatica and Taenia solium.
Nemathelminthes: General characteristics and classification up to classes*. Life cycle and pathogenicity of Ascaris lumbricoides and Wuchereria bancrofti. Parasitic adaptations in helminthes.

*Note: Classification to be followed from “Barnes, R.D. (1982). Invertebrate Zoology, V Edition”
BZO-C1: Non-Chordates I : Protists to Pseudocoelomates

PRACTICALS

Total Lectures : 60  
Credits : 2

1. **Protozoa**: Study of whole mount of *Euglena, Amoeba* and *Paramecium*, binary fission and conjugation in *Paramecium*; examination of pond water collected from different places for diversity in Protista.


3. **Cnidaria**: Study of *Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora*.

4. **Ctenophora**: One specimen/slide of any ctenophore.

5. **Platyhelminthes**: Study of adult *Fasciola hepatica, Taenia solium* and their life cycles (slides/microphotographs).


SUGGESTED READINGS


BZO-C2: Principles of Ecology

THEORY

Total Lectures : 60
Credits : 4

Objectives:
• To educate the students about the basic environmental phenomena like ecosystem, energy flow through the ecosystem and biogeochemical cycles.
• To enable the students understand the adaptations of the animals to their environment.

UNIT 1: Introduction to Ecology (15 hrs)

UNIT 2: Population, Growth and Regulation (15 hrs)
Unitary and Modular populations
Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion.
Exponential and logistic growth, equation and patterns, r and K strategies.
Population regulation - density-dependent and independent factors.
Population interactions, Gause’s Principle with laboratory and field examples.
Lotka-Volterram equation for competition and predation.

UNIT 3: Community (15 hrs)
Community characteristics: species richness, dominance, diversity, abundance, vertical stratification
Ecotone and edge effect
Ecological succession with one example
Theories pertaining to climax community

UNIT 4: Ecosystem (15 hrs)
Types of ecosystems with one example in detail
Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains and Food web
Energy flow through the ecosystem
Ecological pyramids and Ecological efficiencies
Nutrient and biogeochemical cycle with one example of Nitrogen cycle
Human modified ecosystem
BZO-C2: Principles of Ecology
PRACTICALS

Credits: 2

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.
2. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community.
5. Determination of pH.
7. Determination of free CO₂.

SUGGESTED READINGS
GENERIC ELECTIVE SUBJECTS
Offered by Department of Zoology for students of other departments

SEMESTER I

BZO-C-GE1: ANIMAL DIVERSITY
B.Sc (Hons.) Zoology

GENERAL ELECTIVE

BZO-C-GE1: ANIMAL DIVERSITY THEORY

Total Lectures: 60  
Credits: 4

Objectives:
- To enable the students to develop an appreciation for the biodiversity of invertebrate and vertebrates.
- To impart knowledge about co-existence of different forms of living organisms ranging from unicellular to multicellular animals.

UNIT 1 (15 hrs)
Protista: General characters of protozoa; life cycle of Plasmodium.
Porifera: General characters and canal system in Porifera.
Radiata: General characters of cnidarians and polymorphism.
Aceolomates: General characters of helminthes; life cycle of Taenia solium
Pseudocoelomates: General characters of Nemethehelminthes; parasitic adaptations.

UNIT 2 (15 hrs)
Coelomate Protostomes: General characters of Annelida; metamerism.
Arthropoda: General characters, social life in insects.
Mollusca: General characters of mollusca; pearl formation
Coelomate Deuterostomes: General characters of Echinodermata, water vascular system in starfish.
Protochordata: Salient features.

UNIT 3 (15 hrs)
Pisces: Osmoregulation, migration of fishes.
Amphibia: General characters, adaptations for terrestrial life, parental care in Amphibia.
Amniotes: Origin of reptiles, terrestrial adaptations in reptiles.

UNIT 4 (15 hrs)
Aves: The origin of birds; flight adaptations
Mammalia: Early evolution of mammals; primates; dentition in mammals.
BZO-C-GE1: ANIMAL DIVERSITY
PRACTICALS

Credits: 2

1. Study of following specimens:
   **Non Chordates:** Euglena, Noctiluca, Paramecium, Sycon, Physalia, Tubipora, Metridium, Taenia, Ascaris, Nereis, Earthworm, Aphrodite, Leech, Peripatus, Limulus, hermit crab, Daphnia, millipede, centipede, beetle, Chiton, Dentalium, Octopus, Asterias and Antedon.

   **Chordates:** Balanoglossus, Amphioxus, Petromyzon, Pristis, Hippocampus, Labeo, Icthyophis/Uraeotyphlus, Salamander, Rhacophorus Draco, Uromastix, Naja, Viper, model of Archaeopteryx; Birds: pigeon, duck, crow, owl, Milvus, king fisher; Mammals: primates, scaly ant eater, spiny ant eater, dolphin, squirrel and bat.

2. Study of following permanent slides:
   Cross section of Sycon, sea anemone and Ascaris (male and female), water vascular system, tube feet, bipinnaria and pluteus larva.

3. Study of following permanent slides, charts and videos:
   - T. S. of earthworm passing through pharynx, gizzard, and typhlosolar intestine
   - Septal & pharyngeal nephridia of earthworm.
   - Unstained mounts of placoid, cycloid and ctenoid scales.

4. Demonstration of dissections with the help of flow charts, slides or videos.*
   - Digestive and nervous system of cockroach.
   - Urinogenital system of rat

*As per UGC guidelines.

**SUGGESTED READINGS**


B.Sc. (Honors) in Zoology (Semester System)  
Under the Framework of Honors School System  

Choice Based Credit System (CBCS)  

SEMESTER II
Semester II

CORE COURSE (ZOOLOGY)

Theory Papers:
Core Course-3 (BZO-C3): Non-Chordates II 100 Marks (4 credits)
Core Course-4 (BZO-C4): Cell Biology 100 Marks (4 credits)

Practicals:
Core Course-3 Practical (BZO-C3 Lab): Non-Chordates II 50 Marks (2 credits)
Core Course-4 Practical (BZO-C4 Lab): Cell Biology 50 Marks (2 credits)

GENERAL ELECTIVE (ZOOLOGY)

Theory Papers:
Each student from other disciplines may opt any two of the general electives offered by the Science Departments of Panjab University:
General Elective -2 (BZO-C-GE2) 100 Marks (4 credits)

Practicals:
General Elective -2 Practical (BZO-C-GE2 Lab) 50 Marks (2 credits)

ABILITY ENHANCEMENT COMPULSORY COURSE FOR CHEMISTRY STUDENTS

Each student of Zoology Department has to opt one Ability Enhancement Compulsory Course of the following:
Environmental Science (BZO-AECC 2) 50 Marks (2 credits)

650 Total Marks (26 Total credits)

GENERIC ELECTIVE

1. Course under these will be offered only if a minimum of 10 students opt for the same
2. Students of Zoology will opt for GE from course offered by other Departments under CBCS programme.

EVALUATION

1. There shall be one Mid Term Examination of 20% of the total marks (20 or 10 marks) in each semester.
2. End-semester examination will be of 80% of the total marks (80 or 40 marks).
3. If a subject has practical component, each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practicals of 20% marks (10 marks). The final examination will be of 80% marks (40 marks).
Pattern of end-semester question paper
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CORE COURSES (ZOOLOGY)
SEMESTER II
B.Sc (Hons.) Zoology

Semester II

BZO-C3: Non-chordates II: Coelomates

THEORY

Total Lectures: 60

Credits: 4

Objectives:

• To acquaint the students with the non-chordates i.e. Annelids, Arthropoda and Mollusca, Onychophora and Echinodermata and study their functional anatomy.

• To enable the students to understand the difference in their morphology and general anatomy and to classify and study their general characters.

• To enable the students to understand the dominance of Arthropods and their association with human welfare in a number of ways.

• To impart in depth knowledge to students about the different modes of living and structural modification acquired to suit varied living conditions.

UNIT 1: Introduction to Coelomates, Annelida (15 hrs)
Annelida: General characteristics and classification up to classes, excretion, respiration and reproduction in Annelids.

UNIT 2: Arthropoda (15 hrs)
Arthropoda: General characteristics and classification up to classes, respiration in arthropods. Metamorphosis in insects, social life in:

  a. Bees: Species, castes, division of labour, nest architecture and swarming.
  b. Termites: Castes, Nest architecture, swarming and colony formation.

UNIT 3: Mollusca (15 hrs)
Mollusca: General characteristics and classification up to classes, respiration in mollusca, torsion and detorsion in gastropoda, pearl formation in bivalves, evolutionary significance of trochophore larva.

UNIT 4: Echinodermata and Onychophora (15 hrs)
Echinodermata: General characteristics and classification up to classes, water-vascular system in Asteroidea, larval forms in Echinodermata, affinities with chordates.
Onychophora: General characteristics and evolutionary significance.
BZO-C3: Non-chordates II: Coelomates

PRACTICALS

Credits : 2

1. Study of following specimens:
   **Annelids** - Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria.
   **Arthropods** - Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta, termites and honey bees.
   **Onychophora** – Peripatus.
   **Molluscs** - Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus.
   **Echinodermates** - Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria and Antedon.

2. Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm through flow chart, slides or videos.
3. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm with the help of flow charts, slides or videos.
4. Mount of mouth parts and dissection of digestive system and nervous system of *periplaneta* through flow chart, slides or videos.
5. To submit a project report on any related topic to larval forms (crustacean, mollusk and echinoderm).


SUGGESTED READINGS

BZO-C4: Cell Biology

THEORY

Total Lectures: 60  
Credits : 4

Objectives: Cell Biology deals with the detailed study of a cell including cell structure, cell composition, cell organelles and the interaction of cells with other cells and the larger environment in which they exist.

UNIT 1: Cell and Plasma membrane (15 hrs)

Overview of Cells: Prokaryotic and eukaryotic cells, virus, viroids, mycoplasma, prions.

Plasma membrane: various models of plasma membrane structure; transport across membranes: active and passive transport, facilitated transport; cell junctions: tight junctions, desmosomes, gap junctions.

UNIT 2: Cytoskeleton and Nucleus (15hrs)

Cytoskeleton: Structure and functions: microtubules, microfilaments and intermediate filaments.


UNIT 3: Endomembrane System, Mitochondria and Peroxisomes (15 hrs)

Endomembrane system: structure and functions: endoplasmic reticulum, golgi apparatus, lysosomes.


UNIT 4: Cell division and Cell Signalling (15 hrs)

Cell Division: Mitosis, meiosis, cell cycle and its regulation.

Cell Signaling: GPCR and role of second messenger (cAMP).
BZO-C4: Cell Biology

PRACTICALS

Credits: 2

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis
2. Study of various stages of meiosis.
3. Preparation of permanent slide to show the presence of barr body in human female blood cells/cheek cells.
4. Preparation of permanent slide to demonstrate:
   i. DNA by feulgen reaction
   ii. DNA and RNA by MGP
   iii. Mucopolysaccharides by PAS reaction
   iv. Proteins by mercurobromophenol blue/fast green

SUGGESTED READINGS

GENERIC ELECTIVE SUBJECTS
Offered by Department of Zoology for students of other departments

SEMESTER II

BZO-C-GE2: HUMAN PHYSIOLOGY
BZO-C-GE2: HUMAN PHYSIOLOGY
THEORY

Total Lectures: 60
Credits: 4

Objectives:

- To enable the students know about all the physiological processes going on in the human body.
- To make the students understand the functions of hormones and their mechanism of action.

UNIT 1: Digestion and Absorption of Food. (15 hrs)
Structure and function of digestive glands; digestion and absorption of carbohydrates, fats and proteins; nervous and hormonal control of digestion (in brief).

UNIT 2: Respiratory Physiology and Renal Physiology. (15 hrs)
Ventilation, external and internal respiration, transport of oxygen and carbon dioxide in blood, factors affecting transport of gases.
Functional anatomy of kidney, mechanism and regulation of urine formation.

UNIT 3: Functioning of Excitable Tissue (Nerve and Muscle) and Cardiovascular Physiology. (15 hrs)
Structure of neuron, propagation of nerve impulse (myelinated and non-myelinated nerve fibre); structure of skeletal muscle, mechanism of muscle contraction (sliding filament theory), neuromuscular junction.
Structure of heart, coordination of heartbeat, cardiac cycle, ecg.

UNIT 4: Endocrine and Reproductive Physiology (15 hrs)
Structure and function of endocrine glands (pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, and testes), brief account of spermatogenesis and oogenesis, menstrual cycle.
BZO-C-GE2: HUMAN PHYSIOLOGY
PRACTICALS

Credits: 2

1*. Preparation of temporary mounts: neurons and blood film.
2. Preparation of haemin and haemochromogen crystals.
3*. Estimation of haemoglobin using Sahli’s haemoglobinometer.
4. Examination of permanent histological sections of mammalian oesophagus, stomach, duodenum, rectum, lung, kidney, thyroid, pancreas, adrenal, testis, ovary.

* The experiments can be performed depending upon usage of animals in UG courses.

SUGGESTED READINGS

B.Sc. (Honors) in Zoology (Semester System)
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Choice Based Credit System (CBCS)

SEMESTER III
Semester III

B.Sc (Hons.) Zoology

CORE COURSE (ZOOLOGY)

Theory Papers:
Core Course-5 (BZO-C 5): Diversity of Chordates 100 Marks (4 credits)
Core Course-6 (BZO-C 6): Physiology: Controlling and Coordinating Systems 100 Marks (4 credits)
Core Course-7 (BZO-C 7): Fundamentals Biochemistry 100 Marks (4 credits)

Practicals:
Core Course-5 Practical (BZO-C 5 Lab): Diversity of Chordates 50 Marks (2 credits)
Core Course-6 Practical (BZO-C 6 Lab): Physiology: Controlling and Coordinating Systems 50 Marks (2 credits)
Core Course-7 Practical (BZO-C 7 Lab) Fundamentals Biochemistry 50 Marks (2 credits)

GENERAL ELECTIVE (ZOOLOGY)

Theory Papers:
Each student from other disciplines may opt any two of the general electives offered by the Science Departments of Panjab University:
General Elective -3 (BZO-C-GE3) 100 Marks (4 credits)

Practicals:
General Elective -3 Practical (BZO-C-GE3 Lab) 50 Marks (2 credits)

SKILL ENHANCEMENT COMPULSORY COURSE

Each student of Zoology Department has to opt one Skill Enhancement Compulsory Course:
Skill Enhancement Course (SEC *) 50 Marks (2 credits)

650 Total Marks (26 Total credits)

GENERIC ELECTIVE

1. Course under these will be offered only if a minimum of 10 students opt for the same
2. Students of Zoology will opt for GE from course offered by other Departments under CBCS programme.

*SKILL ENHANCEMENT COURSES (any one per semester in semesters 3-4)

1. BZO-SEC1: Apiculture
2. BZO-SEC2: Aquarium Fish Keeping
3. BZO-SEC3: Medical Diagnostics
4. BZO-SEC4: Research Methodology
EVALUATION

1. There shall be one Mid Term Examination of 20% of the total marks (20 or 10 marks) in each semester.
2. End-semester examination will be of 80% of the total marks (80 or 40 marks).
3. If a subject has practical component, each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practicals of 20% marks (10 marks). The final examination will be of 80% marks (40 marks).

Pattern of end-semester question paper

(i) Nine questions in all with equal weightage (16 or 8 marks). The candidate will be asked to attempt five questions.
(ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.
(iii) The remaining eight questions will be in Four UNITs, each unit comprising of two questions.
(iv) Students will attempt one question from each UNIT and the compulsory question.

\[
\text{Computation of Semester Grade Point Average (SGPA)}
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SGPA=Total Credit point in the semester/total credits

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CORE COURSES (ZOOLOGY) 
SEMESTER III
B.Sc (Hons.) Zoology

Semester III

BZO-C5: DIVERSITY OF CHORDATES
THEORY

Total Lectures: 60  
Credits: 4

Objectives:

• To impart knowledge about origin, taxonomic classification and structure and functions of chordates
• to make the students understand the basic characters, advancements and adaptations of different types of vertebrates.

UNIT 1: (15 hrs)
Introduction to Chordates
General characteristics and outline classification
Protochordata
General characteristics of Hemichordata, Urochordata and Cephalochordata; study of larval forms in protochordates; retrogressive metamorphosis in Urochordata
Origin of Chordata
Dipleurula concept and the echinoderm theory of origin of chordates
Advanced features of vertebrates over Protochordata

UNIT 2: (15 hrs)
Agnatha
General characteristics and classification of cyclostomes up to class
Pisces
General characteristics of chondrichthyes and osteichthyes, classification up to order; migration, osmoregulation and parental care in fishes.
Amphibia
Origin of Tetrapoda (evolution of terrestrial ectotherms); general characteristics and classification up to order; parental care in amphibians.

UNIT 3: (15 hrs)
Reptilia
General characteristics and classification up to order; affinities of Sphenodon; (poison apparatus and biting mechanism in snakes).
Aves
General characteristics and classification up to order Archaeopteryx—a connecting link; principles and aerodynamics of flight, flight adaptations and migration in birds

UNIT 4: (15 hrs)
Mammals
General characters and classification up to order; affinities of prototheria; adaptive radiation with reference to locomotory appendages
Zoogeography
Zoogeographical realms, theories pertaining to distribution of animals, platetectonic and continental drift theory, distribution of vertebrates in different realms.
BZO-C5: DIVERSITY OF CHORDATES
PRACTICALS

Credits: 2

1. Protochordata
*Balanoglossus, Herdmania, Branchiostoma*, colonial urochordata sections of *Balanoglossus* through proboscis and branchiogenital regions, sections of *Amphioxus* through pharyngeal, intestinal and caudal regions with the help of flow charts, slides or videos. Permanent slide of *Herdmania* spicules

2. Agnatha
*Petromyzon, Myxine*

3. Fishes
*Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/Diodon, Anabas*, flat fish

4. Amphibia
*Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandra*

5. Reptilia
*Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus*

Key for identification of poisonous and non-poisonous snakes

6. Aves
Study of twelve common birds from different orders, types of beaks and claws

7. Mammalia
*Sorex*, bat (insectivorous and frugivorous), *Funambulus, Loris, Herpestes, Erinaceous*. demonstration of dissection of fowl head with the help of flow charts, slides or videos.

Power point presentation on study of any two animals from two different classes by students (may be included if dissections not given permission)

Classification from Young, J. Z. (2004) to be followed

SUGGESTED READINGS

BZO-C6: PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEMS (THEORY)

Total Lectures: 60  
Credtis: 4

Objectives:
- To enable the students know about all the physiological processes controlling the human body.
- To make the students understand the functions of hormones and their mechanism of action.

UNIT 1: (15 hrs)
Tissues
Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue

Bone and Cartilage
Structure and types of bones and cartilages, ossification, bone growth and resorption.

UNIT 2: (15 hrs)
Nervous System
Structure of neuron, resting membrane potential, origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; types of synapse, synaptic transmission and, neuromuscular junction; reflex action and its types - reflex arc; physiology of hearing and vision.

Muscle
Histology of different types of muscle; ultra structure of skeletal muscle; molecular and chemical basis of muscle contraction; characteristics of muscle twitch; motor unit, summation and tetanus.

UNIT 3: (15hrs)
Reproductive System
Histology of testis and ovary; physiology of male and female reproduction; puberty, methods of contraception in male and female.

UNIT 4: (15hrs)
Endocrine System
Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action; classification of hormones; regulation of their secretion; mode of hormone action, signal transduction pathways for steroidal and non-steroidal hormones; hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system; placental hormones
BZO-C6: ANIMAL PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEMS
PRACTICALS

Credits: 2

1. Recording of simple muscle twitch with electrical stimulation (or Virtual)
2. Demonstration of the unconditioned reflex action (deep tendon reflex such as knee jerk reflex)
3. Study of permanent slides of mammalian skin, squamous epithelium, striated muscle fibres and nerve cells, cartilage, bone, spinal cord, nerve cell, pituitary, pancreas, testis, ovary, adrenal, thyroid and parathyroid
4. Microtomy: Preparation of permanent slide of any five mammalian (goat/white rat) tissues.

(*Subject to UGC guidelines)

SUGGESTED READINGS

BZO-C7: FUNDAMENTALS OF BIOCHEMISTRY
THEORY

Total Lectures: 60          Credits: 4

Objectives:
• To acquaint the students with the structure, chemical properties and biological significance of macromolecules of physiological importance.

UNIT 1: (15 hrs)
Carbohydrates
Structure and biological importance: monosaccharides, disaccharides, polysaccharides and glycoconjugates.

Lipids
Structure and significance: physiologically important saturated and unsaturated fatty acids, triacylglycerols, phospholipids, glycolipids, steroids.

UNIT 2: (15hrs)
Proteins
Amino acids: Structure, classification and general properties of α-amino acids; physiological importance of essential and non-essential α-amino acids
Proteins: Bonds stabilizing protein structure; levels of organization in proteins; denaturation; introduction to simple and conjugate proteins
Immunoglobulins: Basic structure, classes and function, antigenic determinants.

UNIT 3: (15hrs)
Nucleic Acids
Structure: Purines and pyrimidines, nucleosides, nucleotides, nucleic acids cot curves: base pairing, denaturation and renaturation of DNA, types of DNA and RNA, complementarity of DNA, hypohyperchromaticity of DNA.

UNIT 4: (15hrs)
Enzymes
Nomenclature and classification; cofactors; specificity of enzyme action; isozymes; mechanism of enzyme action; enzyme kinetics; factors affecting rate of enzyme-catalyzed reactions; derivation of Michaelis-Menten equation, concept of Km and Vmax, lineweaver-burk plot; multi-substrate reactions; enzyme inhibition; allosteric enzymes and their kinetics; regulation of enzyme action.
BZO-C7: FUNDAMENTALS OF BIOCHEMISTRY
PRACTICAL

Credits: 2

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
3. Action of salivary amylase under optimum conditions.
5. Demonstration of proteins separation by SDS-PAGE.
6. Demonstration of structures of carbohydrate proteins and lipids by ball and stick models.

SUGGESTED READINGS

GENERIC ELECTIVE SUBJECTS
Offered by Department of Zoology for students of other departments

SEMESTER III

BZO-C-GE3: INSECT VECTORS AND DISEASES
BZO-C-GE3: INSECT VECTORS AND DISEASES
THEORY

Total Lectures: 60                                                                                                    Credits: 4

Objectives:
• To acquaint the students with the general and identifying features of insects.
• To introduce the student to the important insect vectors causing diseases in animals and men.

UNIT 1: (15 hrs)
Introduction to insects - general features of insects, morphological features, head – eyes, types of antennae, mouth parts w.r.t. feeding habits

Insects as Vectors- classification of insects up to orders, detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera

UNIT 2: (15 hrs)
Concept of Vectors- brief introduction of carrier and vectors (mechanical and biological vector), reservoirs, host-vector relationship, vectorial capacity, adaptations as vectors, host specificity
Dipterans as important insect vectors – mosquitoes, sand fly, houseflies
Study of house fly as important mechanical vector, myiasis, control of house fly
Fleas as important insect vectors
Human louse (head, body and pubic louse) as important insect vectors
Bugs as insect vectors; blood-sucking bugs

UNIT 3: Dipteran as Disease Vectors: (15 hrs)
Study of mosquito-borne diseases – malaria, dengue, chikungunya, viral encephalitis, filariasis; control of mosquitoes
Study of sand fly-borne diseases – visceral leishmaniasis, cutaneous leishmaniasis, phlebotomus fever; control of sand fly

UNIT 4: (15 hrs)
Siphonaptera as Disease Vectors
Host-specificity of fleas, study of flea-borne diseases – plague, typhus fever; control of fleas

Siphunculata as Disease Vectors
Study of louse-borne diseases –typhus fever, relapsing fever, trench fever, vagabond’s disease, phthiriasis; control of human louse

Hemiptera as Disease Vectors
Chagas disease, bed bugs as mechanical vectors, control and prevention measures as mechanical vectors, control and prevention measures
BZO-C-GE3: INSECT VECTORS AND DISEASES
PRACTICALS

1. Study of different kinds of mouth parts of insects with the help of flow charts, slides or videos.
2. Study of following insect vectors through permanent slides/photographs: *Aedes*, *Culex*, *Anopheles*, *Pediculus humanus capitis*, *Pediculus humanus corporis*, *Phthirus pubis*, *Xenopsylla cheopis*, *Cimex lectularius*, *Phlebotomus argentipes*, *Musca domestica* through permanent slides/photographs.
3. Study of different diseases transmitted by above insect vectors.

Submission of a project report on any one of the insect vectors and disease transmitted

SUGGESTED READINGS

B.Sc. (Honors) in Zoology (Semester System)
Under the Framework of Honors School System

Choice Based Credit System (CBCS)

SEMESTER IV
B.Sc (Hons.) Zoology

Semester IV

CORE COURSE (ZOOLOGY)

Theory Papers:
Core Course-8 (BZO-C 8): Comparative Anatomy of Vertebrates 100 Marks (4 credits)
Core Course-9 (BZO-C 9): Physiology: Life Sustaining Systems 100 Marks (4 credits)
Core Course-10 (BZO-C10): Biochemistry of Metabolic Processes 100 Marks (4 credits)

Practicals:
Core Course-8 Practical (BZO-C8 Lab): Comparative Anatomy of Vertebrates 50 Marks (2 credits)
Core Course-9 Practical (BZO-C9 Lab): Physiology: Life Sustaining Systems 50 Marks (2 credits)
Core Course-10 Practical (BZO-C10 Lab): Biochemistry of Metabolic Processes 50 Marks (2 credits)

GENERAL ELECTIVE (ZOOLOGY)

Theory Papers:
Each student from other disciplines may opt any two of the general electives offered by the Science Departments of Panjab University:
General Elective- 4 (BZO-C-GE4) 100 Marks (4 credits)

Practicals:
General Elective- 4 Practical (BZO-C-GE4 Lab) 50 Marks (2 credits)

SKILL ENHANCEMENT COMPULSORY COURSE

Each student of Zoology Department has to opt one Skill Enhancement Compulsory Course:
Skill Enhancement Course (SEC *) 50 Marks (2 credits)

650 Total Marks (26 Total credits)

*SKILL ENHANCEMENT COURSES (any one per semester in semesters 3-4)
1. BZO-SEC1: Apiculture
2. BZO-SEC2: Aquarium Fish Keeping
3. BZO-SEC3: Medical Diagnostics
4. BZO-SEC4: Research Methodology

GUIDELINES
1. Course under GE and SEC will be offered only if a minimum of 10 students opt for the same
2. Students of Zoology will opt for GE from course offered by other Departments under CBCS programme.
EVALUATION

1. There shall be one Mid Term Examination of 20% of the total marks (20 or 10 marks) in each semester.
2. End-semester examination will be of 80% of the total marks (80 or 40 marks).
3. If a subject has practical component, each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practicals of 20% marks (10 marks). The final examination will be of 80% marks (40 marks).

Pattern of end-semester question paper
(i) Nine questions in all with equal weightage (16 or 8 marks). The candidate will be asked to attempt five questions.
(ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.
(iii) The remaining eight questions will be in Four UNITs, each unit comprising of two questions.
(iv) Students will attempt one question from each UNIT and the compulsory question.

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\text{Computation of Semester Grade Point Average (SGPA)}
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4+2=6 & X= (\text{Marks}\% / 10) & 6 \times X \\
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\text{SGPA} = \text{Total Credit point in the semester / total credits}
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CORE COURSES (ZOOLOGY)
SEMESTER IV
Semester IV

BZO-C8: COMPARATIVE ANATOMY OF VERTEBRATES
THEORY

Total Lectures: 60          Credits: 4

Objectives:
• To enable the students to develop an appreciation for the biodiversity of vertebrates.
• To impart knowledge about different forms of system in an organisms which help in maintaining homeostasis.

UNIT 1: (15 hrs)
Integumentary System
Structure, functions and derivatives of integument.

Skeletal System
Overview of axial and appendicular skeleton, jaw suspensorium, visceral arches.

UNIT 2: (15 hrs)
Digestive System
Alimentary canal and associated glands, dentition.

Respiratory System
Skin, gills, lungs and air sacs; accessory respiratory organs.

UNIT 3: (14 hrs)
Circulatory System
General plan of circulation, evolution of heart and aortic arches.

Urinogenital System
Succession of kidney, evolution of urinogenital ducts, types of mammalian uteri.

UNIT 4: (15 hrs)
Nervous System
Comparative account of brain, autonomic nervous system, spinal cord, cranial nerves in mammals

Sense Organs
Classification of receptors
Brief account of visual and auditory receptors in man.
BZO-C8: COMPARATIVE ANATOMY OF VERTEBRATES
PRACTICALS

Credits: 2

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Disarticulated skeleton of frog, varanus, fowl, rabbit
3. Carapace and plastron of turtle /tortoise
4. Mammalian skulls: One herbivorous and one carnivorous animal
5. Demonstration of dissection of rat to study arterial and urinogenital system with the help of flow charts, slides or videos.
6. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted)
7. Project on skeletal modifications in vertebrates (may be included if dissection not permitted)

SUGGESTED READINGS

Total Lectures: 60          Credits: 4

Objectives:
• To make the students aware about the different physiological processes of human body.

UNIT 1: Physiology of Digestion (15 hrs)
Structural organization and functions of gastrointestinal tract and associated glands; mechanical and chemical digestion of food; absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; hormonal control of secretion of enzymes in gastrointestinal tract.

UNIT 2: Physiology of Respiration (15 hrs)
Histology of trachea and lung; mechanism of respiration, pulmonary ventilation; respiratory volumes and capacities; transport of oxygen and carbon dioxide in blood; respiratory pigments, dissociation curves and the factors influencing it; carbon monoxide poisoning; control of respiration.

UNIT 3: Renal Physiology (15 hrs)
Structure of kidney and its functional unit; mechanism of urine formation; regulation of water balance; regulation of acid-base balance.

UNIT 4: Blood and Physiology of Heart (15 hrs)
Components of blood and their functions; structure and functions of haemoglobin haemostasis: blood clotting system, haemopoiesis blood groups: Rh factor, ABO and MN.

Structure of mammalian heart; coronary circulation; origin and conduction of cardiac impulses, cardiac cycle; cardiac output and its regulation. electrocardiogram, blood pressure and its regulation.
BZO-C9: ANIMAL PHYSIOLOGY: LIFE SUSTAINING SYSTEMS
PRACTICALS

Credits: 2

1. Determination of ABO Blood group.
2. Enumeration of red blood cells and white blood cells using haemocytometer.*
3. Estimation of haemoglobin using Sahli’s haemoglobinometer*
4. Recording of blood pressure using a sphygmomanometer.
5. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney
6. Identification of blood cells in a blood smear.*
7. Differential leukocyte count. *

(*Subject to UGC guidelines)

SUGGESTED READINGS

BZO-C10: BIOCHEMISTRY OF METABOLIC PROCESSES
THEORY

Total Lectures: 60          Credits: 4

Objectives:
• To provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis
• To enable students understand the molecular and cellular mechanism for metabolism of different macromolecules.

UNIT 1: Overview of Metabolism (15 hrs)
Catabolism vs anabolism, stages of catabolism, compartmentalization of metabolic pathways, shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions; Use of reducing equivalents and cofactors; intermediary metabolism and regulatory mechanisms.

UNIT 2: Protein Metabolism (15 hrs)
Catabolism of amino acids: Transamination, deamination, urea cycle; fate of C-skeleton of glucogenic and ketogenic amino acids.

UNIT 3: Carbohydrate Metabolism (15 hrs)
Sequence of reactions and regulation of glycolysis, citric acid cycle, phosphate pentose pathway, gluconeogenesis, glycogenolysis and glycogenesis.

UNIT 4: (15 hrs)
Lipid Metabolism
β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms; biosynthesis of palmitic acid.

Oxidative Phosphorylation
Malate-aspartate and glycerol-phosphate shuttle, mitochondrial respiratory chain, inhibitors and uncouplers of electron transport system.
BZO-C10: BIOCHEMISTRY OF METABOLIC PROCESSES
PRACTICALS

Credits: 2

1. Estimation of total protein in given solutions by Lowry’s and Bradford’s method.
2. Detection of SGOT and SGPT or GST and GSH in serum/ tissue
3. To study the enzymatic activity of trypsin and lipase.
4. To perform the acid and alkaline phosphatase assay from serum/ tissue.
5. To study the effect of substrate concentration on the activity of acid phosphatase.
6. To study the effect of pH on the activity of alkaline phosphatase.
7. To carry out the quantitative estimation of glycogen in the tissue.
8. To determine glucose concentration in the RBCs.

SUGGESTED READINGS

GENERIC ELECTIVE SUBJECTS
Offered by Department of Zoology for students of other departments

SEMESTER IV

BZO-C-GE4: AQUATIC BIOLOGY
BZO-C-GE4: AQUATIC BIOLOGY
THEORY

Total Lectures: 60

Credits: 4

Objectives:

- To enable the students understand the different fresh water habitats, the classification of waterbodies based on various physicochemical and biological parameters and the importance of fishery science.

UNIT 1: Aquatic Biomes (15 hrs)

Aquatic Biomes: Brief introduction of the aquatic biomes: Freshwater ecosystem (lotic and lentic waters), wetlands, estuaries, intertidal zones, oceanic pelagic zone and marine benthic zone. Ecological classification of organisms.

UNIT 2: Freshwater Biology (15 hrs)

Streams: Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.

Lakes: Origin and classification and zonation in lakes

Physico–chemical Characteristics in lentic waters: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity and dissolved gases (Oxygen, Carbon dioxide)

Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous.

UNIT 3: Marine Biology (15 hrs)

Marine Biology: Salinity and density of Sea water
Continental shelf
Adaptations of deep sea organisms
Coral reefs
Sea weeds

UNIT 4: Management of Aquatic Resources (15 hrs)

Management of Aquatic Resources: Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment; Water quality assessment- BOD and COD.
BZO-C-GE4: AQUATIC BIOLOGY
PRACTICALS

Credits: 2

1. Determine the area of a lake using graphimetric method.
2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.
3. Determine the amount of Turbidity/transparency, Dissolved Oxygen, and Free Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from a nearby lake / water body.
4. Instruments used in limnology (Secchi disc, Conductivity meter, Turbidity meter) and their significance.
5. A Project Report on a visit to a Sewage treatment plant/Marine Bio-reserve/Fisheries Institutes.

SUGGESTED READINGS

SKILL ENHANCEMENT SUBJECTS
Offered by Department of Zoology

SEMESTER III & IV

1. BZO-SEC1: Apiculture
2. BZO-SEC2: Aquarium Fish Keeping
3. BZO-SEC3: Medical Diagnostics
4. BZO-SEC4: Research Methodology
SKILL ENHANCEMENT COURSES

BZO-SEC 1-APICULTURE

Credits: 2

UNIT 1: Biology of Bees (6 hrs)
History, classification and biology of honey bees
Social organization of bee colony

UNIT 2: Rearing of Bees (6 hrs)
Artificial bee rearing (apiary), beehives – newton and langstroth
Bee pasturage
Selection of bee species for apiculture
Bee keeping equipment
Methods of extraction of honey (indigenous and modern)

UNIT 3: Diseases and Enemies (6 hrs)
Bee diseases and enemies
Control and preventive measures

UNIT 4: (6 hrs)
Bee Economy
Products of apiculture industry and its uses (honey, bees wax, propolis), pollen etc.

Entrepreneurship in Apiculture
Bee keeping Industry – recent efforts, modern methods in employing artificial, beehives for cross pollination in horticultural gardens

SUGGESTED READINGS

UNIT 1: Introduction to Aquarium Fish Keeping (6 hrs)
• Basics of aquaculture-definition and scope
• The potential scope of Aquarium Fish Industry and export potential
• Different varieties of exotic and indigenous aquarium fish

UNIT 2: Introduction to aquarium accessories and ornamental fishes (6 hrs)
• Introduction to aquarium and aquarium accessories
• Basic knowledge and profile of some selected indigenous Indian ornamental fish

UNIT 3: Engineering aspect and construction of aquarium (6 hrs)
• Design and construction of fresh water
• Aerators, filters, lighting, plants
• Biofilters in aquarium.

UNIT 4: Maintenance of aquarium and transportation of fish (6 hrs)
• Ambient Physico-chemical conditions for aquarium keeping
• Fish feeds and use of live fish feed organisms
• Live fish transport - Fish handling, packing and forwarding techniques

SUGGESTED READINGS

BZO-SEC 3-MEDICAL DIAGNOSTICS

UNIT 1: (6 hrs)
Introduction to Medical Diagnostics and its Importance

Diagnostic Methods Used for Urine Analysis
Urine analysis: physical characteristics; abnormal constituents.

UNIT 2: Diagnostics Methods Used for Analysis of Blood (6 hrs)
Blood composition, preparation of blood smear and differential leucocyte count (d.l.c) using leishman's stain, platelet count using haemocytometer, erythrocyte sedimentary rate (e.s.r), packed cell volume (p.c.v.)

UNIT 3: (6 hrs)
Non-infectious Diseases
Causes, types, symptoms, complications, diagnosis and prevention of diabetes (type i and type ii), hypertension (primary and secondary), testing of blood glucose using glucometer/kit.

UNIT 4: (6 hrs)
Infectious diseases
Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis.

Tumours
Types (benign/malignant), detection and metastasis; medical imaging: x-ray of bone fracture, pet, mri and ct scan (using photographs).

SUGGESTED READINGS

BZO-SEC 4- RESEARCH METHODOLOGY

Credits: 2

UNIT 1: Foundations of Research (6 hrs)
Meaning, objectives, motivation: research methods vs methodology, types of research: analytical vs descriptive, quantitative vs qualitative, basic vs applied

UNIT 2: Research Design (6 hrs)
Need for research design: features of good design, important concepts related to good design- observation and facts, prediction and explanation, development of models. developing a research plan: problem identification, experimentation, determining experimental and sample designs

UNIT 3: Data Collection, Analysis and Report Writing (6 hrs)
Observation and collection of data-methods of data collection- sampling methods, data processing and analysis strategies, technical reports and thesis writing, preparation of tables and bibliography. data presentation using digital technology

UNIT 4: Ethical Issues (6 hrs)
Intellectual property rights, commercialization, copyright, royalty, patent law, plagiarism, citation, acknowledgement

SUGGESTED READINGS

B.Sc. (Honors) in Zoology (Semester System)
Under the Framework of Honors School System

Choice Based Credit System (CBCS)

SEMESTER V
**B.Sc (Hons.) Zoology**

**Semester V**

**CORE COURSE (ZOOLOGY)**

**Theory Papers:**
- Core Course-11 (BZO-C 11): Molecular Biology 100 Marks (4 credits)
- Core Course-12 (BZO-C 12): Principles of Genetics 100 Marks (4 credits)

**Practicals:**
- Core Course-11 Practical (BZO-C 11 Lab): Molecular Biology 50 Marks (2 credits)
- Core Course-12 Practical (BZO-C 12 Lab): Principles of Genetics 50 Marks (2 credits)

**DISCIPLINE SPECIFIC ELECTIVE COURSES**

**Theory Papers:**
Each student from other disciplines may opt any two of the discipline specific elective courses offered by the Departments of Zoology:
- Discipline Specific Elective (DSE**) 100 Marks (4 credits)
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**Practicals:**
- Discipline Specific Elective - Practical (DSE** Lab) 50 Marks (2 credits)
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**600 Total Marks (24 Total credits)**

**DISCIPLINE SPECIFIC ELECTIVE COURSES (any two per semester in semesters 5-6)**

1. BZO-DSE1: Endocrinology
2. BZO-DSE2: Reproductive Biology
3. BZO-DSE3: Wild Life Conservation and Management
4. BZO-DSE4: Animal Biotechnology
5. BZO-DSE5: Fish and Fisheries
6. BZO-DSE6: Parasitology
7. BZO-DSE7: Immunology
8. BZO-DSE8: Biology of Insecta

**GUIDELINES**

1. Courses under DSE will be offered only if a minimum of 10 students opt for the same

**EVALUATION**

1. There shall be one Mid Term Examination of 20% Marks (20 marks) in each semester.
2. End-semester examination will be of 80% of total marks (80 marks).
3. Each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practicals of 20% marks (10 marks). The final examination will be of 80% marks (40 marks).
**Pattern of end-semester question paper**

(i) Nine questions in all with equal weightage (16 marks). The candidate will be asked to attempt five questions.

(ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.

(iii) The remaining eight questions will be in **Four UNITs**, each unit comprising of two questions.

(iv) Students will attempt one question from each UNIT and the compulsory question.

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**Computation of Semester Grade Point Average (SGPA)**

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**Grade and Grade Points:**

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CORE COURSES (ZOOCOLOGY)
SEMESTER V
Semester V
BZO-C11: MOLECULAR BIOLOGY
THEORY

Total Lectures: 60  
Credits:

Objectives:

• To make the students understand the organization of the genetic material and its evolution, genetic code and the basic principles of genetics.

UNIT 1: (15 hrs)
Nucleic Acids
Watson and Crick model of DNA

DNA Replication
DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, Replication of circular and linear ds-DNA, replication of telomeres.

DNA Repair Mechanisms
Pyrimidine dimerization and mismatch repair, SOS, nucleotide excision repair.

UNIT 2: (15 hrs)
Transcription
RNA polymerase and transcription UNIT, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors.

Post Transcriptional Modifications and Processing of Eukaryotic RNA
Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA.

UNIT 3: (15 hrs)
Translation
Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation.

UNIT 4: (15 hrs)
Gene Regulation
Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac operon and trp operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing, Genetic imprinting.

Regulatory RNAs
Ribo-switches, RNA interference, miRNA, siRNA.
BZO-C11: MOLECULAR BIOLOGY
PRACTICALS

Credits: 2

1. Study of Polytene chromosomes from *Chironomous/Drosophila* larvae
2. Preparation of liquid culture medium (LB) and raise culture of *E. coli*
3. Estimation of the growth kinetics of *E. coli* by turbidity method
4. Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking
5. Demonstration of antibiotic sensitivity/resistance of *E. coli* to antibiotic pressure and interpretation of results
6. Quantitative estimation of DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement)
7. Quantitative estimation of RNA using Orcinol reaction
8. Study and interpretation of electron micrographs/photograph showing
   (a) DNA replication
   (b) Transcription
   (c) Split genes

SUGGESTED READINGS

BZO-C12: PRINCIPLES OF GENETICS
THEORY

Total Lectures: 60 Credits: 4

Objectives:
- This course covers genetics, the science of heredity, from its basic principles to the most recent advances in the field. Imparts basic knowledge of classical (transmission) and molecular genetics.

UNIT 1: (15 hrs)
Mendelian Genetics and its Extension
Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex-influenced and sex-limited characters inheritance.

Mutations
Types of gene mutations (Classification), Types of chromosomal aberrations (Classification, figures and with one suitable example of each), Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method.

UNIT 2: Linkage, Crossing Over and Chromosomal Mapping (15 hrs)
Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, Interference and coincidence, Somatic cell hybridization.

UNIT 3: (15 hrs)
Sex Determination
Chromosomal mechanisms of sex determination in Drosophila and Man

Extra-chromosomal Inheritance
Criteria for extra-chromosomal inheritance, Antibiotic resistance in Chlamydomonas, Mitochondrial mutations in Saccharomyces, Infective heredity in Paramecium and maternal effects.

Polygenic Inheritance
Polygenic inheritance with suitable examples; simple numericals based on it.

UNIT 4: (15 hrs)
Recombination in Bacteria and Viruses
Conjugation, Transformation, Transduction, Complementation test in Bacteriophage

Transposable Genetic Elements
Transposons in bacteria, Ac-Ds elements in maize and P elements in Drosophila, Transposons in humans.
BZO-C12: PRINCIPLES OF GENETICS  
PRACTICALS  

Credits: 2

1. To study the Mendelian laws and gene interactions.  
2. Chi-square analyses using seeds/beads.  
3. Linkage maps based on data from conjugation, transformation and transduction.  
4. Linkage maps based on data from Drosophila crosses.  
5. Study of human karyotype (normal and abnormal).  
6. Pedigree analysis of some human inherited traits.

SUGGESTED READINGS

B.Sc. (Honors) in Zoology (Semester System)  
Under the Framework of Honors School System  

Choice Based Credit System (CBCS)  

SEMESTER VI
Semester VI

B.Sc (Hons.) Zoology

CORE COURSE (ZOOLOGY)

Theory Papers:
Core Course-13 (BZO-C13): Developmental Biology 100 Marks (4 credits)
Core Course-14 (BZO-C14): Evolutionary Biology 100 Marks (4 credits)

Practicals:
Core Course-13 Practical (BZO-C13 Lab): Developmental Biology 50 Marks (2 credits)
Core Course-14 Practical (BZO-C14 Lab): Evolutionary Biology 50 Marks (2 credits)

DISCIPLINE SPECIFIC ELECTIVE COURSES

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CORE COURSES (ZOOLOGY)
SEMESTER VI
B.Sc (Hons.) Zoology

SEMESTER VI

BZO-C13: DEVELOPMENTAL BIOLOGY
THEORY

Total Lectures: 60         Credits: 4

Objectives:

• To enable the students understand the processes of development in various animals and the phenomena associated with them.
• It also aims to make students understand the genetic involvement and the role of maternal environment on fetal development.
• It will also enable the students understand the environmental influences on development.

UNIT 1: (15 hrs)

Introduction

Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division

Implications of Developmental Biology

Teratogenesis: Teratogenic agents and their effects on embryonic development; In vitro fertilization, Stem cell (ESC), Amniocentesis

UNIT 2: Early Embryonic Development (15 hrs)

Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula.

UNIT 3: Late Embryonic Development (15 hrs)

Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizers

Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)

UNIT 4: Post Embryonic Development (15 hrs)

Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories.
BZO-C12: DEVELOPMENTAL BIOLOGY
PRACTICALS

Credits: 2

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)
2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
3. Study of the developmental stages and life cycle of Drosophila from stock culture
4. Study of different sections of placenta (photomicrograph/ slides)
5. Project report on Drosophila culture/chick embryo development

SUGGESTED READINGS

BZO-C13: EVOLUTIONARY BIOLOGY
THEORY

Total Lectures: 60          Credits: 4

Objectives:
• To enable the students understand the mechanism and process of origin and evolution of life on earth.
• It also aims to educate the students about population genetics and its phylogeny.

UNIT 1: (15 hrs)
Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes

Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism

Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches)

UNIT 2: (15 hrs)
Extinctions, Back ground and mass extinctions (causes and effects), detailed example of K-T extinction.

Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from Dryopithecus leading to Homo sapiens, molecular analysis of human origin.

Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees, interpretation of trees

UNIT 3: (15 hrs)
Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse, Molecular (universality of genetic code and protein synthesising machinery, three domains of life, neutral theory of molecular evolution, molecular clock ,example of globin gene family, rRNA/cyt c

Sources of variations: Heritable variations and their role in evolution

UNIT 4: (15 hrs)
Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, selection coefficient, derivation of one UNIT of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. Genetic Drift (mechanism, founder’s effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies.
BZO-C13: EVOLUTIONARY BIOLOGY
PRACTICALS

Credits: 2

1. Study of fossils from models/ pictures
2. Study of homology and analogy from suitable specimens
3. Study and verification of Hardy-Weinberg Law by chi square analysis
4. Demonstration of role of natural selection and genetic drift in changing allele frequencies using
   simulation studies
5. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in
   relation to their age and sex.
6. Construction of phylogenetic trees with the help of bioinformatics tools (Clustal X, Phylip, NJ) and its
   interpretation.

SUGGESTED READINGS

   9780763700669.
   9780321558237.
   ISBN No.- 9781118129210.
   9780470085851.
DISCIPLINE SPECIFIC ELECTIVE SUBJECTS

SEMESTER V & VI

1. BZO-DSE1: Endocrinology
2. BZO-DSE2: Reproductive Biology
3. BZO-DSE3: Wild Life Conservation and Management
4. BZO-DSE4: Animal Biotechnology
5. BZO-DSE5: Fish and Fisheries
6. BZO-DSE6: Parasitology
7. BZO-DSE7: Immunology
8. BZO-DSE8: Biology of Insecta
DISCIPLINE SPECIFIC ELECTIVE

BZO-DSE1- ENDOCRINOLOGY
THEORY

Total Lectures: 60

UNIT 1: Introduction to Endocrinology (15hrs)
History of endocrinology, Classification, Characteristic and Transport of Hormones, Neurosecretions and Neurohormones.

Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction.

UNIT 2: Epiphysis, Hypothalamo-hypophysial Axis (15hrs)
Structure of hypothalamus, Hypothalamic nuclei and their functions, Regulation of neuroendocrine glands, Feedback mechanisms
Structure of pituitary gland, Hormones and their functions, Hypothalamohypophysial portal system, Disorders of pituitary gland.

UNIT 3: Peripheral Endocrine Glands (15hrs)
Structure, Hormones, Functions and Regulation of Thyroid gland, Parathyroid, Adrenal, Pancreas, Ovary and Testis.
Disorders of endocrine glands.

UNIT 4: Regulation of Hormone Action (15hrs)
Hormone action at Cellular level: Hormone receptors, transduction and regulation Hormone action at Molecular level: Molecular mediators, Genetic control of hormone action, Hormones in homeostasis.
BZO-DSE1-ENDOCRINOLOGY
PRACTICALS

Credits: 2

1. Dissect and display of Endocrine glands in laboratory bred rat.*
2. Study of the permanent slides of all the endocrine glands.
3. Procurement and permanent slide preparation of the following endocrine glands from the slaughter house:
   i. Pancreas
   ii. Adrenal
   iii. Thyroid
   iv. Testes
   v. Ovary
4. Estimation of plasma level of any hormone using ELISA.

SUGGESTED READINGS

UNIT 1: Reproductive Endocrinology (15 hrs)

UNIT 2: Functional anatomy of male reproduction (15 hrs)
Outline and histological of male reproductive system in rat and human; Testis: Cellular functions, germ cell, system cell renewal; Spermatogenesis: kinetics and hormonal regulation; Androgen synthesis and metabolism; Epididymal function and sperm maturation; Accessory glands functions; Sperm transportation in male tract.

UNIT 3: Functional anatomy of female reproduction (15 hrs)
Outline and histological of female reproductive system in rat and human; Ovary: folliculogenesis, ovulation, corpus luteum formation and regression; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (rat and human) and their regulation, changes in the female tract; Ovum transport in the fallopian tubes; Sperm transport in the female tract, fertilization; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, foeto – maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation.

UNIT 4: Reproductive Health (15 hrs)
Infertility in male and female: causes, diagnosis and management; Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST; Modern contraceptive technologies; Demographic terminology used in family planning.
BZO-DSE2-REPRODUCTIVE BIOLOGY
PRACTICALS

Credits: 2

1. Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.
2. Examination of vaginal smear rats from live animals.
4. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
5. Human vaginal exfoliate cytology.
7. Study of modern contraceptive devices.

SUGGESTED READINGS

BZO-DSE3-WILD LIFE CONSERVATION AND MANAGEMENT THEORY

Total Lectures: 60         Credits: 4

UNIT 1: Introduction to Wild Life (15 hrs)
Values of wild life- positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies.

UNIT 2: Evaluation and management of wild life (15 hrs)
Habitat analysis, Physical parameters: Topography, Geology, Soil and water; Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures: remote sensing and GIS.

Management of habitats
Setting back succession; Grazing logging; Mechanical treatment; Advancing the successional process; Cover construction; Preservation of general genetic diversity; Restoration of degraded habitats

UNIT 3: Population estimation (15 hrs)
Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, Hair identification, Pug marks and census method.

Management planning of wild life in protected areas
Estimation of carrying capacity; Eco-tourism/Wild life tourism in forests; Concept of climax persistence; Ecology of perturbence.

UNIT 4: Management of excess population (15 hrs)
Bio-telemetry; Care of injured and diseased animal; Quarantine; Common diseases of wild animal

Protected areas
National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; management challenges in Tiger reserve.
BZO-DSE3-WILDLIFE CONSERVATION AND MANAGEMENT PRACTICALS

Credits: 2

1. Identification of mammalian fauna, avian fauna, herpeto-fauna
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses)
3. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc.
4. Demonstration of different field techniques for fauna
5. Trail/transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences)

SUGGESTED READINGS

BZO-DSE4-ANIMAL BIOTECHNOLOGY
THEORY

Credits: 4

UNIT 1: Introduction (15 hrs)
Concept and scope of biotechnology.
Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics).
Restriction enzymes: Nomenclature, detailed study of Type II. Transformation techniques: Calcium chloride method and electroporation.

UNIT 2: Molecular Techniques in Gene manipulation (15 hrs)
Construction of genomic and cDNA libraries and screening by colony and plaque hybridization.
Southern, Northern and Western blotting DNA sequencing: Sanger method.
Polymerase Chain Reaction, DNA Finger Printing and DNA microarray.

UNIT 3: Genetically Modified Organisms (15 hrs)
Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection.
Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knockout mice.
Production of transgenic plants: Agrobacterium mediated transformation. Applications of transgenic plants: insect and herbicide resistant plants.

UNIT 4: Culture Techniques and Applications (15 hrs)
Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia).
Recombinant DNA in medicines: Recombinant insulin and human growth hormone, Gene therapy.
BZO-DSE4-ANIMAL BIOTECHNOLOGY
PRACTICALS

Credits: 2

1. Genomic DNA isolation from *E. coli*.
2. Plasmid DNA isolation (pUC 18/19) from *E. coli*.
3. Restriction digestion of plasmid DNA.
4. Construction of circular and linear restriction map from the data provided.
5. Calculation of transformation efficiency from the data provided.
6. To study following techniques through photographs.
   a. Southern Blotting
   b. Northern Blotting
   c. Western Blotting
   d. DNA Sequencing (Sanger’s Method)
   e. PCR
   f. DNA fingerprinting
7. Project report on animal cell culture.

SUGGESTED READINGS

UNIT 1: General classification of fishes (15 hrs)
Introduction and Classification
General description of fish; Account of systematic classification of fishes (up to classes); Classification based on feeding habit, habitat and manner of reproduction.

UNIT 2: General account of fish morphology and physiology-I (15 hrs)
Body form in various groups of fishes (cartilaginous and bony fishes)
Body coverings: Scales, types (placoid, cosmoid, ganoid, cycloid, ctenoid), functions and modifications
Fins and locomotion: Structure of typical fin of a bony fish, paired fins, unpaired fins and the modifications of the fins
Buoyancy: Structure of swim bladder, variations of swim bladder in different groups of fishes, functions of swim bladder. Weberian ossicles and swim bladder

UNIT 3 General account of fish Morphology and physiology-II (15 hrs)
Respiration: Structure of typical gill, types and variations of gills in various groups of fishes, air breathing organs in fishes
Osmoregulation
Reproductive strategies (special reference to Indian fishes)
Mechanoreceptors
Electric organs and Bio-luminescence

UNIT 4 Fish in research and fish behaviour (15 hrs)
Schooling, Parental care
Migration
Electric organs and bioluminiscense
Transgenic fish, zebrafish as a model organism in research
Maintenance, housing and care of zebra fish in aquarium
BZO-DSE5--FISH AND FISHERIES
PRACTICALS

Credits: 2

1. Museum specimens: General account of Elasmobranchs and Teleosts.
2. Study of variation in body form of fish with museum specimens.
4. Study of different types of scales (through permanent slides/photographs).
5. Study of air breathing organs in *Channa, Heteropneustes, Anabas* and *Clarias* through pictures and videos.
7. Project Report on a visit to any fish farm/zebra fish rearing laboratory.

SUGGESTED READINGS

UNIT I: (15 hrs)
*Introduction to Parasitology*
Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector). Host parasite relationship

*Parasitic Protists*
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Entamoeba histolytica, Giardia intestinalis, Trypanosoma gambiense, Leishmania donovani, Plasmodium vivax*

UNIT II: Parasitic Platyhelminthes (15 hrs)
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Fasciola hepatica, Schistosoma haematobium, Taenia solium and Hymenolepis nana*

UNIT III: Parasitic Nematodes (15 hrs)

UNIT IV: (15 hrs)
*Parasitic Arthropoda*
Biology, importance and control of ticks, mites, *Pediculus humanus* (head and body louse), *Xenopsylla cheopis and Cimex lectularius*

*Parasitic Vertebrates*
A brief account of parasitic vertebrates; Cookicutter Shark, Candiru, Hood Mockingbird and Vampire bat
BZO-DSE6-- PARASITOLOGY
PRACTICALS

Credits :2

1. Study of life stages of *Entamoeba histolytica*, *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani* and *Plasmodium vivax* through permanent slides/micro photographs.
2. Study of adult and life stages of *Fasciola hepatica*, *Schistosoma haematobium*, *Taenia solium* and *Hymenolepis nana* through permanent slides/micro photographs.
3. Study of adult and life stages of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis* through permanent slides/micro photographs.
5. Study of *Pediculus humanus* (Head louse and Body louse), *Xenopsylla cheopis* and *Cimex lectularius* through permanent slides/photographs.
6. Study of nematode/cestode parasites from the intestines of sheep/goat.

[Intestine can be procured from poultry/market as a byproduct]
Submission of a brief report on parasitic vertebrates.

SUGGESTED READINGS

BZO-DSE7- IMMUNOLOGY
THEORY

Total Lectures :60
Credits :4

Objectives:

• To acquaint the students with the basic concepts of immunology and the immune effector mechanisms. To make the student understand the role of immunity in controlling the pathogenic infection.

UNIT 1: Overview of Immune System, Innate and Adaptive Immunity. (15 hrs)
Historical perspective of Immunology, Early theories of Immunology, Cells and organs of the Immune system.
Anatomical barriers, inflammation, cell and molecules involved in innate immunity, adaptive immunity (cell mediated and humoral), Passive: artificial and natural immunity, Active: artificial and natural immunity, immune dysfunctions (brief account of autoimmunity with reference to Rheumatoid Arthritis and tolerance, AIDS).

UNIT 2: Antigens and Immunoglobulins. (15 hrs)
Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes.
Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA and RIA), Polyclonal sera.

UNIT 3: Major MHC, Cytokines and Hybridoma technology. (15 hrs)
Structure and functions of MHC molecules. Endogenous and exogenous pathways of antigen processing and presentation.
Properties and functions of cytokines, Therapeutics Cytokines.
Hybridoma technology: Monoclonal antibodies in therapeutics and diagnosis.

UNIT 4: Complement System, Hypersensitivity and Vaccines. (15 hrs)
Components and pathways of complement activation.
Gell and Coombs’ classification and brief description of various types of hypersensitivities. Various types of vaccines.
BZO-DSE7- IMMUNOLOGY
PRACTICALS

Credits: 2

1. Demonstration of lymphoid organs.
2. Histological study of spleen, thymus and lymph nodes through slides/photographs
3. Preparation of stained blood film to study various types of blood cells.
5. ABO blood group determination.
6. Cell counting and viability test from splenocytes of laboratory animals/cell lines.
7. Demonstration of:
   a. ELISA
   b. Immunoelectrophoresis

* The experiments can be performed depending upon usage of animals in UG courses.

SUGGESTED READINGS

UNIT 1: Introduction (15 hrs)
General features of insects.
Distribution and success of insects on the earth; structure and physiology of digestive and nervous systems, sensory receptors.
Insects as mechanical and biological vectors, brief discussion on houseflies and mosquitoes as important insect vectors.

UNIT 2: Insect Taxonomy (15 hrs)
Basis of insect classification; classification of insects up to orders.
Growth and metamorphosis.
External features; head, eyes, types of antennae.

UNIT 3: General Morphology of Insects (15 hrs)
Mouth parts of insects with respect to their feeding habits.
Thorax: wings and wing articulation, types of Legs adapted to diverse habitat.
Abdominal appendages and genitalia.

UNIT 4: Physiology of Insects (15hrs)
Structure and physiology of insect body systems - excretory, respiratory and reproductive system.
BZO-DSE8- BIOLOGY OF INSECTA
PRACTICALS

Credits: 2

1. Study of one specimen from each insect order
2. Study of different kinds of antennae, legs and mouth parts of insects
3. Study of head and sclerites of any one insect
4. Study of insect wings and their venation.
5. Methodology of collection, preservation and identification of insects through power point.
6. Morphological studies of various castes of *Apis*, *Camponotus* and *Odontotermes*
7. Study of any three insect pests and their damages
8. Study of any three beneficial insects and their products

Field study of insects and submission of a project report on the insect diversity

SUGGESTED READINGS