

Programme: **B.Sc. Semester-V NEP (Zoology- Major)**

Course Category: **Discipline Specific Core (DSC)**

Name of Course: **General Mammalian Physiology – Paper I**

Theory- 2 Credits + Practical - 1 Credit

Course Outcomes (COs)

After successful completion of this course, students will be able to:

CO1: To describe the structural organization and physiological aspects of mammalian digestive, respiratory, circulatory, and excretory systems.

CO2: To understand biochemical and physiological mechanisms involved in digestion, respiration, blood circulation, and urine formation.

CO3: To understand the regulatory mechanisms controlling major physiological processes in mammals.

CO4: To acquire knowledge of various physiological disorders, including respiratory disorders, cardiovascular diseases, and renal dysfunctions.

CO5: Apply theoretical physiological concepts to laboratory experiments and interpret experimental data scientifically.

CO6: Identify and interpret the histological structure of major mammalian organs including digestive, respiratory, and excretory tissues.

CO7: Develop practical laboratory skills, observation ability, data interpretation skills, and understanding of clinical relevance in physiology.

THEORY

Course Code: **BZO5T09**

Credits: **2**

Teaching Hours: **30 Hrs.**

Unit – I: Digestive Physiology

7 Hrs 30 Mins

1.1 Structure and functions of Digestive glands: Salivary, Gastric, Intestinal, Liver and Pancreas

1.2 Digestion and Absorption of Food: Carbohydrates, Proteins and Lipids

1.3 Regulation of Digestion: Neural regulation of digestion, Hormonal regulation - Gastrointestinal hormones



1.4 Gastrointestinal Disorder: Achalasia, Gastritis, Pancreatitis, Colitis, Irritable Bowel Syndrome (IBS), and peptic ulcers,

Unit – II: Respiratory Physiology

7 Hrs 30 Mins

2.1 Respiratory Organs in Mammals: Structure of lungs, Bronchial tree, Alveoli and respiratory membrane

2.2 Mechanism of Breathing: Inspiration and expiration, Role of diaphragm and intercostal muscles, Lung volumes and capacities

2.3 Transport of Respiratory Gases: Transport of oxygen by haemoglobin, Oxygen dissociation curve, Transport of carbon dioxide, Regulation of blood pH

2.4 Respiratory disorders: Acute disorder (Apnoea, Dyspnoea, Hypoxia, Hypercapnia) and Chronic disorder (Asthma, Chronic Obstructive Pulmonary Disease (COPD)).

Unit – III: Circulatory Physiology

7 Hrs 30 Mins

3.1 Blood: Composition and functions of blood, Mechanism of blood clotting – intrinsic and extrinsic factors.

3.2 Heart and Cardiac Cycle: Structure of mammalian heart, Cardiac cycle

3.3 Electrocardiogram (ECG) and Blood Pressure: Electrocardiogram (ECG), Blood pressure and its regulation, Hypertension and hypotension

3.4 Lymphatic System: Composition and functions of lymph, Lymphatic vessels and organs

Unit – IV: Excretory Physiology

7 Hrs 30 Mins

4.1 Structure of Mammalian Kidney: External and internal structure, Nephron structure, Blood supply of kidney, Juxtaglomerular apparatus

4.2 Formation of Urine: Glomerular filtration, Tubular reabsorption, Tubular secretion, Counter-current mechanism, Dialysis.

4.3 Regulation of Urine Formation: Role of ADH, Role of aldosterone, Role of Angiotensin Regulation of water and electrolyte balance, Acid–base balance

4.4 Disorders of Excretory System: Uremia, Renal failure, Nephritis, Renal Calculi (Kidney stones), Ketonuria.

***(80 Marks Theory Paper and 20 Marks for Theory CIE)**



PRACTICAL

Course Code: **BZO5P09**

Credit: 1

Teaching Hours: 30 Hrs

List of Practical

1. Detection of action of salivary amylase on starch
2. Detection of carbohydrates, proteins and Lipids using Qualitative tests.
3. Study of oxygen dissociation curve, using charts, photographs, models or ICT tools.
4. Measurement of lung capacity with Spirometer
5. Preparation Haemin crystal
6. Total count of WBC and RBC
7. Detection of Blood Group
8. Detection of urea, albumin, sugar and creatin in urine
9. Study of histological slides of Mammal – T.S. salivary gland, T.S. stomach, T.S. intestine, T.S. pancreas, T.S. liver, T.S. lung and T.S. kidney

Assessment Scheme

B.Sc. Semester V – General Mammalian Physiology I (Practical)

Course Type: Discipline Specific Core (DSC)

Course Code: BZO5P09

Credits: 1

Total Marks: 50

- Continuous Internal Evaluation (CIE): 25 Marks
- Semester End Examination (SEE): 25 Marks

I. Continuous Internal Evaluation (CIE) – 25 Marks

Component	Description	Marks
Practical Performance	Performance in biochemical and physiological experiments	10
Practical Record / Journal	Maintenance of record with diagrams, results and interpretations, regular submission	5
Internal Test / Skill Assessment	Short practical-based test / spot identification	5
Viva Voce (Internal)	Conceptual understanding of experiments	5
Total		25



II. Semester End Examination (SEE) – 25 Marks

Practical Examination Pattern

Component	Description	Marks
Major Practical	Any one experiment (WBC/RBC count, detection of salivary amylase, urine analysis,)	10
Minor Practical	Any one experiment (Blood group, Haemin crystal, qualitative test Carbohydrate, proteins and lipids)	5
Spotting (5 spots × 1 mark)	Histological Slides	5
Viva Voce	Questions related to performed experiment	3
Record Verification	Certified journal submission	2
Total		25

List of Recommended Books:

1. Guyton, A.C. & Hall, J.E. – *Textbook of Medical Physiology*, Elsevier.
2. Widmaier, E.P., Raff, H., & Strang, K.T. – *Vander's Human Physiology: The Mechanisms of Body Function*, McGraw-Hill.
3. Tortora, G.J. & Derrickson, B.H. – *Principles of Anatomy and Physiology*, Wiley.
4. Hadley, M.E. & Levine, J.E. – *Endocrinology*, Pearson.
5. Knobil, E. & Neill, J.D. (Eds.) – *Knobil & Neill's Physiology of Reproduction*, Academic Press.
5. William F. Ganong - *Review of Medical Physiology*, McGraw-Hill.
6. Lauralee Sherwood - *Human Physiology*, Cengage Learning.
7. Text book of Zoology DSC Semester V – Himalaya Publication House
8. A.K. Berry - *Textbook of Animal Physiology*, Emkay Publishers.
9. C. C. Chatterjee – *Human Physiology Vol I & II* , CBS Publisher



Programme: **B.Sc. Semester - V NEP (Zoology - Major)**

Course Category: **Discipline Specific Course (DSC)**

Name of the Course: **Applied Zoology**

Theory- 2 Credits + Practical - 1 Credit

Course Outcomes (COs): After completion of this course, students will be able to:

CO1: Explain aquaculture practices and fisheries resources for sustainable production.

CO2: Apply knowledge of apiculture, sericulture, and lac culture for entrepreneurship.

CO3: Understand scientific animal husbandry practices and livestock management.

CO4: Demonstrate basic understanding of modern biological instruments and laboratory techniques.

CO5: Apply zoological knowledge in agriculture, industry, and biotechnology sectors.

CO6: Develop observational, documentation, and reporting skills through field visits to fish farms, apiaries, dairy, or poultry units.

CO7: Apply practical zoological knowledge for entrepreneurship, pest management, aquaculture, and allied biological sectors.

THEORY

Course Code: **BZO5T10**

Credits: **2**

Teaching Hours: **30 Hrs**

Unit I: Aquaculture and Fisheries

7 Hrs 30 Mins

1.1 Pearl Culture: Principles and history of pearl culture; pearl-producing molluscs; techniques of pearl oyster culture; grafting and nucleus implantation; pearl harvesting and economic importance.

1.2 Prawn Culture: Species of commercial importance; life cycle of prawn (*M. rosenbergii*); hatchery technology; pond preparation and management; diseases and their control; economic prospects.

1.3 Inland and Marine Fisheries: Fishery resources of India; freshwater, brackish water, and marine fisheries; fish preservation, processing, and marketing.

1.4 Fish Nutrition and Feed Technology: Nutritional requirements of fish; feed formulation and feed types; artificial feed production; feeding strategies and feed management.



Unit II: Applied Entomology

7 Hrs 30

Mins 2.1 Apiculture: Species of honey bees; social organization; Movable Frame Hive; Honey, beeswax, propolis, and royal jelly — their composition, economic importance, and marketing strategies.

2.2 Sericulture: Types of Silkworm, Life cycle and rearing of mulberry and non-mulberry silkworm (*Antheraea mylitta*); brief idea of silk production, processing, and marketing.

2.3 Lac Culture: Life cycle of lac insect; lac processing, lac products - processing, economic significance, and marketing strategies.

2.4 Pest and Pest Management: Classification of pests—agricultural, stored-grain, veterinary, and medical pests; principles and approaches to pest control, including (i) biological control using predators and parasites with their merits and limitations, and (ii) chemical control using pyrethroids and carbamates, along with their advantages and drawbacks.

.Unit III: Animal Husbandry

7 Hrs 30 Mins

3.1 Poultry Farming: Introduction to poultry birds (chicken, turkey, duck, ostrich); basic principles of housing and feeding, common diseases and their management, egg and meat production systems, economic importance of poultry farming.

3.2 Goat Farming: Introduction to important goat breeds (Jamunapari, Osmanabadi, Black Bengal), basic feeding and housing management, health care and disease prevention, economic importance of goat farming in rural and commercial sectors.

3.3 Dairy Farming: Introduction to major breeds of cattle (Sahiwal, Gir, Holstein Friesian, Jersey) and buffalo (Murrah, Mehsana, Jaffarabadi), basic dairy management practices and common diseases, economic importance of the dairy industry..

3.4 Pig Farming: Introduction to important pig breeds (Ghungroo, Doom, Large White Yorkshire), housing and feeding management, and disease control; economic importance of pig farming.

Unit IV: Biological Instrumentation and Techniques

7 Hrs 30 Mins

4.1 Microscopy: Structure and applications of advanced microscopes: Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Confocal microscope, and Phase-contrast microscope.

4.2 Electrophoresis: Principles and applications of agarose gel electrophoresis, SDS-PAGE, and native PAGE.



4.3 Separation of Biomolecules: Principles and applications of gel filtration chromatography and ion-exchange chromatography.

4.4 Animal Cell Culture and Flow Cytometry: Principles of animal cell culture; culture media and aseptic techniques; applications; introduction to flow cytometry and its biological applications.

***(80 Marks Theory Paper and 20 Marks for Theory CIE)**

PRACTICAL

Course Code: **BZO5P10**

Credit: 1

Teaching Hours: **30 Hrs**

1. Identification and systematic study of economically important freshwater and marine species, including *Catla catla*, *Labeo rohita* (Rohu), *Cirrhinus mrigala* (Mrigal), *Ctenopharyngodon idella* (Grass Carp), *Hypophthalmichthys molitrix* (Silver Carp), *Cyprinus carpio* (Common Carp), *Channa* spp. (Snakehead), *Clarias batrachus*, *Heteropneustes fossilis*, *Wallago attu*, *Mystus* spp., prawns (*Macrobrachium rosenbergii*, *Penaeus monodon*), and pearl oyster (*Pinctada fucata*), with reference to their morphological features and economic importance, using charts, photographs, specimens or ICT tools.
2. Study of Agriculture pest – Grasshopper, Red Cotton Bug, Gram Pod Borer, Cotton Pink Bollworm, Cotton Spotted Bollworm, using charts, photographs, specimens or ICT tools.
3. Study of Medical pest – House Fly, Mosquito, *Pediculus Humanus*, using charts, photographs, specimens or ICT tools.
4. Study of Veterinary pest – Stable Fly, Dog Tick, Bird Lice, using charts, photographs, specimens or ICT tools.
5. Study of Stored grain pest – Stored grain weevil, Flour moth, using charts, photographs, specimens or ICT tools.
6. Study of Useful insects – Honeybee, Silk Moth, Lac Insect, using charts, photographs, specimens or ICT tools.
7. Mounting : Mouth parts, Legs, Wings of any Insects and Sting of Honeybee



8. Demonstration of chromatography and electrophoresis techniques.
9. Study and demonstration of basic laboratory instrumentation, including autoclave, centrifuge, pH meter, oven, and micropipette, with emphasis on their principles, operation, and applications in biological laboratories.
10. Visit to fish farm / apiary / dairy / poultry unit and submission of report.

Assessment Scheme

B.Sc. Semester V – Applied Zoology (Practical)

Course Type: Discipline Specific Core (DSC)

Course Code: BZO5P10

Credits: 1

Continuous Internal Evaluation (CIE) – 50 Marks

Component	Description	Marks
Practical Performance	Performance in Identification, Mounting, Instrument Handling and Participation & Laboratory Conduct	20
Practical Record / Journal	Maintenance of record with diagrams, results, Completion and regular submission	10
Internal Test / Skill Assessment	Short practical-based test / spot identification	10
Field Visit Report	Content relevance and accuracy, Observational skills, Presentation	5
Viva Voce (Internal)	Conceptual understanding, Economic importance, Instrument principles, Pest classification	5
Total		50

List of Recommended Books:

1. Pillay, T.V.R. & Kutty, M.N. (2005). *Aquaculture: Principles and Practices*. Blackwell Publishing.
2. Jhingran, V.G. (2010). *Fish and Fisheries of India*. Hindustan Publishing Corporation.
3. New, M.B. & Valenti, W.C. (2000). *Freshwater Prawn Culture: The Farming of Macrobrachium rosenbergii*. Blackwell Science.
4. Mishra, R.C. (1995). *Honey Bees and Their Management in India*. ICAR Publications.
5. Ganga, G. & Chetty, J.S. (1991). *An Introduction to Sericulture*. Oxford & IBH Publishing.



6. Srivastava, R.P. & Ramamurthy, V.V. (2017). *Lac Culture and Technology*. Indian Council of Agricultural Research (ICAR).
7. Dhaliwal, G.S. & Arora, R. (2010). *Principles of Insect Pest Management*. Kalyani Publishers.
8. Banerjee, G.C. (2018). *A Textbook of Animal Husbandry*. Oxford & IBH Publishing.
9. ICAR Handbook of Animal Husbandry (Latest Edition). ICAR Publications.
10. Textbook of Zoology Semester V. Himalaya Publishing House.
11. Singh, R.A. (2008). *Poultry Production*. Kalyani Publishers.
12. Upadhyay, A., Upadhyay, K. & Nath, N. (2017). *Biophysical Chemistry: Principles and Techniques*. Himalaya Publishing House.



Programme: **B.Sc. Zoology – Semester V NEP (Zoology – Major)**

Course Category: **Discipline Specific Core (DSC)**

Name of the Course: **Evolutionary Biology**

Theory- 2 Credits + Practical - 1 Credit

Course Outcomes (COs): After completion of this course, students will be able to:

CO1: Explain the origin of life and major evolutionary events.

CO2: Describe mechanisms of evolution and population genetics principles.

CO3: Understand speciation processes and macroevolutionary patterns.

CO4: Illustrate human evolution and molecular evolutionary concepts.

CO5: Apply evolutionary principles in medicine, agriculture, and conservation.

CO6: Identify and interpret major fossil forms and fossil replicas, and explain their evolutionary significance.

CO7: Construct and interpret phylogenetic trees and cladograms to understand evolutionary relationships among organisms.

CO8: Differentiate between homologous and analogous organs and explain evolutionary importance of connecting links such as *Archaeopteryx* and *Peripatus*.

THEORY

Course Code: **BZO5T11**

Credits: **2**

Teaching Hours: **30 Hrs**

Unit I: Origin of Life and Early Evolution

1.1 Theories of origin of life – Chemical evolution, Oparin–Haldane concept, Miller–Urey experiment

1.2 Evolution of prokaryotes and eukaryotes – endosymbiotic theory

1.3 Geological time scale - Precambrian, Paleozoic Era, Mesozoic Era, Cenozoic Era and Overview of major evolutionary events (Origin of prokaryotes, Evolution of eukaryotic cells (endosymbiotic theory), Transition from water to land, Evolution of amniotic egg.)

1.4 Fossils and fossilization – types, dating methods, and significance



Unit II: Mechanisms of Evolution

- 2.1 Sources of variation – mutation and recombination
- 2.2 Population genetics – gene pool, allele frequency, Hardy–Weinberg equilibrium
- 2.3 Forces of evolution – natural selection, genetic drift, gene flow
- 2.4 Types of Evolution – Divergent evolution, Convergent evolution and Adaptive radiation

Unit III: Speciation and Macroevolution

- 3.1 Concept of species and isolating mechanisms
- 3.2 Modes of speciation - Allopatric, Perpatric, Parapatric and Sympatric
- 3.3 Patterns of evolution – Phyletic gradualism and Punctuated equilibrium
- 3.4 Mass extinction - Concept of Mass Extinction, Big Five Mass Extinction Events (Overview Only), Causes of Mass Extinction and evolutionary radiations

Unit IV: Human Evolution and Applied Evolution

- 4.1 Primate Characteristics and Major Primate Groups - Diagnostic features of primates, Evolutionary origin of primates (brief overview), New World monkeys, Old World monkeys and apes
- 4.2 Evolution of humans – *Australopithecus*, *Homo habilis*, *Homo erectus*, *Homo neanderthalensis*, *Homo sapiens*
- 4.3 Molecular evolution – molecular clock (Definition, Concept that mutations accumulate at a relatively constant rate over time, Use of molecular clock to estimate divergence time) and phylogeny (Phylogenetic trees - cladograms vs phylograms, Nodes, branches, common ancestor, Monophyletic, paraphyletic, and polyphyletic groups, Concept of homology vs analogy)
- 4.4 Applications of evolutionary biology – medicine, agriculture, and environment

***(80 Marks Theory Paper and 20 Marks for Theory CIE)**



PRACTICAL

Course Code: **BZO5P11**

Credit: **1**

Teaching Hours: **30 Hrs**

List of Practical

1. Study of fossils and fossil replicas (trilobite, ammonite, Coral fossils horse evolution series) using charts, photographs, specimens or ICT tools.
2. Study and interpretation of phylogenetic trees and cladograms using charts, photographs, specimens or ICT tools.
3. Hardy–Weinberg equilibrium calculations using hypothetical data.
4. Study of homologous organs (Human arm, Bat wing, Whale flipper, Horse forelimb) and analogous organs (Wings of Bird, Bat, Insect) using charts, photographs, specimens or ICT tools.
5. Study of adaptive radiation - Darwin's finches (Different beak shapes, Correlation between beak type and food source, Ecological adaptation) and Mammalian limbs
Study of adaptive radiation - Human (grasping,), Bat (flying), Whale (swimming), Horse (running) using charts, photographs, specimens or ICT tools.
6. Study of connecting links – Archaeopteryx (Reptilian Characters, Avian Characters and Evolutionary Significance), Peripatus (Annelidan Characters, Arthropodan Characters and Evolutionary Significance) using charts, photographs, specimens or ICT tools.
7. Comparative study of primate skulls (Cranial Capacity, Foramen Magnum Position, Facial Profile, Brow Ridge, Zygomatic Arch) and dentition (Dental Formula, Types of Teeth, Functional Adaptation) using charts, photographs, specimens or ICT tools.
8. Field visit to museum/zoological park and submission of evolutionary report.



Assessment scheme B.Sc. Semester V – Evolutionary Biology (Practical)

Total Marks: 50

- Continuous Internal Evaluation (CIE): 25 Marks
- Semester End Examination (SEE): 25 Marks

I. Continuous Internal Evaluation (CIE) – 25 Marks

Component	Description	Marks
Practical Performance	Participation in fossil study, tree interpretation, HW calculations, comparative analysis	10
Practical Record	Completion of Practical Record with diagrams, calculations, and interpretations	5
Field Visit Report	Museum/zoological park visit report and evolutionary analysis	5
Internal Viva / Skill Test	Concept-based oral test / short practical test	5
Total		25

II. Semester End Examination (SEE) – 25 Marks

Practical Examination Pattern

Component	Description	Marks
Major Practical	Hardy–Weinberg calculation / Phylogenetic tree interpretation	8
Minor Practical	Connecting link / adaptive radiation identification	5
Spotting (5 spots × 1 mark)	Fossils, analogous organs, homologous organs, primate skulls and dentition	5
Viva Voce	Questions related to practical concepts	5
Record Verification	Certified journal submission	2
Total		25

List of Recommended Books

1. Futuyma, D. J. & Kirkpatrick, M. (2017). *Evolution* (4th Edition). Sinauer Associates / Oxford University Press.
2. Ridley, M. (2004). *Evolution* (3rd Edition). Blackwell Publishing.
3. Freeman, S. & Herron, J. C. (2007). *Evolutionary Analysis* (4th Edition). Pearson Education.
4. Strickberger, M. W. (2008). *Evolution* (3rd Edition). Jones & Bartlett Publishers.
5. Minkoff, E. C. (1983). *Evolutionary Biology*. Addison-Wesley.



6. Hall, B. K. & Hallgrimsson, B. (2014). *Strickberger's Evolution* (5th Edition). Jones & Bartlett Learning.
7. Campbell, N. A. et al. (2020). *Campbell Biology* (12th Edition). Pearson.
8. Stanley, S. M. (1999). *Earth System History*. W.H. Freeman.
9. Mayr, E. (2001). *What Evolution Is*. Basic Books.
10. Lewin, R. & Foley, R. A. (2004). *Principles of Human Evolution* (2nd Edition). Blackwell Publishing.
11. Graur, D. & Li, W.-H. (2000). *Fundamentals of Molecular Evolution*. Sinauer Associates.
12. Klug, W. S., Cummings, M. R., Spencer, C. A. & Palladino, M. A. (2018). *Concepts of Genetics*. Pearson.
13. Bhamrah, H. S. & Juneja, K. – *Evolutionary Biology*. Anmol Publications.
14. Rastogi, V. B. – *Organic Evolution*. Kedarnath Ram Nath.
15. A textbook of Zoology Semester V DSC – Himalaya Publishing House
16. Singh, B. D. – *Evolution*. Kalyani Publishers.



Programme: **B.Sc. Semester-V NEP Zoology- (Major)**

Course Category: **Discipline Specific Elective (DSE)**

Name of Course: **Systematic Entomology**

Course Outcomes

After completing this course, students will be able to:

CO1: Explain foundational principles of taxonomy, systematics, and phylogenetic classification.

CO2: Describe the evolutionary origin and diversification of insects.

CO3: Classify insects up to order and family level using diagnostic characters.

CO4: Apply dichotomous keys and modern systematic approaches in insect identification.

CO5: Interpret economic and ecological significance of major insect groups.

THEORY

Course Code: **BZO5T12**

Credits: **3**

Teaching Hours: **45 Hrs.**

Unit I: Principles of Systematics and Evolution of Insects

11 hr 15 min

1.1 Foundations of Taxonomy and Systematics: History, scope, and significance of systematics; principles of taxonomy; homology and analogy; cladistics and phylogenetic systematics; concepts of monophyletic, paraphyletic, and polyphyletic groups; sexual dimorphism in insects.

1.2 Classification of Insects: Basis of insect classification across historical periods—Pre-Linnaean, Linnaean, and Post-Linnaean taxonomy; major classification schemes (Richards and Davies, Kristensen, Triplehorn and Johnson); modern classification of Class Insecta, hierarchical categories (rank, taxon, category).



1.3 Origin and Evolution of Insects: Origin of arthropods and insects; major evolutionary transitions in insects; overview of insect phylogeny; classification of Superclass Hexapoda—Classes Entognatha (Collembola, Protura, Diplura) and Insecta; evolutionary significance of major insect lineages.

1.4 Modern Approaches in Systematics and Nomenclature: Molecular systematics; DNA barcoding (); cytotaxonomy; numerical taxonomy (phenetics); principles of the International Code of Zoological Nomenclature (ICZN); homonymy, synonymy, and type concept in zoological nomenclature.

Unit II: Primitive and Hemimetabolous Insects

11 hr 15 min

2.1 Ametabola: Thysanura, Diplura, Protura, Collembola — Distinguishing characters, general biology, ecological significance.

2.2 Paleopteran Orders: Ephemeroptera and Odonata — Distinguishing characters, general biology, ecological importance.

2.3 Orthopteroid Orders (Oligoneoptera): Plecoptera, Grylloblattodea, Orthoptera, Phasmatodea, Dermaptera — distinguishing characters, general biology and ecological significance.

2.4 Hemipteroid Orders (Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera, Hemiptera — feeding adaptations, pest status, and vector importance.

Unit III: Transitional Groups and Lower Holometabola

11 hr 15 min

3.1 Blattoid and Related Orders: Blattodea, Mantodea, Isoptera, Embioptera, Zoraptera — distinguishing characters, ecological significance, and social behavior in Isoptera.

3.2 Neuropteroid Complex: Megaloptera, Raphidioptera, Neuroptera — distinguishing characters, general biology, and ecological significance.



3.3 Panorpid Orders: Mecoptera, Siphonaptera, Trichoptera — adaptations and medical/veterinary importance.

3.4 Introduction to Endopterygota: Evolution of complete metamorphosis; adaptive significance of holometabola; evolutionary advantages of larval and adult specialization.

Unit IV: Higher Holometabola and Economic Entomology

11 hr 15 min

4.1 Coleoptera: Diagnostic characters; major families — Coccinellidae, Scarabaeidae, Cerambycidae, Curculionidae; agricultural and ecological importance.

4.2 Lepidoptera: Morphology and families — Papilionidae, Noctuidae, Pyralidae, Bombycidae; economic importance including pests and sericulture relevance.

4.3 Diptera: Families — Culicidae, Muscidae, Tephritidae, Tachinidae; role as disease vectors and biological control agents.

4.4 Hymenoptera: Families — Apidae, Ichneumonidae, Braconidae, Formicidae; pollination, parasitism, and ecosystem services.

***(120 Marks Theory Paper and 30 Marks for Theory CIE)**

PRACTICAL

Course Code: **BZO5P12**

Credit: 1

Teaching Hours: **30 Hrs**

List of Practical

1. Study of external morphology of a model insect (cockroach/grasshopper) with special reference to segmentation and appendages.
2. Identification of insect in order coleoptera using Dichotomous key for Coleoptera based on observable characters.



3. Preparation of permanent slides/mounts to study diagnostic taxonomic characters: antennae types, mouthparts, leg modifications, wing types.
4. Study of standard entomological techniques for the collection and preservation of insect pests, collection methods (sweep net, aspirator, beating tray, pitfall trap, and light trap), followed by pinning, spreading, dry and wet preservation, and scientific labeling of specimens, using charts, models, and ICT-based tools.
5. Identification of ecological important insects (pollinators – Honey bee, predators – Lady Bird Beetle, parasitoids - Wasp) and economical important insects (Agriculture pests – Red Cotton Bug, Rice stem borer, store grain pest – Rice Weevil, medical pest – Head louse, veterinary pest – Horse fly).
6. Photographic documentation of life cycle of any one economically important insect.
7. Demonstration of molecular approaches in taxonomy (DNA barcoding), using charts, models, and ICT-based tools.
8. Field visit to study insect diversity, host relationships, and habitat preferences; submission of a field report

Assessment Scheme (Practical)

Name of the Course: Systematic Entomology

Course Category: Discipline Specific Elective (DSE)

CIE Marks: **50**

Course Code: BZO5P12

Credit: 1

Component	Description	Marks
Practical Performance	Performance in Morphological Study, Mounting, Dichotomous Key Construction, Understanding of collection methods and labeling and Participation & Laboratory Conduct	20
Practical Record / Journal	Maintenance of record with taxonomic descriptions, diagrams, results, completion and regular submission	10
Internal Test / Skill Assessment	Short practical-based test / spot identification	10
Field Visit Report	Observation of insect diversity and habitat, Photographic documentation of life cycle, Presentation and clarity	5
Viva Voce (Internal)	Diagnostic characters of insect orders, Taxonomic terminology, Ecological and economic significance, Entomological techniques	5
Total		50



Reference Books:

1. Indian Insects: Diversity and Science-Ramani, S., Mohanraj, P., & Yeshwanth, H. M. (Eds.). CRC Press, 2020.
2. Modern Entomology-Tembhare, D. B. Himalaya Publishing House
3. The Insects: An Outline of Entomology, 3rd Edition- Gullan, P. J. & Cranston, P. S. Wiley-Blackwell.
4. Principles of Insect Morphology- Snodgrass, R. E. McGraw-Hill, New York, 1935.
5. Triplehorn, C. A. & Johnson, N. F. *Borror and DeLong's Introduction to the Study of Insects*. Brooks/Cole.
6. Chapman, R. F. *The Insects: Structure and Function*. Cambridge University Press.
7. Imms, A. D. *Imms' General Textbook of Entomology*. Springer / Chapman & Hall.
8. Richards, O. W. & Davies, R. G. *Imms' General Textbook of Entomology, Vols. 1-2*.
9. Capinera, J. L. (Ed.) *Encyclopedia of Entomology*. Springer.
10. McGavin, G. C. *Essential Entomology: An Order-by-Order Introduction*. Oxford University Press.
11. A Textbook of Zoology Semester V DSE Systematic Entomology – Himalaya Publishing House
12. Daly, H. V., Doyen, J. T. & Ehrlich, P. R. *Introduction to Insect Biology and Diversity*. Oxford University Press.
13. Pedigo, L. P. & Rice, M. E. *Entomology and Pest Management*. Waveland Press.



Programme: **B.Sc. Semester-V NEP Zoology- (Major)**

Course Category: **Discipline Specific Elective (DSE)**

Name of Course: **Systematic Ichthyology**

Course Outcomes (COs)

After successful completion of this course, students will be able to:

CO-1: Evaluate Taxonomic Frameworks: Critically analyze historical and modern classification systems (Berg and Nelson) and apply the principles of Cladistics and ICZN rules to the systematic identification and naming of fish species.

CO-2: Compare Fish Diversity and Evolution: Differentiate between the morphological and anatomical characteristics of Agnathans, Chondrichthyes and Osteichthyes, while explaining the evolutionary significance of Sarcopterygii in the origin of tetrapods.

CO-3: Explain Functional Physiology: Illustrate the physiological mechanisms in fishes, including integumentary variations, electric organs, buoyancy regulation through the swim bladder, the lateral line system and electroreception.

CO-4: Analyze Applied Ichthyology: Assess the socio-economic importance of fish by-products, the ecological drivers of fish migration and the management of fish health through the study of pathology and harvest technologies.

CO-5: Execute Technical and Field Skills: Demonstrate proficiency in laboratory techniques- including fish identification, anatomical dissection and water quality analysis- and apply field-survey methods to document local fish diversity.

THEORY

Course Code: **BZ05T12**

Credits: **3**

Teaching Hours: **45 Hrs**

UNIT I: Systematics, Phylogeny and Taxonomic Principles

11 hr 15 min

1.1 History, Scope and Importance of Ichthyology: Origin and development of ichthyology; scope of ichthyology in zoology, ecological and scientific importance of fishes.

1.2 Berg's Classification of Fishes: Salient features of Berg's classification; major groups of fishes; basis of classification; significance and limitations of Berg's system.

1.3 Modern Cladistics and Nelson's Classification of Fishes: Principles of cladistics; phylogenetic relationships among fishes; outline of Nelson's classification; advantages of modern phylogenetic systems over traditional classifications.



1.4 Principles of Taxonomy and ICZN (International Code of Zoological Nomenclature):

Concept and principles of taxonomy; hierarchical categories; binomial nomenclature; rules and significance of ICZN in scientific naming of fishes.

Unit II: Diversity of Fishes

11 hr 15 min

2.1 Superclass Agnatha: General characters of jawless fishes; extinct ostracoderms and living cyclostomes; classification, morphology, and evolutionary significance of Myxine and Petromyzon.

2.2 Class Chondrichthyes: General characters and classification; Elasmobranchii and Holocephali; structure and reproductive biology of cartilaginous fishes.

2.3 Class Osteichthyes – Actinopterygii: General characters and classification of ray-finned fishes; Chondrostei, Holostei, and Teleostei.

2.4 Subclass Sarcopterygii: General characters of lobe-finned fishes; Dipnoi and Actinistia; Evolutionary significance in the origin of tetrapods.

Unit III: Functional Morphology and Physiology

11 hr 15 min

3.1 Integumentary System and Scales: Structure and functions of fish skin; epidermis and dermis; types of scales—placoid, ganoid, cycloid, and ctenoid; Significance of scales.

3.2 Swim Bladder and Weberian Ossicles: Structure and functions of swim bladder; physostomous and physoclistous types; role in buoyancy and respiration; Weberian apparatus and its role in sound transmission.

3.3 Electric Organs: Structure and functions of electric organs in fishes; role in electric signal production.

3.4 Lateral line system and Electoreception: Structure and function of the lateral line system; role of neuromasts in detecting water movements, vibrations and pressure changes. Concept of electoreception and its role in sensing electrical signals in fishes. Types of electoreceptors: ampullary and tuberous receptors.

Unit IV: Applied Ichthyology and Fisheries Technology

11 hr 15 min

4.1 Fish Products and By-Products: Fish as a source of food, fish oil, fish meal, isinglass, fish glue, fish manure

4.2 Fish Migration: Types of migration—anadromous, catadromous, potamodromous and oceanodromous; physiological and environmental factors controlling migration.



4.3 Fish Pathology: Common fish diseases; bacterial, viral, fungal and parasitic infections; symptoms, causes and preventive measures.

4.4 Harvest Technology: Fishing Crafts and Gears, Types of fishing crafts- non-mechanized and mechanized; fishing gears—hooks and lines, gill nets, cast nets, drag nets, trawls.

***(120 Marks Theory Paper and 30 Marks for Theory CIE)**

PRACTICAL

Course Code: **BZO5P12**

Credit: **1**

Teaching Hours: **30 Hrs**

List of Practical

- 1) Identification and classification of major fish groups from preserved specimens: Cyclostomata (*Petromyzon* and *Myxine*), Chondrichthyes (*Scoliodon*, *Pristis*, *Torpedo*), and Osteichthyes (*Labeo*, *Catla*, *Exocoetus*, *Anabas*, *Hippocampus*, *Echeneis*).
- 2) Observation of diverse fin types and scale types (Placoid, Ganoid, Cycloid, Ctenoid) using microscopic slides and fresh preparations.
- 3) Anatomical observation of a common bony fish with the help of ICT or charts. (e.g., *Labeo* or *Clarias*) to study the digestive system, respiratory system (gills) and the swim bladder.
- 4) Study of accessory respiratory organs in *Anabas*, *Clarias*, and *Channa* the help of ICT or charts, models or prepared specimens.
- 5) Physical and chemical analysis of water from a local fish pond: Estimation of temperature, pH, dissolved oxygen, and free CO₂.
- 6) Identification of common ectoparasites (*Argulus*, *Lernaea*, *Ichthyophthirius*) with the help of ICT or charts.
- 7) Visit to a local fish hatchery to observe induced breeding techniques and broodstock management.
- 8) Visit to a fish market or landing center to record the diversity of local fish species and identify them using taxonomic keys.



Assessment Scheme (Practical)

Course Code: **BZO5P12**

Credit: 1

CIE Marks: **50**

Component	Description	Marks
Practical Performance	Regular attendance, safe handling of preserved specimens, microscopes, interpretation of water quality parameters; parasite identification skills; adherence to laboratory ethics	20
Practical Record	Neat labeled diagrams of fish groups, fins, scales, anatomical systems; water analysis data; parasite identification; field visit reports	10
Internal Test / Skill Assessment	Short practical-based test / spot identification	10
Field Visit Report	Observation, Photographic documentation, Presentation and clarity	5
Viva Voce (Internal)	Questions related to fish classification, anatomical adaptations, accessory respiratory organs, aquaculture relevance	5
Total		50

List of Recommended Books

- 1) Bone, Q., & Moore, R. H. (2008). *Biology of fishes* (3rd ed.). Taylor & Francis. ISBN: 9781134186310
- 2) Jayaram, K. C. (1999). *The freshwater fishes of the Indian region*. Narendra Publishing House. ISBN-13: 978-8190795210.
- 3) Jhingran, V. G. (1991). *Fish and fisheries of India* (Rev. & enl. 3rd ed.). Hindustan Publishing Corporation. ISBN 9788170750178.
- 4) Khanna, S. S., & Singh, H. R. (2014). *A textbook of fish biology and fisheries*. Narendra Publishing House. ISBN: 9789384337117
- 5) Lagler, K. F., Bardach, J. E., Miller, R. R., & Passino, D. R. M. (1977). *Ichthyology*. John Wiley & Sons. ISBN : 9780471511663.



- 6) Nelson, J. S., Grande, T. C., & Wilson, M. V. (2016). *Fishes of the world* (5th ed.). Wiley.
ISBN: 978-1-118-34233-6
- 7) A textbook of Zoology Semester V DSE – Systematic Ichthyology. Himalaya Publishing House.
- 8) Srivastava, C. B. L. (2009). *A textbook of fishery science and Indian fisheries*. Kitab Mahal
ISBN: 9788122501391

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Programme: **B.Sc. Semester-V NEP Zoology- (Major)**

Course Category: **Discipline Specific Elective (DSE)**

Name of Course: **Male Mammalian Reproductive Physiology**

Course Outcomes (COs)

After successful completion of this course, students will be able to:

CO-1: Describe anatomy and histology of male reproductive organs

CO-2: Explain spermatogenesis and hormonal regulation

CO-3: Understand semen composition and fertilization

CO-4: Analyze causes of male infertility and contraception methods

CO-5: Perform basic laboratory techniques related to male reproduction

THEORY

Course Code: **BZ05T12**

Credits: **3**

Teaching Hours: **45 Hrs**

Unit I: Introduction and Anatomy

11 hr 15 min

1.1 Overview of mammalian reproductive system: General organization and functional significance of the male reproductive system in mammals.

1.2 Primary and secondary sex organs: Distinction between primary reproductive organs (testes) and secondary/accessory sex organs; their structural and functional roles.

1.3 Gross Anatomy of Male Reproductive Organs: Structure and organization of testes, seminiferous tubules, epididymis, and vas deferens; their role in sperm production and transport.

1.4 Accessory reproductive gland: Structure and functions of accessory glands (seminal vesicles, prostate gland, and bulbourethral glands); contribution to semen formation.

Unit II: Spermatogenesis and Sperm Physiology

11 hr 15 min

2.1 Structure of Spermatozoon and Acrosome Reaction: Ultrastructure of sperm (head, middle piece, and tail); role of acrosome reaction in fertilization.

2.2 Spermiogenesis and sperm maturation: Process of spermatogenesis in seminiferous tubules; stages of spermiogenesis; maturation and storage of sperm in epididymis.

2.3 Semen: Volume, composition, and physiological functions of semen; role of seminal plasma in sperm viability and transport.



2.4 Sperm motility and metabolism: Mechanism of sperm motility; energy sources and metabolic requirements for sperm function.

Unit III: Male Fertility, Infertility and Contraception

11 hr 15 min

3.1 Causes of male infertility Genetic, hormonal, environmental, and lifestyle factors affecting male fertility.

3.2 Semen analysis parameters: Basic parameters of semen analysis including sperm count, motility, morphology, and viability.

3.3 Male contraceptive methods: Overview of male contraceptive methods including barrier methods, hormonal approaches (introductory concept), and surgical sterilization (vasectomy).

3.4 Reproductive Health and Sexually Transmitted Infections (STIs): Basic understanding of reproductive health; common STIs affecting male reproductive function and preventive measures.

Unit IV: Hormonal Regulation

11 hr 15 min

4.1 Hypothalamic-pituitary-gonadal (HPG) axis: Organization and regulation of the HPG axis in males.

4.2 Role of Reproductive Hormones: Functions of GnRH, FSH, LH, testosterone, and inhibin in spermatogenesis and male reproductive physiology.

4.3 Mechanism of action of Androgens: Basic mechanism of androgen hormone action at the cellular level.

4.4 Puberty and Aging in Males: Hormonal and physiological changes during puberty; age-related changes in male reproductive function.

***(120 Marks Theory Paper and 30 Marks for Theory CIE)**

PRACTICAL

Course Code: **BZO5P12**

Credit: 1

Teaching Hours: 30 Hrs

List of Experiments

1. Study of male reproductive system using charts/models
2. Histological study of testis, epididymis, prostate (permanent slides)
3. Study and identification of various stages of spermatogenesis using histological slides and diagrams.



4. Study of sperm structure under the microscope.
5. Demonstration and interpretation of semen analysis parameters (sperm count, motility, morphology, and viability) using laboratory data or virtual datasets.
6. Study of the influence of reproductive hormones on male reproductive organs using charts, models, and case-based discussions.
7. Identification and understanding of major male reproductive hormones (GnRH, FSH, LH, testosterone, inhibin) using charts and ELISA demonstration (where feasible).
8. Case study on male infertility - Analysis and discussion of selected clinical cases related to male infertility and associated diagnostic parameters.
9. Visit to Artificial insemination centre

Assessment Scheme (Practical)

Name of the Course: **Male Mammalian Reproductive Physiology**

Course Category: **Discipline Specific Elective (DSE)**

Course Code: **BZO5P12**

Credit: 1

CIE Marks: **50**

Component	Description	Marks
Practical Performance	Regular attendance, punctuality, proper handling of slides, microscopes, recognition of spermatogenesis stages, microscopic observation skills, interpretation of semen analysis data and models; adherence to safety and ethical practices	20
Practical Record	Neat labeled diagrams (testis, sperm structure), observations, semen analysis interpretation, case study documentation, regular submission	10
Internal Test / Skill Assessment	Short practical-based test / spot identification	10
Field Visit Report	Observation, Photographic documentation, Presentation and clarity	5
Viva Voce (Internal)	Questions related to spermatogenesis, sperm physiology, hormones, infertility, and assisted reproductive techniques	5
Total		50



List of Recommended Books:

1. Guyton, A. C., & Hall, J. E. (Latest Edition). *Textbook of Medical Physiology*. Elsevier.
2. Ganong, W. F. (Latest Edition). *Review of Medical Physiology*. McGraw-Hill Education.
3. Tortora, G. J., & Derrickson, B. (Latest Edition). *Principles of Anatomy and Physiology*. Wiley.
4. Sherwood, L. (Latest Edition). *Human Physiology: From Cells to Systems*. Cengage Learning.
5. Arora, M. P., & Arora, A. *Reproductive Physiology*. S. Chand Publishing.
6. Yadav, P. R. *Reproductive Biology*. Rastogi Publications.
7. Sadler, T. W. (Latest Edition). *Langman's Medical Embryology*. Wolters Kluwer.
8. A textbook of Zoology Semester V DSE – Male Mammalian Reproductive Physiology. Himalaya Publishing House.
9. Junqueira, L. C., & Carneiro, J. (Latest Edition). *Basic Histology*. McGraw-Hill Education.



Programme: **B.Sc. Semester-V NEP Zoology- (Major)**

Course Category: **Discipline Specific Elective (DSE)**

Name of Course: **Endocrinology**

Course Outcomes (COs)

After successful completion of this course, students will be able to:

CO1: Explain the basic concepts of endocrinology, including endocrine axes, classification of hormones, mechanisms of hormone action, and regulation of hormone secretion.

CO2: Describe the structure, hormones, physiological functions, and disorders associated with major endocrine glands such as the thyroid, parathyroid, adrenal gland, pancreas, and other hormone-secreting organs.

CO3: Interpret the role of hormones in reproductive physiology, including endocrine functions of testes and ovaries, hormonal regulation of puberty, and reproductive anomalies.

CO4: Analyze the role of endocrine regulation in growth, metabolism, stress, and behavior, and evaluate endocrine disorders and modern techniques used in endocrinological research and diagnosis.

CO5: Demonstrate practical understanding of endocrine glands, hormones, and related disorders through laboratory experiments and case study analysis.

THEORY

Course Code: **BZ05T12**

Credits: **3**

Teaching Hours: **45 Hrs**

Unit I: Introduction to Endocrinology

11 hr 15 min

1.1 Definition and general account of endocrine axes in vertebrates (HPA, HPG, HPT, and HPS axes).

1.2 Hormones – classification based on chemical nature, solubility, functions, and mechanism of hormone action.

1.3 Hypothalamo–pituitary portal system; hormones of the pituitary gland and related disorders.

1.4 Regulation of hormone secretion – feedback control and neural regulation.



Unit II: Major Endocrine Glands and Metabolism**11 hr 15 min**

- 2.1 Thyroid and Parathyroid Glands – Structure, hormones, functions and disorders.
- 2.2 Adrenal Gland – Structure, hormones, functions and disorders.
- 2.3 Pancreas and Gastrointestinal Hormones – Structure, hormones, functions and disorders of the pancreas; gastrointestinal hormones (somatostatin, gastrin, and secretin).
- 2.4 Endocrine Functions of Other Organs – Hormones of the heart, kidney, pineal gland, and thymus.

Unit III: Reproductive Endocrinology**11 hr 15 min**

- 3.1 Endocrine Role of Testes – Testosterone, androstenedione, and 5-dihydrotestosterone (DHT).
- 3.2 Endocrine Role of Ovaries – Estrogen, progesterone, human chorionic gonadotropin (hCG), relaxin and prolactin.
- 3.3 Hormonal Regulation of Puberty and Adolescence.
- 3.4 Reproductive Anomalies – Congenital disorders (hypogonadism and cryptorchidism); MOET (superovulation, artificial insemination, and embryo transfer).

Unit IV: Applied Endocrinology and Endocrine Disorders**11 hr 15 min**

- 4.1 Endocrine regulation of growth, metabolism, reproduction, stress and water balance.
- 4.2 Endocrine disorders – diabetes mellitus, thyroid disorders, Addison's disease, Cushing's syndrome and obesity.
- 4.3 Behavioural endocrinology – endocrine control of stress, sleep and biological rhythms.
- 4.4 Recent advances and techniques – Xenohormones and endocrine disruptors, hormone therapy and hormone assays (RIA, CLIA, ELISA).

(120 Marks Theory Paper and 30 Marks for Theory CIE)*PRACTICAL**Course Code: **BZO5P12****Credit: 1**Teaching Hours: **30 Hrs****List of Practical**

- 1. Anatomical observation of major endocrine glands (pituitary, thyroid, adrenal, pancreas, testes, and ovaries) using charts, models or preserved specimens of any vertebrate.



2. Study of histological slides of endocrine glands: T.S. pituitary, thyroid, adrenal gland, pancreas (islets of Langerhans), testis and ovary.
3. Estimation of blood glucose level using a glucometer and interpretation in relation to pancreatic hormone function.
4. Demonstration of estimation of thyroid hormones (T3 and T4) using the ELISA technique or simulated laboratory data.
5. Study of hormonal regulation of the menstrual cycle using charts, models or graphical representation of hormonal fluctuations.
6. Case study analysis of selected endocrine disorders, including diabetes mellitus, goitre, dwarfism and gigantism.
7. Detection of hCG in urine using a pregnancy test kit.
8. Preparation of a report on the process of Multiple Ovulation and Embryo Transfer (MOET).
9. Educational visit to a pathology laboratory, hospital, dairy farm, or aquaculture facility followed by preparation and submission of a field report related to endocrine applications.

Assessment Scheme (Practical)

Course Code: BZO5P12

Credit: 1

CIE Marks: 50

Continuous Internal Evaluation (CIE) – 50 Marks

Component	Description	Marks
Practical Performance	Regular attendance, proper handling of slides, use of glucometer, handling of ELISA/pregnancy kit (demonstration-based), data interpretation; adherence to safety protocols	20
Practical Record	Neat labeled diagrams, slide descriptions, observations, interpretation, case study documentation, timely submission	10
Internal Test / Skill Assessment	Short practical-based test / spot identification	10
Field Visit Report	Observation, Photographic documentation, Presentation and clarity	5
Viva Voce (Internal)	Questions on gland structure, hormone functions, endocrine disorders, and applied aspects (MOET, diagnostics, etc.)	5
Total		



50

Reference books

1. Hadley, M. E., & Levine, J. E. (2009). *Endocrinology* (6th ed.). Pearson Education. ISBN 9788131726105
2. Norris, D. O., & Carr, J. A. (2020). *Vertebrate Endocrinology* (6th ed.). Academic Press. ISBN: 9780128200933
3. Guyton, A. C., & Hall, J. E. (2021). *Textbook of Medical Physiology* (14th ed.). Elsevier.
4. Hill, R. W., Wyse, G. A., & Anderson, M. (2016). *Animal Physiology* (4th ed.). Sinauer Associates.
5. Ganong, W. F. (2018). *Ganong's Review of Medical Physiology* (27th ed.). McGraw-Hill Education.
6. J. Larry Jameson Harrison's Endocrinology, Second Edition McGraw-Hill Education
7. A textbook of Zoology Semester V DSE – Endocrinology. Himalaya Publishing House.
8. K. Sebulingam and Prema Sebulingam. (2012) Essentials of Medical Physiology (6th ed) Jaypee Brothers Medical Publishers.



Programme: B.Sc. Semester V -NEP (Zoology – Major)

Course Category: **Vocational Skill Course**

Name of the Course: **Silkworm culture**

Course Code: **BVS5P07**

Credit: **2 (Practical)**

Teaching Hours: **60 Hrs.**

Course Outcomes (COs): After successful completion of this course, students will be able to:

CO1: Identify and classify different types of silkworms used in sericulture.

CO2: Demonstrate practical knowledge of cultivation practices, including nursery management and field preparation.

CO3: Apply standard silkworm rearing techniques and manage rearing houses and appliances effectively.

CO4: Identify major diseases and pests of silkworms and describe appropriate preventive and management strategies.

CO5: Perform cocoon harvesting, sorting, and grading based on standard sericulture practices.

CO6: Explain basic silk reeling techniques and recognize important by-products of sericulture.

CO7: Develop practical exposure to sericulture through field visits, internships, or training in sericulture farms, grainages, or silk reeling units.

Practical:

1. Identification and classification of different types of silkworms: Mulberry, Tasar, Eri, Muga using charts, models, photographs, and ICT tools.
2. Study of host plants for rearing different types of silkworms using available plant material, charts, models, photographs, and ICT tools.
3. Study of host plant cultivation practices: *soil preparation, planting, spacing, manuring and irrigation* through field visit / models / charts / ICT tools.
4. Identification of life cycle stages of silkworm (*Bombyx mori*) using specimens / charts / photographs / ICT tools.
5. Study of silkworm rearing house and rearing appliances with the help of models / charts / photographs / ICT tools.



7. Study of feeding methods, bed cleaning and spacing during different larval instars using demonstrations / charts / ICT tools.
8. Identification and study of major silkworm diseases: *Pebrine*, *Grasserie*, *Flacherie*, *Muscardine* with the help of charts / photographs / ICT tools.
9. Study of common silkworm pests in silkworm rearing with the help of charts / models / ICT tools.
10. Study of cocoon harvesting, sorting and grading techniques using charts / photographs / ICT tools.
11. Study of traditional silk reeling methods and identification of sericulture by-products with the help of models / charts / photographs / ICT tools.
12. Visit to sericulture farm / grainage / silk reeling unit wherever feasible.
13. Market survey related to cocoon or silk products to understand the economic aspects of sericulture.

Assessment Scheme

Course: Silkworm Culture (VSC)

Total Marks: 100 (SEE = 50 marks + CIE = 50 Marks)

I. Continuous Internal Evaluation (CIE) – 50 Marks

Component	Description	Marks
Practical Performance	Identification skills, handling of specimens, participation in demonstrations	15
Practical Record / Journal	Maintenance of practical file with diagrams, observations, and notes	10
Field Visit Report	Report on visit to sericulture farm / grainage / reeling unit	10
Market Survey Report	Survey on cocoon/silk products, pricing, and marketing channels	10
Internal Viva / Skill Test	Oral examination and spot identification	5
Total		50



II. Semester End Examination (SEE) – 50 Marks

Practical Examination Pattern

Component	Description	Marks
Major Practical	Identification / demonstration (e.g., silkworm types, host plants, diseases, rearing appliances)	20
Minor Practical	Cocoon grading / disease identification / pest identification	15
Viva Voce	Questions based on practical syllabus	10
Record Verification	Certified practical journal	5
Total		50

Suggested Reading:

1. Aruga, H. (1998). *Principles of sericulture*. New Delhi, India: Oxford & IBH Publishing Co. Pvt. Ltd.
2. Benchamin, K. (1994). *Principles of sericulture*. Bangalore, India: Central Silk Board.
3. *Training manuals on sericulture practices*. Bangalore, India: Central Silk Board, Ministry of Textiles, Government of India.
4. Food and Agriculture Organization of the United Nations (FAO). (1976). *Sericulture manuals* (Vols. I–III). Rome, Italy: FAO Central Silk Board – Training Manuals
5. Ganga, G., & Sulochana Chetty, J. (1991). *An introduction to sericulture*. New Delhi, India: Oxford & IBH Publishing Co. Pvt. Ltd.
6. Textbook of Zoology Semester V - Himalaya Publishing House



B.Sc. Semester – V
Minor 5: BZO3T05
Life and Diversity of Animals - Chordates
(Protochordata to Amphibia)
Theory-2 Credits + Practical- 1 Credits

Course Outcomes: Students should be able to

- CO 1. Describe classes and orders of phylum Chordata.
- CO 2. Identify, Classify various animals of the Phylum Chordata.
- CO 3. Differentiate between Protochordate and higher Chordates upto Amphibia based on their characters.
- CO 4. Analyze the anatomy and physiology of protochordates, agnathans, pisces and amphibians.
- CO 5. Create interlinking and mapping between various chordate groups.

Unit – I **7.5 hrs.**

- 1.1 Origin and ancestry of Chordata
- 1.2 General character and classification of Chordata upto classes, affinities of protochordates with Hemichordata and Agnatha.
- 1.3 *Herdmania*: digestive system, ascidian tadpole and retrogressive metamorphosis.
- 1.4 *Amphioxus*: digestive system, sense organs (Kolliker's pit and infundibular organ) and protonephridia.

Unit – II **7.5 hrs.**

- 2.1 Vertebrata: General characters, affinities of vertebrata with protochordata.
- 2.2 Petromyzon: Digestive system, Respiratory system, Reproductive system.
- 2.3 Ammocoete larva, General characters of Myxine.
- 2.4 Ostracoderm: General characters with examples, reason of extinction.

Unit – III **7.5 hrs.**

- 3.1 Pisces: Salient features of Chondrichthyes and Osteichthyes.
- 3.2 General characters of Dipnoi: *Neoceratodus*, *Protopterus* *Lepidosiren*.
- 3.3 *Labeo rohita*: External features, Respiratory System, Urinogenital system.
- 3.4 Migration in fishes (Types and causes).



Unit – IV

7.5 hrs.

4.1 Amphibia: Origin of Amphibia, affinities with Pisces.

4.2 Parental care and Neoteny in Amphibia.

4.3 Axolotl Larva, Hibernation and aestivation in Anura.

4.4 Frog (*Rana tigrina*): Circulatory system, Respiratory system.

BZO3P05: Practical –Life and Diversity of Animals – Chordates (Protochordata to Amphibia) (1 Credit)

1. Identification, classification , distinguishing characters and adaptive features of

I. Urochordata: *Herdmania*, *Salpa*

II. Cephalochordata : *Amphioxus*

III. Cyclostomata : *Petromyzon*

IV. Pisces : *Pristis*, *Torpedo*, *Notopterus*, *Ophiocephalus*, *Catla*, *Clarius*.

V. Amphibia: *Ichthyophis* , *Bufo*, *Salamander*.

2. Anatomical observation of fish-

i Digestive system

ii Reproductive system

iii Brain

3. Study of permanent slides-

T.S. *Amphioxus* through pharynx, Intestine, Gonad and Caudal region; V.S. Skin, T.S. Testis, T.S. Ovary of Frog.

4. Permanent stained preparation: fish scales.

5. Submission of charts of interlinking of different groups of chordates up to Amphibia.

Practical Examination Scheme

Distribution of marks (For SEE)

Total Marks: 25

1.	Identification and comments on spots.	10
2.	Draw and label Brain/ Digestive system/ Reproductive system of fish.	05
3.	Permanent stained preparation of fish scales.	05
4.	Submission of certified practical record	02
5.	Viva voce	03

Reference Books

1. Text book of Zoology vol II – Parker and Haswell



2. T. B. of Vertebrate Zoology -S. N. Prasad
3. Chordate Zoology –E. L. Jorden and P. S. Verma
4. Vertebrate Zoology – Vishwanath
5. Zoology of Chordates – Nigam H. C.
6. Phylum: Chordata – Newman H.H.
7. Biology of Vertebrates –Walter & Sayles
8. The Vertebrate Body – Romer A. S.
9. Comparative Anatomy of the Vertebrates – Kingslay J. D.
10. The Biology of Amphibia – Noble G. K.
11. Snakes of India – Gharpura K. G.
12. Life of Mammals – Young J.Z.
13. Modern textbook of Zoology Vertebrates – Kotpal R. L.
14. Introduction to Chordates – Majupuria T.C.
15. Vertebrate Zoology – Dhami & Dhami
16. T. B. Vertebrate Zoology – Agrawal
17. Protochordates – Chatterjee & Pandey
18. Protochordates – Bhatia
19. T. B. of Chordates – Bhamrah and Juneja
20. Chordate Anatomy –M.P. Arora
21. The Chordates – Alexander. 3



B.Sc. Semester – V

Minor 6: BZO3T06

Genetics

Theory 2 credits + Practical 1 credit

Course Outcomes: Students will able to

CO 1. Understand the Fundamental Principles of Genetics: Explain Mendelian inheritance, the Chromosome Theory of Inheritance, mitochondrial DNA and plasmids, and genetic variation and mutation, distinguish various chromosomal aberrations, recognize types of mutations (point mutations, frameshift), and evaluate their roles in genetic diversity and disease.

CO 2. Comprehend the Mechanisms of Genetic Inheritance and Gene Structure: Explore genetic inheritance mechanisms, gene structure, chromosomal mapping concepts, and cytoplasmic inheritance. Analyze pedigree analysis for autosomal and X-linked traits to identify inheritance patterns.

CO 3. Analyze Genetic Variation and Evolutionary Dynamics: Apply the Hardy-Weinberg principle to study genetic equilibrium and the impact of factors such as mutation, selection, and genetic drift on population genetics, Explain the genetic basis of speciation, adaptation, and evolutionary processes, Use quantitative genetics to explore polygenic traits, heritability, and their role in natural selection and evolution.

CO 4. Examine Human Genetics and Genetic Disorders: Interpret human karyotypes and identify chromosomal and genetic disorders, Understand the inheritance patterns of single-gene and multifactorial disorders, Discuss the ethical considerations in genetic counseling, genetic testing, and biotechnology, especially in the context of human health.

CO 5. Explore Advanced Topics in Genetics and Their Applications: Analyze the genetic basis of cancer, oncogenes, and tumor suppressor genes, and the role of mutations and environmental factors in cancer development, Discuss the role of epigenetics and environmental influences on gene expression and development, Evaluate the applications of gene therapy, agriculture, and biotechnology, addressing ethical and societal implications.

Unit 1

7.5 hrs.

1.1 Mendelian Genetics: Mendel's laws of inheritance (Law of segregation, Law of independent assortment), Monohybrid and dihybrid crosses, Test cross and back cross.

1.2 Interaction of genes: Epistasis: dominant epistasis (12:3:1) e.g. coat colour in dog (Brown dog X white dog); recessive epistasis (9:3:4) e.g. coat colour in mice. Codominance e.g. Roan cattle; incomplete dominance e.g. Andalusian fowl.

1.3 Extracellular genome: Presence and functions of mitochondrial DNA. Plasmids- Types and significance.

1.4 Genetic Variation: Chromosomal aberrations (deletions, duplications, inversions, translocations), Spontaneous and induced mutations. Types of point mutation- deletion, insertion, substitution, transversion, transition, frameshift mutation.



Unit II

7.5 hrs.

2.1 Chromosome Theory of Inheritance: Linkage and crossing over: types and significance, Chromosomal mapping in eukaryotes. 4

2.2 Cytoplasmic inheritance: *Kappa* particles in *Paramecium*, CO₂ sensitivity in *Drosophila*, milk factor in mice.

2.3 Pedigree analysis: Pedigree analysis, Autosomal Recessive Inheritance, Autosomal Dominant Inheritance, X-linked recessive Inheritance, X-linked dominant Inheritance, and Y linked inheritance.

2.4 Concepts of genes: Classical concept of gene, Molecular concept of gene- Cistron, Muton and Recon.

Unit III

7.5 hrs.

3.1 Population Genetics: Gene pool and allele frequency, Hardy-Weinberg principle and its applications, Factors affecting genetic equilibrium (mutation, migration, selection, genetic drift).

3.2 Quantitative Genetics: Polygenic inheritance and continuous variation e.g. Skin colour in human, eye colour in human, sickle-cell anaemia. Inbreeding and outbreeding, hybrid vigor.

3.3 Speciation and Evolution: Species concepts and speciation mechanisms (Parapatric, Sympatric and Allopatric Speciation), Adaptive radiation, divergent and convergent evolution.

3.4 Human Genetics: Karyotyping and chromosomal disorders (Down syndrome, Turner syndrome, Klinefelter syndrome), Genetic counseling and prenatal diagnosis (Aminocentesis and Chorionic villi test).

Unit IV

7.5 hrs.

4.1 Genetic Disorders and Inborn Errors of Metabolism: Single-gene disorders (e.g., cystic fibrosis, sickle-cell anemia), Inborn errors of metabolism (e.g., phenylketonuria, alkaptonuria).

4.2 Cancer Genetics: Mechanism of activation of oncogenes (point mutation, gene amplification and chromosomal translocations); mechanism of inactivation of tumor suppressor genes (mutation, deletions and epigenetic silencing).

4.3 Epigenetics and Environmental Influence on Genes: Role of environment in gene expression, Epigenetic changes in response to environmental stimuli, Developmental plasticity and gene-environment interactions, Impact of nutrition, stress, and toxins on gene expression.

4.4 Applications of Genetics in Medicine and Agriculture: Gene therapy: principles and challenges, Genetic modification in livestock; Ethical, social, and legal issues in genetic research and biotechnology.



BZOP06: Practical- Genetics (1 Credit)

1. To study monohybrid cross ratio using beads.
2. To study dihybrid cross ratio using beads.
3. Construct chromosomal maps in eukaryotes by calculating crossover frequencies.
4. Study of normal human karyotype (Normal male and female).
5. Study of characters and karyotypes of Down Syndrome.
6. Study of characters and karyotypes of Klinefelter Syndrome. 5
7. Study of characters and karyotypes of Turner Syndrome.
8. Study of the genetic traits (Hardy Weinberg law) in human being (Tongue rolling, ear lobe, PTC taster/ non taster).
9. The field visit to Institute/Laboratory/ agricultural field/ animal husbandry etc. for understanding of gene therapy techniques or the genetic modification of crops or livestock.

Reference Books

1. Genetics and Genetic Engineering – Joshi
2. Genetic Engineering and its applications – Joshi
3. Genetics – Gardener
4. Genetics – Winchester
5. Genetics – Gupta
6. Principles of Genetics – Sinnot Dunn, Dobzansy
7. Genetics – Ahluwalia
8. Genetics – Sarin
9. Elementary Genetics – Singleton
10. General Genetics – SRb, Owen & Edger
11. Genetics – Alenberg
12. Foundation of Genetics – Pai
13. Genetics - Stickberger
14. T. B. of Genetics- Veerbala Rastogi
15. Gene VI by Benjamin Lewis, Oxford press
16. Gene VIII by Benjamin Lewis, Oxford press
17. Genetics Vol. I and II by Pawar C. B., Himalaya publication



Programme: **B.Sc. Semester-VI NEP (Zoology- Major)**

Course Category: **Discipline Specific Core (DSC)**

Name of Course: **General Mammalian Physiology II**

Theory- 2 Credits + Practical - 1 Credit

Course Outcomes (COs)

After successful completion of this course, students will be able to:

CO1: Explain the structural organization and functional mechanisms of mammalian muscle, nerve, endocrine, reproductive, and sensory systems.

CO2: Describe physiological mechanisms such as muscle contraction, nerve impulse transmission, hormonal regulation, and reproductive processes.

CO3: Interpret cellular and molecular basis of neuromuscular transmission, synaptic function, and hormone action.

CO4: Correlate physiological processes with associated disorders such as endocrine imbalances, reproductive dysfunctions, concepts of infertility and assisted reproductive techniques.

CO5: Explain the physiological basis of sensory perception (vision, hearing, taste, and smell), homeostasis, thermoregulation, and stress response.

THEORY

Course Code: **BZO6T13**

Credits: **2**

Teaching Hours: **30 Periods**

Unit – I: Muscle Physiology

7 Hrs 30 Mins

1.1 Types of Muscles: Skeletal, smooth, and cardiac muscles, Ultrastructure of muscle fiber

1.2 Mechanism of Muscle Contraction: Sliding filament theory, Role of actin and myosin, Excitation–contraction coupling, Energy sources for contraction

1.3 Properties of Muscles: Twitch, Tetanus, Summation, Tonus, All or none principle, Muscle fatigue and rigor mortis

1.4 Neuromuscular Junction: Structure of neuromuscular junction, Role of acetylcholine, Transmission of impulse, Disorders of neuromuscular junction



Unit – II: Nerve Physiology

7 Hrs 30 Mins

2.1 Structure of Neuron: Types of neurons, E.M. structure of neuron

2.2 Nerve Impulse: Resting membrane potential, Action potential, Propagation of nerve impulse, Saltatory conduction

2.3 Synapse: Structure of synapse, Chemical and electrical synapses, Synaptic transmission

2.4 Neurotransmitters: Types of neurotransmitters, Synthesis and release, Mechanism of action, Disorders related to neurotransmitters

Unit – III: Endocrine Physiology

7 Hrs 30 Mins

3.1 Hypothalamus and Pituitary Gland: Hormones of hypothalamus, Anterior, Intermediate and Posterior pituitary hormones, Feedback regulation, Pituitary gland disorders

3.2 Thyroid and Parathyroid Glands: Thyroid hormones and functions, Regulation of thyroid secretion, Parathyroid hormone and calcium balance, Disorders of thyroid and parathyroid gland.

3.3 Adrenal and Pancreatic Hormones: Hormones of adrenal cortex and medulla, Insulin and glucagon, Regulation of blood glucose, Disorders of adrenal gland and endocrine pancreas.

3.4 Mechanism of Hormone Action: Types of hormone receptors, Second messenger system, Signal transduction pathways.

Unit – IV: Reproductive, Sensory and Stress Physiology

7 Hrs 30 Mins

4.1 Male Reproductive Physiology: Structure of male reproductive system, Spermatogenesis, Semen composition, Hormonal regulation, causes of male infertility and basic concepts of male contraceptive methods.

4.2 Female Reproductive Physiology: Structure of female reproductive system, Oogenesis, Menstrual cycle, Hormonal regulation, causes of female infertility, basic concepts of contraceptive methods, introduction to *in vitro* fertilization (IVF).

4.3 Sensory Physiology: Physiology of vision, Physiology of hearing, Physiology of taste, Physiology of smell

4.4 Homeostasis and Stress Physiology: Concept of homeostasis, Thermoregulation, Stress response. Role of adrenal hormones in stress

***(80 Marks Theory Paper and 20 Marks for Theory CIE)**



PRACTICAL

Course Code: **BZO6P13**
Teaching Hours: **30 Hours**

Credit: 1

1. Study of the concept and physiological basis of muscle fatigue, using charts, models, or ICT tools.
2. Demonstration and study of the structure and function of the neuromuscular junction, using charts, models, or ICT tools.
3. Demonstration and study of reflex actions—knee jerk and/or ankle jerk—with basic clinical correlation.
4. Study of positive and negative feedback mechanisms of hormone regulation, using charts, models, or ICT tools.
5. Case study-based learning of endocrine disorders (diabetes, thyroid disorders)
6. Study of different stages of spermatogenesis and oogenesis, using histological slides charts, models, or ICT tools.
7. Determination of sperm count in a given semen sample
8. Demonstration and study of the structure of sensory organs (eye, ear) , using charts, models, or ICT tools.
9. Study of the physiological effects of exercise by measuring parameters such as heart rate, respiratory rate, and sweating under resting and stress conditions.
10. Study of histological slides of Mammals – T.S. pituitary, thyroid, adrenal, testis, ovary; uterus, placenta, medulated and non medulated nerve fibre, smooth and striated muscle

Assessment Scheme (Practical)

B.Sc. Semester VI – General Mammalian Physiology II

Course Type: Discipline Specific Core (DSC)

Credits: 1

Course Code: BZO6P13

Total Marks: 50

- Continuous Internal Evaluation (CIE): 25 Marks
- Semester End Examination (SEE): 25 Marks

I. Continuous Internal Evaluation (CIE) – 25 Marks

Component	Description	Marks
Practical Performance	Performance in physiological experiments, Participation, discipline & regularity	10
Practical Record	Maintenance of record with diagrams, results and interpretations, completion & regular submission	5
Internal Test / Skill Assessment	Short practical-based test / spot identification	5
Viva Voce (Internal)	Conceptual understanding of experiments	5
Total		25

II. Semester End Examination (SEE) – 25 Marks

Practical Examination Pattern

Component	Description	Marks
Major Practical	Any one experiment (Sperm count determination, Measurement of physiological parameters during exercise, different stages of spermatogenesis and oogenesis)	10
Minor Practical	Any one experiment (Demonstration of reflex action, sensory organs, Interpretation of hormonal feedback mechanism)	5
Spotting (5 spots × 1 mark)	Histological Slides	5
Viva Voce	Questions related to performed experiment	3
Record Verification	Certified journal submission	2
Total		25

Reference Books

1. Guyton, A.C. & Hall, J.E. – *Textbook of Medical Physiology*, Elsevier.
2. Widmaier, E.P., Raff, H., & Strang, K.T. – *Vander's Human Physiology: The Mechanisms of Body Function*, McGraw-Hill.
3. Tortora, G.J. & Derrickson, B.H. – *Principles of Anatomy and Physiology*, Wiley.
4. Hadley, M.E. & Levine, J.E. – *Endocrinology*, Pearson.
5. Knobil, E. & Neill, J.D. (Eds.) – *Knobil & Neill's Physiology of Reproduction*, Academic Press.
5. William F. Ganong - *Review of Medical Physiology*, McGraw-Hill.
6. Lauralee Sherwood - *Human Physiology*, Cengage Learning.
7. Text book of Zoology DSC Semester VI – Himalaya Publication House
8. A.K. Berry - *Textbook of Animal Physiology*, Emkay Publishers.
9. C. C. Chatterjee – *Human Physiology Vol I & II* , CBS Publisher



Programme: B.Sc. Semester-VI NEP (Zoology- Major)

Course Category: Discipline Specific Core (DSC)

Name of Course: Parasitology

Theory- 2 Credits + Practical - 1 Credit

Course Outcomes (COs)

After successful completion of this course, students will be able to:

CO1: Explain the fundamental principles of parasitology, including types of parasites, host–parasite relationships, modes of transmission, and mechanisms of pathogenesis.

CO2: Describe the morphology, life cycles, transmission patterns, and pathogenic effects of major protozoan parasites of medical importance.

CO3: Understand the structural organization, classification, life cycles, and disease-causing mechanisms of helminth parasites including trematodes, cestodes, and nematodes.

CO4: Analyze the epidemiology, clinical manifestations, diagnostic techniques, prevention, and treatment strategies of important parasitic diseases.

CO5: Identify medically and veterinary important ectoparasites and insect vectors, and evaluate their role in disease transmission and control programs.

CO6: Interpret host immune responses and parasite adaptations, and relate parasite biology to public health management and disease control strategies.

THEORY

Course Code: BZO6T14

Credits: 2

Teaching Hours: 30 Hours

Unit I: Introduction to Parasitology

7Hrs 30 Min

1.1 Basic Concepts of Parasitology and Host–Parasite Relationships: Definition and scope of parasitology; types of parasites based on habitat, host dependence, degree of pathogenicity, and host specificity, Types of hosts (Stages of Parasite’s Development, Conditions for Parasite’s Development, Transmission Agents of Parasites), Evolution of host–parasite relationships, parasite life cycle patterns, and mechanisms of pathogenesis.

1.2 Distribution, Transmission, and Zoonotic Diseases: Sources of parasitic infection including soil, water, food, and animals (zoonoses); Modes of transmission—direct and indirect transmission, Course of infection: incubation period, prodromal period, illness period, decline period, and convalescence period, Clinical manifestations including morphological, behavioral, and physiological symptoms.



1.3 Diagnosis, Prevention, and Control of Parasitic Diseases: Methods of diagnosis including faecal examination (ova and parasite detection), blood tests, imaging techniques, immunodiagnostic tests, and laboratory culture methods; Principles of prevention and control of parasitic infections in humans and animals.

1.4 Host Immunity and Parasite Adaptations: General immune responses against parasites—humoral immunity and cell-mediated immunity. Hypersensitivity reactions and regulation of immune responses. Self-defense mechanisms of the host. Adaptations in parasites including immunological, morphological, nutritional, biochemical, and life cycle adaptations that facilitate survival within the host.

Unit II: Protozoan Parasites of Medical Importance

7Hrs 30 Min

2.1 Intestinal Protozoan Parasites: Study of *Giardia lamblia* and *Entamoeba histolytica* with reference to their morphology, life cycle, mode of transmission, pathogenesis, clinical manifestations, diagnosis, and treatment.

2.2 Urogenital and Tissue Protozoan Parasites: Study of *Trichomonas vaginalis* and *Toxoplasma gondii* including morphology, life cycle, transmission, pathogenesis, clinical manifestations, diagnosis, and preventive measures.

2.3 Blood and Tissue Flagellates: Study of *Trypanosoma* spp. (African and American trypanosomiasis) and *Leishmania* spp. (leishmaniasis), including life cycle, mode of transmission through vectors, pathogenesis, prevention, and treatment.

2.4 Sporozoan Parasites and Coccidia: Study of *Plasmodium* spp. (malaria parasite) and *Cryptosporidium* spp., focusing on life cycle, transmission, pathogenicity, clinical manifestations, diagnosis, prevention, and treatment.

Unit III: Helminth Parasites – Platyhelminthes

7Hrs 30 Min

3.1 Introduction to Helminths: General morphology, structure organization and classification of parasitic helminths with special reference to the phylum Platyhelminthes. Overview of adaptations for parasitic mode of life.

3.2 Trematodes (Flukes) – I: Study of blood flukes (*Schistosoma* spp.) with reference to morphology, life cycle, mode of transmission, pathogenesis, clinical manifestations, and control of schistosomiasis.

3.3 Trematodes (Flukes) – II: Study of *Fasciola hepatica* (liver fluke) including life cycle, transmission, pathogenesis, diagnosis, prevention, and treatment.

3.4 Cestodes (Tapeworms): Study of *Taenia* species with emphasis on morphology, life cycle, transmission, pathogenicity, preventive measures, and treatment.



Unit IV: Nematodes, Ectoparasites, and Control of Parasitic Diseases

7Hrs 30 Min

4.1 Intestinal Nematodes: Study of *Ascaris lumbricoides* with reference to morphology, life cycle, mode of transmission, pathogenic effects, clinical manifestations, diagnosis, prevention, and treatment.

4.2 Tissue Nematodes: Study of *Wuchereria bancrofti* including life cycle, transmission through mosquito vectors, pathogenesis, clinical features of filariasis, preventive measures, and treatment.

4.3 Ectoparasites of Medical and Veterinary Importance: Study of important ectoparasites including flies (bot flies, black flies, sand flies), mosquitoes (vectors of Japanese encephalitis, and dog heartworm), ticks, mites, lice, and fleas. Emphasis on pathogenicity, symptoms, diagnostic approaches, and public health significance.

4.4 Treatment and Control of Parasitic Diseases: Principles of parasite treatment and control with emphasis on understanding parasite life cycles for effective management. Overview of antiparasitic drugs and characteristics of an ideal antiparasitic agent. Basic concepts of vaccines against parasitic diseases (attenuated, killed, recombinant, toxoid, and DNA vaccines). Strategies for prevention and control including environmental modification, vector control, eradication and elimination programs, public health measures, legislation, and the role of organizations and modern tools such as GIS in disease surveillance.

***(80 Marks Theory Paper and 20 Marks for Theory CIE)**

PRACTICAL

Course Code: **BZO6P14**

Credits: **1**

Teaching Hours: **30 Hours**

1. Study and identification of parasitic protozoans - *Giardia lamblia* (trophozoite and cyst), *Entamoeba histolytica* (trophozoite and cyst), *Trichomonas vaginalis*, *Plasmodium* spp. (trophozoite, schizont), *Trypanosoma* spp., *Leishmania* spp. (amastigote and promastigote forms) using permanent slides, models, charts, photographs, and ICT-based resources.
2. Study and identification of parasitic helminths - *Fasciola hepatica*, *Schistosoma* spp., *Taenia* spp., *Ascaris lumbricoides*, *Wuchereria bancrofti*, using preserved specimens, permanent slides, models, charts, and digital resources.
3. Study and Identification of Ectoparasites and Vectors: Mosquito (*Anopheles*, *Culex*), Sand fly, Housefly, Tick, Louse, Flea, using preserved specimens, permanent slides, models, charts, and digital resources.
4. Identification of ova and larval stages of common helminths using charts/photographs/models.
5. Examination of Blood Smear for Hemoparasites (Demonstration): Preparation and study of stained blood smear for detection of *Plasmodium* and microfilariae (demonstration-based).
6. Case Study Analysis: Study of selected parasitic diseases (malaria, amoebiasis, ascariasis, filariasis) including symptoms, diagnosis, and prevention strategies.



7. Life Cycle Interpretation: Diagrammatic representation and explanation of life cycles of any two parasites, highlighting infective stages and control points.

8. Field Visit (Where Feasible): Visit to diagnostic laboratory / public health laboratory / veterinary clinic and submission of field report.

Assessment Scheme

B.Sc. Semester VI – Parasitology

Course Type: Discipline Specific Core (DSC)

Credits: 1

Course Code: BZO6P14

Total Marks: 50

Continuous Internal Evaluation (CIE) – 50 Marks

Component	Description	Marks
Practical Performance	Performance in Identification, Examination of Blood Smear, Case Study Analysis, Participation & Laboratory Conduct	20
Practical Record / Journal	Maintenance of record with diagrams, results, completion and regularity	10
Internal Test / Skill Assessment	Short practical-based test / spot identification	10
Field Visit Report	Observational skills, Presentation	5
Viva Voce (Internal)	Understanding of parasite biology, Epidemiology and control, Diagnostic techniques, Public health relevance	5
Total		50

Reference Books

1. Chatterjee, K.D. – *Parasitology (Protozoology and Helminthology)*. CBS Publishers & Distributors.
2. Paniker, C.K.J. & Ghosh, S. – *Textbook of Medical Parasitology*. Jaypee Brothers Medical Publishers.
3. Arora, D.R. & Arora, B. – *Medical Parasitology*. CBS Publishers.
5. Roberts, L.S., Janovy, J., & Nadler, S. – *Foundations of Parasitology*. McGraw-Hill.
6. Kreier, J.P. & Baker, J.R. – *Parasitic Protozoa*. Academic Press.
7. Garcia, L.S. – *Diagnostic Medical Parasitology*. ASM Press.
7. Cheng, T.C. – *General Parasitology*. Academic Press.
8. Soulsby, E.J.L. – *Helminths, Arthropods and Protozoa of Domesticated Animals*. Baillière Tindall.
9. Abbas, A.K., Lichtman, A.H. & Pillai, S. – *Basic Immunology*. Elsevier.
10. A textbook of Zoology DSC Semester VI - Himalaya Publishing House
11. Service, M.W. – *Medical Entomology for Students*. Cambridge University Press.
12. Pedigo, L.P. & Rice, M.E. – *Entomology and Pest Management*. Pearson.
13. Park, K. – *Preventive and Social Medicine*. Banarsidas Bhanot.
14. ICMR Manuals on Parasitic Diseases (Latest editions).



Programme: **B.Sc. Semester VI NEP (Zoology – Major)**

Course Category: **Discipline Specific Core (DSC)**

Name of Course: **Molecular Biology**

Theory- 2 Credits + Practical - 1 Credit

Course Outcomes (COs):

After successful completion of this course, students will be able to:

CO1: Describe the structure and organization of nucleic acids, including DNA and RNA, and explain experimental evidence supporting DNA and RNA as genetic material.

CO2: Explain genome organization in prokaryotes and eukaryotes, chromatin structure, and higher-order DNA packaging in relation to gene function.

CO3: Illustrate the mechanisms of DNA replication, repair, recombination, and regulation, and discuss their importance in maintaining genome stability.

CO4: Describe the processes of transcription and translation in prokaryotes and eukaryotes, and explain the significance of the genetic code in protein synthesis.

CO5: Explain mechanisms of gene regulation in prokaryotes and eukaryotes, including operon models and transcriptional control.

CO6: Understand the principles and applications of basic and modern molecular biology techniques such as electrophoresis, blotting, PCR, DNA sequencing, and molecular markers.

THEORY

Course Code: **BZO6T15**

Credits: **2**

Teaching Hours: **30**

Unit I: Nucleic Acids – Structure and Organization

7 Hrs 30 Mins

1.1 DNA Structure: Chemical composition of DNA, Watson and Crick double helix model, Forms of DNA (A-DNA, B-DNA, Z-DNA), DNA as genetic material (Griffith's Transformation Experiment, Avery, MacLeod and McCarty's Experiment, Hershey and Chase's Experiment)

1.2 RNA Structure: Chemical composition of RNA, Types of RNA (mRNA, tRNA, rRNA), Structural features of tRNA, RNA as genetic material with reference to the Fraenkel-Conrat experiment on Tobacco Mosaic Virus (TMV).

1.3. Gene and Genome: General organization of the genome in prokaryotes and eukaryotes; structural organization of a typical eukaryotic gene (exons, introns, promoter region), Overview of genome size variation and the C-value paradox (basic concept only), introduction to repetitive and non-repetitive DNA sequences, gene families (single-copy and multigene families), and pseudogenes.



1.4 Chromatin Organization: Nucleosome as the basic structural unit of chromatin, role of histone and non-histone proteins, Types of chromatin - Euchromatin and heterochromatin, Packaging of DNA into Higher Order Structures (Beads-on-a-String (Primary Structure), The 30 nm Fibre (Secondary Structure), Higher Order (Tertiary Structures), Looped Domains (Quaternary Structure).

Unit II: DNA Replication, Repair, and Recombination

7 Hrs 30 Mins

2.1 DNA Replication: Semi-conservative model of DNA replication; basic steps of replication in prokaryotes—initiation, elongation, and termination; concept of origin of replication and replication fork, Enzymes involved in DNA replication in *E. coli*, including DNA polymerases, helicase, primase, DNA ligase, topoisomerase, and single-strand binding proteins. Overview of rolling circle replication (introductory concept), Mechanism of DNA replication in eukaryotes—initiation at multiple origins, major eukaryotic DNA polymerases (basic functions only), replication through chromatin, and the end-replication problem. Concept of telomeres and role of telomerase in chromosome maintenance.

2.2 DNA Damage and Repair: Types and causes of DNA damage, including replication errors and damage due to physical and chemical agents, Mechanisms of DNA repair, including proofreading during replication, direct repair, base excision repair, nucleotide excision repair, mismatch repair, and recombinational repair (introductory overview).

2.3 Recombination: Types of Recombination, Holliday model for Homologous recombination, Site-specific recombination in Eukaryotes and its Biological Significance.

2.4 Regulation of DNA Replication: Regulation of DNA replication with reference to origin recognition, initiation control mechanisms, and coordination with the cell cycle, Role of telomeres and telomerase in maintaining chromosome stability, Introduction to cell cycle checkpoints and their significance

Unit III: Transcription and Translation

7 Hrs 30 Mins

3.1 Transcription in Prokaryotes: Structure and function of RNA polymerase in prokaryotes, role of sigma (σ) factor in promoter recognition, promoter sequences and structural organization of genes; Stages of transcription—initiation, elongation, and termination; Basic concept of transcription bubble; Overview of inhibitors of transcription and their applications.

3.2 Transcription in Eukaryotes: Types of eukaryotic RNA polymerases (RNA polymerase I, II, and III) and their functions, Role of promoters and transcription factors in initiation of transcription, Basic steps of transcription by RNA polymerase II—initiation, elongation, and termination

3.3 Translation in Prokaryotes and Eukaryotes: Structure and function of ribosomes, role of mRNA, tRNA, and rRNA in protein synthesis, Stages of translation—initiation, elongation, and termination in prokaryotes and eukaryotes (basic comparison), Overview of inhibitors of protein synthesis and their significance.



3.4 Genetic Code: Characteristics of genetic code, Codon–anticodon interaction, Wobble hypothesis, universality and known exceptions of the genetic code.

Unit IV: Gene Regulation and Molecular Techniques

7 Hrs 30 Mins

4.1 Regulation of Gene Expression in Prokaryotes and Eukaryotes: Organization of bacterial operons with reference to the Lac operon and Tryptophan operon; concept of attenuation, Regulation of gene expression in eukaryotes, including transcription factors, activators and repressors, enhancers and silencers, and chromatin remodeling.

4.2 Basic Techniques in Molecular Biology: Principle and applications of spectrophotometry; types of centrifugation (differential and density gradient centrifugation); introduction to ultracentrifugation. Basic concept of X-ray diffraction (DNA structure determination) and agarose gel electrophoresis for separation of nucleic acids.

4.3 Nucleic Acid and Protein Analysis Techniques: Principle and applications of blotting techniques—Southern, Northern, and Western blotting. Basic concept of ELISA and immunodetection methods. Introduction to hybridoma technology and production of monoclonal antibodies.

4.4 Modern Molecular Techniques and Applications: Principle and applications of PCR, Basic concept of DNA sequencing and molecular DNA markers (RFLP, RAPD, SNPs), Introduction to DNA fingerprinting and its applications.

***(80 Marks Theory Paper and 20 Marks for Theory CIE)**

PRACTICAL

Course Code: **BZO6P15**

Credits: **1**

Teaching Hours: **30**

1. Principle, working, and applications of autoclave, centrifuge, pH meter, micropipettes, digital balance, homogenizer, spectrophotometer, and electrophoresis apparatus.
2. Calculation and preparation of molar and normal solutions used in molecular biology laboratories.
3. Preparation of common laboratory buffers (Tris buffer and phosphate buffer); measurement and adjustment of pH.
4. Demonstration of DNA: Feulgen's reaction (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry farms/ fish markets etc.)
5. Demonstration of DNA and RNA using Methyl Green–Pyronin staining technique (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry farms/ fish markets etc.)



6. Extraction of genomic DNA from plant or animal tissue using phenol extraction method (Demonstration/Video-assisted if laboratory facility is limited).
7. Biochemical estimation of DNA: Diphenylamine method (Source of blood: Local recognized pathology laboratory)
8. Biochemical estimation of RNA: Orcinol method (Source of blood: Local recognized pathology laboratory)
9. Demonstration of separation of amino acids by paper chromatography / thin-layer chromatography (TLC).
10. Agarose Gel Electrophoresis (Demonstration) (Demonstration/Video-assisted if laboratory facility is limited)
11. Polymerase Chain Reaction (PCR) (Demonstration) (Demonstration/Video-assisted if laboratory facility is limited)

Assessment scheme (Practical)

B.Sc. Semester VI - Molecular Biology

Course Type: Discipline Specific Core (DSC)
Credits: 1

Course Code: BZO6P15
Total Marks: 50

- Continuous Internal Evaluation (CIE): 25 Marks
- Semester End Examination (SEE): 25 Marks

I. Continuous Internal Evaluation (CIE) – 25 Marks

Component	Description	Marks
Practical Performance	Regularity, laboratory discipline, handling of instruments, safety practices	10
Practical Record	Completion of Practical Record with diagrams, calculations, and interpretations	5
Skill-based Internal Practical Test	Any one experiment such as Preparation of molar/normal solution, Buffer preparation and pH adjustment, DNA/RNA estimation calculations, Interpretation of electrophoresis/chromatography res	5
Viva-Voce (Internal)	Principles, working, and applications of instruments and techniques	5
Total		25



II. Semester End Examination (SEE) – 25 Marks

Practical Examination Pattern

Component	Description	Marks
Major Practical	Any one experiment: Demonstration of DNA: Feulgen's reaction, DNA/RNA biochemical estimation, chromatography, electrophoresis	8
Minor Practical	Preparation of buffer with pH adjustment, Calculation and preparation of molar and normal solutions used in molecular biology laboratories, Demonstration of DNA and RNA using Methyl Green–Pyronin staining technique	5
Spotting (5 spots × 1 mark)	Identification/principle of Laboratory instruments	5
Viva Voce (External)	Questions related to practical concepts	5
Record Verification	Certified journal submission	2
Total		25

Reference Books

1. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2014). *Molecular Biology of the Gene*. Pearson Education.
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2015). *Molecular Biology of the Cell*. Garland Science.
3. Lodish, H., Berk, A., Kaiser, C. A., et al. (2016). *Molecular Cell Biology*. W.H. Freeman and Company.
4. Brown, T. A. (2017). *Genomes*. Garland Science.
5. Karp, G. (2019). *Cell and Molecular Biology: Concepts and Experiments*. Wiley.
6. De Robertis, E. D. P., & De Robertis, E. M. F. (2017). *Cell and Molecular Biology*. Lippincott Williams & Wilkins.
7. Powar, C. B. (2015). *Cell Biology*. Himalaya Publishing House.
8. Gupta, P. K. (2018). *Molecular Biology and Genetic Engineering*. Rastogi Publications.
9. Wilson, K., & Walker, J. (2018). *Principles and Techniques of Biochemistry and Molecular Biology*. Cambridge University Press.
10. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual*. Cold Spring Harbor Laboratory Press.
11. Plummer, D. T. (2003). *An Introduction to Practical Biochemistry*. Tata McGraw-Hill.
12. Upadhyay, A., Upadhyay, K., & Nath, N. (2014). *Biophysical Chemistry: Principles and Techniques*. Himalaya Publishing House.
13. A Textbook of Zoology DSC Semester VI – Himalaya Publishing House.
14. Lewin, B. (2011). *Genes*. Jones & Bartlett Publishers.



Programme: **B.Sc. Semester VI (NEP) Zoology Major**

Course Category: **Discipline Specific Elective (DSE)**

Name of the Course: **Insect Morphology and Physiology**

Theory- 3 Credits + Practical - 1 Credit

Course Outcomes (COs)

After completion of this course, students will be able to:

CO1: Describe the external morphology of insects, including the structure and functional modifications of the head, thorax, abdomen, and appendages.

CO2: Explain the structure, composition, and physiological role of the insect integument, including the process of moulting and hormonal regulation of growth.

CO3: Illustrate the organization and functioning of the insect respiratory and circulatory systems, including adaptive mechanisms in aquatic and terrestrial environments.

CO4: Understand the structure and functional mechanisms of the insect nervous system and sense organs, and relate them to coordination, behavior, and biological rhythms.

CO5: Analyze the role of chemical communication (pheromones and kairomones) and sensory physiology in insect behavior and vector control strategies.

CO6: Explain the structure and functioning of the insect endocrine and reproductive systems, including hormonal regulation of metamorphosis and specialized reproductive strategies.

THEORY

Course Code: **BZO6T16**

Credits: **3**

Teaching Hours: **45 Hrs.**

Unit I: Insect Morphology and Integumentary System

11 hr 15 min

1.1 Head and appendages: Structure of the insect head; types and functions of antennae; classification and modification of mouthparts with examples (biting, chewing, piercing-sucking, siphoning, etc.).

1.2 Thorax and locomotory structures: Structure of the thorax; wings and basic wing venation; types of legs and their modifications for walking, jumping, swimming, digging, and grasping.

1.3 Abdomen and external genitalia: Segmentation of the abdomen; abdominal appendages including cerci; general structure of male and female external genitalia and their functional significance.

1.4 Integumentary system: Structure and formation of the insect cuticle; basic biochemical composition of the cuticle (chitin and proteins); process and physiology of moulting; role of moulting enzymes and hormones in growth and development.



Unit II: Respiratory and Circulatory System

11 hr 15 min

2.1 Respiratory system: Structure and organization of the insect respiratory system with special reference to the tracheal system. Morphology and function of spiracles, tracheae, and tracheoles. Mechanism of gaseous exchange in insects and its physiological significance.

2.2 Respiratory adaptations: Structural and physiological adaptations of insects for respiration in aquatic environments. Types of respiratory adaptations including tracheal gills, cutaneous respiration, breathing tubes (siphons), plastron (physical gill), and rectal gills. Basic concept of cyclic or discontinuous respiration in terrestrial insects and its physiological significance in gas exchange and water conservation.

2.3 Respiratory metabolism: Basic concept of respiratory metabolism in insects with emphasis on cellular respiration and energy production. Role of the cytochrome oxidase system in the electron transport chain and its significance in oxidative metabolism and ATP generation.

2.4 Circulatory system: Structure and organization of the insect circulatory system (open type). Mechanism of circulation and functioning of the dorsal vessel (heart and aorta). Composition and functions of haemolymph. Types and functions of haemocytes. Introduction to haemopoietic organs and the role of immune molecules in insect defense.

Unit III: Nervous System and Sense Organs

11 hr 15 min

3.1 Nervous system: Structure and organization of the insect nervous system, including the central nervous system (brain and ventral nerve cord), peripheral nervous system, and visceral (sympathetic) nervous system. Functional significance of each component in coordination and control.

3.2 Physiology of nervous system: Mechanism of nerve impulse transmission in insects; structure and function of neurons; synaptic transmission and coordination of activities.

3.3 Sense organs and Biological Rhythms: Types of sense organs in insects (mechanoreceptors, chemoreceptors, photoreceptors, and thermoreceptors); their structure and functions. Basic concept of circadian rhythms with special reference to behavioral patterns in Insects.

3.4 Sensory physiology and behavior: Role of sensory systems in insect behavior, with special reference to host-seeking behavior in mosquitoes. Concept of chemical communication, including pheromones and kairomones, and their importance in vector management and pest control strategies.



Unit IV: Insect Endocrine System and Reproduction

11 hr 15 min

4.1 Endocrine system: Structure and organization of the insect endocrine system, including neurosecretory cells, corpora cardiaca, corpora allata, and associated endocrine complexes. Functional role of these organs in growth, development, and physiological regulation.

4.2 Insect hormones: Types of insect hormones (juvenile hormone, ecdysone, neurohormones, etc.), their sources, functions, and basic mechanisms of action. Role of hormones in moulting, metamorphosis, and reproduction.

4.3 Reproductive systems – General structure and organization of male and female reproductive systems in insects, with reference to representative orders such as Orthoptera and Diptera. Functional significance of reproductive organs.

4.4 Reproductive physiology: Process of egg maturation, fertilization, and embryonic development in insects. Specialized reproductive strategies such as viviparity, ovoviviparity, polyembryony, and parthenogenesis. Hormonal control of reproduction and its physiological importance.

***(120 Marks Theory Paper and 30 Marks for Theory CIE)**

PRACTICAL

Course Code: **BZO6P16**

Credit: **1**

Teaching Hours: **30 Hrs.**

1. Demonstration of /Study and/or dissection of the nervous system of insects, using charts, photographs, specimens or ICT tools.
2. Demonstration of /Study and/or dissection of male and female reproductive systems of insects, using charts, photographs, specimens or ICT tools.
3. Dissection and mounting of mouthparts of mosquito/housefly/ honeybess/ cockroach
4. Counting of haemocytes in insect haemolymph using a haemocytometer
5. Estimation of proteins, sugars, and lipids in insect haemolymph by colorimetric/ spectrophotometric methods
6. Permanent preparation of insect structures – sting apparatus of honey bee/wasp, tympanum of locust, salivary glands of cockroach, mouthparts, legs, and wings
7. Histological study of insect tissues using microtechnique.
8. Determination of pH of gut/ haemolymph contents of an insect.



Assessment Scheme (Practical)

Name of the Course: Insect Morphology and Physiology

Course Category: Discipline Specific Elective (DSE)

Credits: 1

Course Code: BZO6P16

Total Marks: 50

Continuous Internal Evaluation (CIE) – 50 Marks

Component	Description	Marks
Practical Performance	Regular attendance, proper handling of specimens and instruments, maintenance of lab safety	20
Practical Record	Completeness, labeled diagrams, observations, results, interpretation, timely submission	10
Internal Test	Practical-based test	10
Continuous Skill Assessment	Dissection skills, slide preparation, mounting technique, haemocyte counting accuracy, biochemical test performance	5
Viva Voce (Internal)	Questions based on structure, physiology, applied relevance (vector control/IPM linkage)	5
Total		50

List of Recommended Books

1. Chapman, R. F., Simpson, S. J., & Douglas, A. E. (2013). *The Insects: Structure and Function*. Cambridge University Press.
2. Nation, J. L. (2015). *Insect Physiology and Biochemistry*. CRC Press.
3. Gullan, P. J., & Cranston, P. S. (2014). *The Insects: An Outline of Entomology*. Wiley-Blackwell.
4. Wigglesworth, V. B. (2012). *The Principles of Insect Physiology*. Springer.
5. Tembhare, D. B. (2024). *Modern Entomology*. Himalaya Publishing House
6. Imms, A. D. (2012). *A General Textbook of Entomology*. Springer.
7. Richards, O. W., & Davies, R. G. (2010). *Imms' General Textbook of Entomology*. Chapman & Hall.
8. Srivastava, K. P. (2011). *A Textbook of Applied Entomology*. Kalyani Publishers.
9. Pedigo, L. P., & Rice, M. E. (2014). *Entomology and Pest Management*. Waveland Press.
10. Gillott, C. (2005). *Entomology*. Springer.
11. Prakash, A., & Rao, J. (2014). *Laboratory Manual of Entomology*. New India Publishing Agency.
12. A textbook of Zoology Semester VI DSE - Insect Morphology and Physiology. Himalaya Publishing House
13. Plummer, D. T. (2003). *An Introduction to Practical Biochemistry*. Tata McGraw-Hill.



Programme: **B.Sc. Semester VI NEP Zoology Major**

Course Category: **Discipline Specific Elective (DSE)**

Name of Course: **Fish Physiology**

Theory- 3 Credits + Practical - 1 Credit

Course Outcomes (COs): After completion of this course, students will be able to:

CO-1: Explain the structure and functional physiology of the digestive and excretory systems in fishes, including digestion, enzymatic processes, excretion and osmoregulation in different aquatic environments.

CO-2: Describe the organization and physiological mechanisms of the cardiovascular and respiratory systems in fishes, including heart structure, blood circulation, branchial respiration, and accessory respiratory organs.

CO-3: Illustrate the organization and functions of the nervous and endocrine systems in fishes, including neuroendocrine regulation and hormonal control of physiological processes.

CO-4: Explain the structure and functions of the reproductive systems in fishes, including gametogenesis, neuroendocrine regulation of reproduction, and different modes of reproduction.

CO-5: Apply practical skills in fish physiology through anatomical, histological, biochemical and physiological experiments, including estimation of gonadosomatic index, fecundity, oxygen consumption and analysis of fish tissues.

THEORY

Course Code: **BZO6T16**

Credits: 3

Teaching Hours: **45 Hrs.**

Unit – I The digestive and excretory system

11 hr 15 min

- 1.1 Digestive system: Comparative study of the anatomy and histology of the alimentary canal and digestive glands with respect to the type of diet.
- 1.2 Physiology of digestion: Biochemistry of enzymatic digestion of food in herbivorous, carnivorous and omnivorous fishes, absorption and assimilation of digested food, hormonal regulation of feeding and digestion
- 1.3 Excretory System: Organs of the excretory system in fishes and their significance; evolutionary aspects of the excretory system in fishes.
- 1.4 Osmoregulation in Fishes: Physiology of osmoregulatory tissues in freshwater, marine, and euryhaline fishes; role of skin, gills, kidneys and gastrointestinal tract.



Unit – II The Cardiovascular and respiratory system**11 hr 15 min**

2.1 Structure and Functional Organization of Fish Heart: Anatomy and histology of the fish heart; chambers of the heart; conus arteriosus and bulbus arteriosus; cardiac physiology.

2.2 Blood Circulation in Fishes: Single circulation; pathway of blood flow; countercurrent exchange and physiological adaptations.

2.3 Branchial Respiration: Structure of gills; mechanism of branchial respiration and gas exchange.

2.4 Accessory Respiratory Organs in Fishes: Types of accessory respiratory organs in fishes and their adaptive significance; cutaneous respiration, buccopharyngeal epithelium, intestinal respiration, air bladder respiration, labyrinth organ, and dendriform organ.

Unit – III Nervous and Endocrine physiology**11 hr 15 min**

3.1 Nervous System: Organization of the central nervous system in fishes: brain and spinal cord.

3.2 Peripheral and Autonomic Nervous System in Fishes: Cranial and spinal nerves; sympathetic and parasympathetic nervous systems.

3.3 Neuroendocrine Regulation in Fishes: Hypothalamo–pituitary axis and its role in physiological regulation.

3.4 Endocrine System in Fishes: Pituitary, thyroid gland, interrenal tissue, chromaffin tissue and corpuscles of Stannius.

Unit IV: Reproductive System**11 hr 15 min**

4.1 Male Reproductive System: Structure and functions of testes; spermatogenesis.

4.2 Female Reproductive System: Structure and functions of ovaries; vitellogenesis.

4.3 Neuroendocrine Control of Reproduction: Hypothalamo–pituitary–gonadal (HPG) axis.

4.4 Modes of Reproduction: Oviparity, viviparity, and ovoviviparity; sex reversal and factors influencing sex reversal.

***(120 Marks Theory Paper and 30 Marks for Theory CIE)**

PRACTICAL

Course Code: **BZO6P16**

Credit: **1**

Teaching Hours: **30 Hrs.**

For all the practical, except those where the use of live fish is specifically mentioned, dead but fresh fish specimens should be procured from the edible fish market.

1. Estimation of gonadosomatic index (GSI) using provided data.
2. Estimation of fecundity in fishes.

3. Study of accessory respiratory organs in fishes.
4. Anatomical observation of the digestive, reproductive, nervous, and endocrine systems of fish with the help of charts or ICT tools.
5. Histological study of fish tissues: gonads, liver, kidney, and intestine, Gill.
6. Histochemical demonstration of proteins and lipids in fish tissues.
7. Qualitative analysis of proteins and carbohydrates from fish muscles and liver.
8. Estimation of oxygen consumption rate in ornamental fishes.

Assessment Scheme (Practical)

Name of the Course: Fish Physiology

Course Category: Discipline Specific Elective (DSE)

Course Code: BZO6P16

Credits: 1

Total Marks: 50

Continuous Internal Evaluation (CIE) – 50 Marks

Component	Description	Marks
Practical Performance	Regular attendance, proper handling of specimens, slides, reagents, calculations (GSI, fecundity, oxygen consumption), slide identification, histochemical interpretation, qualitative biochemical tests; adherence to safety and ethical practices	20
Practical Record	Neat labeled diagrams, calculations (GSI, fecundity, oxygen consumption), histological descriptions, qualitative test observations, timely submission	10
Internal Test	Practical-based test	10
Continuous Skill Assessment	Dissection skills, slide preparation, mounting technique, haemocyte counting accuracy, biochemical test performance	5
Viva Voce (Internal)	Questions related to reproductive biology, fish physiology, histology, biochemical tests, and applied aquaculture relevance	5
Total		50

Reference books

1. Physiology of Fishes, 5th Edition – Edited by David H. Evans & Suzanne Currie (CRC Marine Biology Series, 2020)
2. Biology and Ecology of Fishes, 3rd Edition – James S. Diana & Tomas O. Höök (Wiley, 2023)
3. Fish Physiology: An Introduction to Functional Morphology – Updated reprint (Academic Press, 2022)
4. Fish Physiology Encyclopedia (2023 Edition) – Encyclopedic reference covering broad physiological topics.
5. Aquatic Physiology: Adaptations of Fishes to Their Environment – Springer, 2021.
6. Fish Physiology Series (Academic Press – Specialized Volumes)
 - a. Fish Physiology: Hypoxia (Vol. 27) – Farrell & Brauner (2020)
 - b. Fish Physiology: Climate Change and Fishes (Vol. 36) – Farrell & Richards (2021)

- c. Fish Physiology: Bioenergetics (Vol. 37) – Farrell & Brauner (2022)
 - d. Fish Physiology: Stress Responses in Fishes (Vol. 38) – Richards & Farrell (2022)
 - e. Fish Physiology: Reproductive Physiology of Fishes (Vol. 39) – Farrell & Brauner (2023)
 - f. Fish Physiology: Sensory Biology of Fishes (Vol. 40) – Farrell & Richards (2023)
 - g. Fish Physiology: Metabolism and Energetics (Vol. 41) – Farrell & Brauner (2024)
 - h. Fish Physiology: Environmental Adaptations (Vol. 42) – Farrell & Richards (2024) Applied & Regional Texts
7. Fish Physiology and Aquaculture Practices – M.P. Singh (2022, India-focused text)
 8. Hoar H.S. & Randall (Eds.) Fish Physiology Vol. 1 to 13: (1964-1994) Academic press London, New York.
 9. Brown M.E. The physiology of fishes Vol. 1 & 2: (1957) Academic press, New York.
 10. Bone, Q; Marshall, Norman Bertram; Blaxter, J.H. S. Biology of fishes Publication date 1995 Publisher London; New York: Blackie
 11. Willam C. Hamlett Sharks, skates, and rays: the biology of elasmobranch fishes 1999 Publisher Baltimore: Johns Hopkins University Press
 12. Hodgson Edward S., Mathewson Robert F., Sensory Biology of Sharks, Skates, and Rays 1978 office of naval research department of the navy Arlington, Va.
 13. Matty A. Fish endocrinology 1985 Chapman and Hall, London: Croom Helm; Portland, Ore.: Timber Press
 14. Bolis Liana, Keynes R. D., Maddrell S.H.P., Comparative physiology of sensory systems 1984 Cambridge university press Cambridge London, New York, New Rochelle, Melbourne, Sydney
 15. Sloman Katherine A., Balshine Sigal, Wilson Rod W., Fish Physiology: Behaviour and Physiology of Fish 1st Edition, Volume 24 - December 13, 2005 Academic Press
 16. Lagler K. F. Ichthyology 2nd edition John Wileys and sons New York
 17. Hart Paul J.B. and Reynolds John D., Handbook of Fish Biology and Fisheries Volume 1 Fish Biology Wiley Online Library.
 18. Jhingran V. G., Fish and fisheries of India 3rd edition Hindustan Publishing Corporation; New edition
 19. A textbook of Zoology Semester VI DSE – Fish Physiology, Himalaya Publishing House
 20. Chonder, S. L. Handbook of breeding of Indian Major Carps by pituitary hormone injection: (1970). Satish book enterprises, Agra

Programme: **B.Sc. Semester - VI NEP (Zoology – Major)**

Course category: **Discipline Specific Elective (DSE)**

Name of the course: **Female Mammalian Reproductive Physiology**

Theory- 3 Credits + Practical - 1 Credit

CO1: To study the location, structure and functions of organs of female reproductive system

CO2: To reveal the phases of menstrual cycle, hormones and process of oogenesis

CO3: To understand the process of pregnancy and birth control methods and IUDs

CO4: To analyze the various prenatal diagnostic tests

THEORY

Course code: BZ06T16

Credit 3

Teaching Hours: 45

Unit 1: Structure and functions of organs of female reproductive system 11 hr 15 min

1.1 Ovaries: Location, gross anatomy, and histological structure of the ovaries; functions of ovaries in oogenesis and hormone secretion. Structure and functions of the uterine (fallopian) tubes in ovum transport and fertilization.

1.2 Uterus: Anatomy and histological organization of the uterus; structural layers and their functional significance in implantation and pregnancy.

1.3 Cervix, vagina and vulva: Structure and functions of the cervix, vagina, and external genitalia (vulva); their roles in reproduction and parturition.

1.4 Mammary gland: Structure and histology of mammary glands; physiological role in lactation and neonatal nutrition.

Unit 2: Female reproductive cycle

11 hr 15 min

2.1 Oogenesis and Folliculogenesis: Process of oogenesis; stages of follicular development and ovulation.

2.2 Oocyte maturation: Development of ovarian follicles from primary follicle to Graafian follicle; structural and hormonal changes during maturation.

2.3 Phases of female reproductive cycle: Menstrual cycle phases.

2.4 Hormonal regulation of female reproductive cycle: Role of hypothalamic, pituitary, and ovarian hormones (GnRH, FSH, LH, estrogen, progesterone) in regulating the reproductive cycle.



Unit 3: Pregnancy and birth control methods**11 hr 15 min**

3.1 Prenatal development: Fertilization, cleavage, implantation, and early embryonic development.

3.2 Placental Development and Pregnancy: Structure and functions of the placenta; stages of pregnancy (three trimesters); basic concept of labor and parturition.

3.3 Birth control methods: Surgical sterilization and hormonal methods, mechanism of action and effectiveness.

3.4 Barrier Methods and Medical Termination: Intra-uterine devices, Spermicides, barrier methods and Abortion

Unit 4: Prenatal diagnostic tests**11 hr 15 min**

4.1 Teratogens and Their Effects: Effects of chemicals, drugs, and radiation on foetal development.

4.2 Prenatal Diagnostic Techniques: Principles and applications of Fetal ultrasonography, Amniocentesis, Chronic Villi sampling, Noninvasive prenatal test

4.3 Hormones of Pregnancy: Sources and functions of hormones secreted during pregnancy

4.4 Early pregnancy tests: Principle and application of early pregnancy tests based on detection of hCG.

***(120 Marks Theory Paper and 30 Marks for Theory CIE)**

PRACTICAL**Course Code: BZO6P16****Credit: 1****Teaching Hours: 30 Hrs**

1. To demonstrate the histological structure of ovary, Uterine tube, uterus, cervix of mammals, using charts, models, and preserved specimens.
2. To study the basal body temperature during complete menstrual cycle
3. Graphical representation and interpretation of hormonal fluctuations during different phases of the menstrual cycle.
4. To demonstrate Various stages of oestrus cycle
5. Demonstration of Pregnancy test with pregnancy kit
6. Gross morphology and histological features of the placenta using charts/models; understanding its functions.
7. Study and report on Intra uterine devices and other contraceptives
8. Visit to IVF center or Ultrasound Sonography center and prepare a report



Assessment Scheme (Practical)

Name of the Course: Female Mammalian Reproductive Physiology

Course Category: Discipline Specific Elective (DSE)

Course Code: BZO6P16

Credits: 1

Total Marks: 50

Continuous Internal Evaluation (CIE) – 50 Marks

Component	Description	Marks
Practical Performance	Regular attendance, punctuality, proper handling of charts, models, kits, and laboratory materials	20
Practical Record	Neat labeled diagrams (ovary, uterus, placenta), BBT charting, hormonal graphs, observations, and timely submission	10
Internal Test	Short practical-based test	10
Report	IVF center or Ultrasound Sonography Visit report	5
Viva Voce (Internal)	Principles, reactions involved, interpretation of results, applications	5
Total		50

Reference Books

1. Knobil, E., & Neill, J. D. (2015). *Physiology of Reproduction*. Academic Press.
2. Johnson, M. H., & Everitt, B. J. (2018). *Essential Reproduction*. Wiley-Blackwell.
3. Hafez, E. S. E., & Hafez, B. (2013). *Reproduction in Farm Animals*. Wiley-Blackwell.
4. Guyton, A. C., & Hall, J. E. (2021). *Textbook of Medical Physiology*. Elsevier.
5. Fox, S. I. (2019). *Human Physiology*. McGraw Hill Education.
6. Tortora, G. J., & Derrickson, B. H. (2017). *Principles of Anatomy and Physiology*. Wiley.
7. Marieb, E. N., & Hoehn, K. (2018). *Human Anatomy and Physiology*. Pearson Education.
8. Sadler, T. W. (2019). *Langman's Medical Embryology*. Wolters Kluwer.
9. Cunningham, F. G., et al. (2022). *Williams Obstetrics*. McGraw Hill.



Programme: **B.Sc. Semester VI NEP Zoology Major**

Course Category: **Discipline Specific Elective (DSE)**

Name of Course: **Biochemistry**

Theory- 3 Credits + Practical - 1 Credit

Course Outcomes (COs)

After completion of this course, students will be able to:

CO1: Describe the classification, structure, and biological significance of carbohydrates, proteins, lipids, and nucleic acids.

CO2: Explain the structural organization of proteins and the functional role of enzymes, including basic concepts of enzyme kinetics and inhibition.

CO3: Illustrate the major metabolic pathways of carbohydrates, lipids, and amino acids and explain their role in energy production and physiological regulation.

CO4: Understand the structure and biological role of DNA and RNA, and explain the significance of ATP and bioenergetics in cellular metabolism.

CO5: Interpret the fundamental principles of oxidative phosphorylation and the electron transport chain in energy generation.

THEORY

Course Code: **BZO6T16**

Credits: 3

Teaching Hours: **45 Hrs.**

Unit I: Carbohydrates

11 hr 15 min

1.1 Classification and General Properties of Carbohydrates: Classification of carbohydrates into monosaccharides, oligosaccharides, and polysaccharides, General physical and chemical properties including solubility, sweetness, reducing nature, mutarotation, and basic reactions of sugars.

1.2 Structure and Biological Functions of Carbohydrates: Structure and functions of important monosaccharides (glucose, fructose), disaccharides (sucrose, lactose), and polysaccharides (starch, glycogen, cellulose), Role of carbohydrates in energy storage and structural support.

1.3 Application of Carbohydrates in Foods: Use of Sugars in Food, Food Applications of Starch Polysaccharides, Food Applications of Non-starch Polysaccharides

1.4 Overview of Carbohydrate Metabolism: Basic pathways of carbohydrate metabolism including glycolysis, glycogenesis, glycogenolysis, and gluconeogenesis (introductory concepts only).



Unit II: Proteins and Enzymes

11 hr 15 min

2.1 Amino Acids: Structure and Properties: General structure of amino acids, classification based on side chains, physical and chemical properties, zwitterionic nature, and isoelectric point (basic concept).

2.2 Levels of Protein Organization and Functions: Primary, secondary (α -helix and β -sheet), tertiary, and quaternary structures of proteins, Types of bonds involved in protein structure. Biological functions of proteins in living systems.

2.3 Overview of Amino Acid Metabolism: General concept of amino acid metabolism including transamination, deamination, ammonia transport, and urea cycle (introductory overview).

2.4 Enzymes and Enzyme Kinetics: Enzymes as biological catalysts; classification and nomenclature, Active site and enzyme–substrate complex, Theories of enzyme action (Lock-and-Key and Induced Fit models), Basic enzyme kinetics including K_m concept, Enzyme inhibition (competitive, non-competitive, and irreversible inhibition), Factors affecting enzyme activity—temperature, pH, enzyme concentration, and substrate concentration.

Unit III: Lipids

11 hr 15 min

3.1 Classification and Biological Importance of Lipids: Classification into simple, compound, and derived lipids, Structure and functions of fatty acids, triglycerides, phospholipids, and steroids, Biological roles in energy storage and membrane structure.

3.2 Fatty Acids and Storage Lipids: Structure of saturated and unsaturated fatty acids, Triacylglycerols and their role as energy reserves, Basic concept of essential fatty acids.

3.3 Lipid Metabolism (Overview): Digestion, absorption, and transport of lipids, Activation and transport of fatty acids. β -oxidation of fatty acids (basic concept only).

3.4 Lipids in Biological Regulation: Role of lipids as signaling molecules and components of cell membranes, Basic introduction to cholesterol and its physiological significance.

Unit IV: Nucleic Acids and Bioenergetics

11 hr 15 min

4.1 Structure and Functions of Nucleic Acids: Structure and functions of DNA and RNA. Types of RNA (mRNA, tRNA, rRNA) and their biological roles.

4.2 Introduction to Bioenergetics: Basic principles of thermodynamics in biological systems, Concept of free energy change (Gibbs free energy) and its significance in biochemical reactions, Redox reactions and their importance in metabolism (introductory concept).

4.3 ATP and High-Energy Compounds: Structure and role of ATP as the energy currency of the cell, ATP synthesis and hydrolysis, Concept of high-energy phosphate bonds.

4.4 Oxidative Phosphorylation and Electron Transport Chain (Overview): Organization of the electron transport chain in mitochondria, Basic concept of chemiosmotic hypothesis and ATP synthesis by ATP synthase, Introduction to inhibitors of electron transport (overview only).

***(120 Marks Theory Paper and 30 Marks for Theory CIE)**



PRACTICAL

Course Code: **BZO6P16**

Credits: **1**

Teaching Hours: **30 Hrs**

1. Preparation of standard solutions and demonstration of the use of a colorimeter and/or spectrophotometer for quantitative biochemical analysis.
2. Qualitative tests for carbohydrates: Molisch's, Benedict's, Fehling's, Iodine tests
3. Qualitative tests for proteins and amino acids: Biuret, Ninhydrin, Xanthoproteic, Millon's tests
4. Qualitative tests for lipids: Sudan III/IV, Emulsion, Grease spot tests
5. Estimation of glucose by colorimetric/spectrometric method
6. Estimation of total proteins by Biuret / Lowry method/ Peterson method
7. Study of enzyme activity: Effect of temperature and pH (amylase / catalase)
8. Demonstration of DNA extraction from plant/animal tissue

Assessment Scheme (Practical)

Name of the Course: Biochemistry

Course Category: Discipline Specific Elective (DSE)

Course Code: BZO6P16

Credits: 1

Total Marks: 50

Continuous Internal Evaluation (CIE) – 50 Marks

Component	Description	Marks
Practical Performance	Regular attendance, punctuality, lab safety, proper handling of chemicals and instruments	20
Practical Record	Completeness of experiments, neat diagrams, correct observations, calculations, results, and timely submission	10
Internal Test	Short practical-based test	10
3. Skill-Based Performance (Continuous Assessment)	Preparation of solutions, accuracy in qualitative tests	5
Viva Voce (Internal)	Principles, reactions involved, interpretation of results, applications	5
Total		50

Reference Books

1. Nelson, D. L., Cox, M. M. (2017). *Lehninger Principles of Biochemistry*. W.H. Freeman and Company, New York.
2. Berg, J. M., Tymoczko, J. L., Gatto, G. J., & Stryer, L. (2019). *Biochemistry*. W.H. Freeman and Company.
3. Voet, D., Voet, J. G., & Pratt, C. W. (2018). *Fundamentals of Biochemistry: Life at the Molecular Level*. Wiley.
4. Satyanarayana, U., & Chakrapani, U. (2019). *Biochemistry*. Elsevier India.

5. Murray, R. K., Bender, D. A., Botham, K. M., Kennelly, P. J., Rodwell, V. W., & Weil, P. A. (2018). *Harper's Illustrated Biochemistry*. McGraw-Hill Education.
6. Jain, J. L., Jain, S., & Jain, N. (2016). *Fundamentals of Biochemistry*. S. Chand & Company, New Delhi.
7. Plummer, D. T. (2003). *An Introduction to Practical Biochemistry*. Tata McGraw-Hill Publishing Company.
8. Wilson, K., & Walker, J. (2018). *Principles and Techniques of Biochemistry and Molecular Biology*. Cambridge University Press.
9. Conn, E. E., & Stumpf, P. K. (2009). *Outlines of Biochemistry*. Wiley India.
10. A textbook of Zoology DSE VI Semester Biochemistry. Himalaya Publishing House.
11. Singh, S. P., & Pandey, S. (2017). *Biochemistry*. S. Chand Publishing.



Programme: **B.Sc. Semester VI -NEP (Zoology Major)**

Course Category: **Vocational Skill Course (VSC)**

Course Title: **Prawn Culture**
Credit: **2 (Practical)**

Course Code: **BVS6P08**
Teaching Hours: **60 Hrs.**

Course Outcomes (COs): After successful completion of this course, students will be able to:

CO1: Identify commercially important freshwater and marine prawn species used in aquaculture.

CO2: Explain the biological characteristics and life cycle of prawns relevant to aquaculture practices.

CO3: Demonstrate pond preparation, water quality management, and feeding strategies in prawn culture.

CO4: Identify common diseases and predators of prawns and describe preventive and management measures.

CO5: Understand harvesting techniques, processing methods, and marketing strategies for prawn products.

CO6: Develop vocational and entrepreneurial skills related to prawn farming and aquaculture industries.

List of Practical

1. Identification of commercially important prawn species: Giant River Prawn (*Macrobrachium rosenbergii*), Giant Tiger Prawn (*Penaeus monodon*), Whiteleg Shrimp (*Litopenaeus vannamei*) and Indian White Prawn (*Fenneropenaeus indicus*) using charts, photographs, specimens, and ICT tools.
2. Study of morphological characteristics and life cycle stages of prawns using models, charts, and preserved specimens.
3. Study of pond preparation techniques including site selection, pond design, liming, fertilization, and water management through field visit / models / charts / ICT tools.
4. Study of prawn hatchery operations including broodstock management, larval rearing, and nursery practices through field visit / models / charts / ICT tools.
5. Study of feeding practices and feed formulation for prawn culture through models / charts / ICT tools.
6. Identification and study of common prawn diseases: viral infections (White Spot Syndrome Virus (WSSV), Yellow Head Virus (YHV), Infectious Hypodermal and Hematopoietic Necrosis (IHHNV), bacterial infections (Vibriosis and Black Spot/Shell disease) and parasitic infections (Cotton Shrimp and black gill disease) with the help of charts / photographs / ICT tools.
7. Study of prawn harvesting techniques (partial harvesting or cull-harvesting and total harvesting or drain harvesting), post-harvest handling (temperature shock and cleaning) and best practices for harvesting methods (Time, Quality control, sorting and water management) through field visit / models / charts / ICT tools.



8. Field visit to aquaculture farm / prawn hatchery / fish farm and submission of a detailed field report.

9. Market survey of prawn products and aquaculture-based enterprises.

Assessment Scheme

Course Category: Vocational Skill Course (VSC)

Course Code: BVS6P08

- Continuous Internal Evaluation (CIE): 50 Marks
- Semester End Examination (SEE): 50 Marks

I. Continuous Internal Evaluation (CIE) – 50 Marks

Component	Description	Marks
Practical Performance	Identification of species, disease recognition, understanding hatchery & pond management practices	15
Practical Record	Maintenance of practical file with labeled diagrams, observations, and notes	10
Field Visit Report	Detailed report on visit to aquaculture farm / hatchery	10
Market Survey Report	Survey of prawn products, market demand, pricing, and enterprise analysis	10
Internal Viva	Oral assessment and spot identification	5
Total		50

II. Semester End Examination (SEE) – 50 Marks

Practical Examination Pattern

Component	Description	Marks
Major Practical	Identification of prawn species / diseases / demonstration of harvesting methods	20
Minor Practical	Life cycle stages / feed formulation / pond preparation methods	15
Viva Voce	Questions based on practical syllabus	10
Record Verification	Certified practical journal	5
Total		50

List of Books Recommended

1. Pillay, T. V. R., & Kutty, M. N. (2005). *Aquaculture: Principles and Practices*. Blackwell Publishing.
2. New, M. B., & Valenti, W. C. (2000). *Freshwater Prawn Culture: The Farming of *Macrobrachium rosenbergii**. FAO Fisheries Technical Paper.
3. Boyd, C. E. (2015). *Water Quality: An Introduction*. Springer.
4. Rath, R. K. (2014). *Freshwater Aquaculture*. Scientific Publishers.
5. Jhingran, V. G. (1991). *Fish and Fisheries of India*. Hindustan Publishing Corporation.
6. Prawn culture (Zoology VSC Semester VI) – Himalaya Publishing House

B.Sc. Semester- VI

Minor 7- BZO4T07

Life and Diversity of Animals- Chordates

(Reptilia to Mammalia)

Theory 2 Credits + Practical- 1 Credit

Course outcomes: By the completion of the course the students will able to

CO 1. Describe, explain characters, classification of Reptile. Could analyze general pattern of different system of reptile.

CO 2. Describe, explain characters, classification of Aves. Could analyze general pattern of different system of Aves.

CO 3. Describe, explain characters, classification of Mammalia. Could analyze general pattern of different system of Mammalia.

CO 4. Compare integuments, urinogenital systems, heart and aortic arches in Reptilia, Aves and Mammalia. Also describe and analyze autonomous nervous system in Mammalia.

Unit – I

7.5 hrs.

1.1 Reptilia: General characters of Reptilia, Classification of Reptilia on the basis of temporal vacuities.

1.2 Calotes: External features, Digestive system, Respiratory system.

1.3 Structure and function of CNS (Brain and spinal cord).

1.4 Identification of Poisonous snakes and biting mechanism of snakes.

Unit – II

7.5 hrs.

2.1 Aves: General characters and classification of Aves on the basis of carina (Ratitae and Carinatae).

2.2 *Columba livia*: External features, Digestive system, Respiratory system

2.3 Structure and function of CNC (Brain and spinal cord)

2.4 Migration in Birds, Flight adaptation in birds

Unit – III

7.5 hrs.

3.1 General characters of Mammalia. Comparision of Prototherians, Metatherians and Eutherians.

3.2 Aquatic, arboreal and Volant adaptation in mammals.

3.3 Rabbit: Structure and function of digestive and respiratory system.



3.4 Rabbit: Structure and function of CNS (Brain and spinal cord).

Unit – IV

7.5 hrs.

4.1 Comparative accounts of integuments and its derivatives in Reptilia, Aves and Mammalia.

4.2 Comparative accounts of urinogenital systems in Reptilia, Aves and Mammalia.

4.3 Comparative accounts of heart and aortic arches in Reptilia, Aves and Mammalia.

4.4 Autonomous nervous system in mammals (Sympatheic and Parasympathetic).

BZO4PO7: Practical- Life and Diversity of Animals- Chordates (Reptilia to Mammalia) (1 Credit)

1. Study of museum specimens (Classification of animals up to orders)

Reptilia: Draco, Chamaeleon, Pharynosoma, Testudo, Russels viper, Naja, Krait, Hydrophis, Crocodile, Alligators.

Aves: Owl, Woodpecker, pigeon, Kingfisher, Kite, Duck, Parakeet.

Mammals: Squirrel, Mongoose, Loris, Bat, Rabbit, Dolphin, Whale.

2. Study of Axial skeleton and Appendicular skeleton of Fowl and Rabbit.

3. Dissections are to be demonstrated only by the virtual/ICT tools.

Anatomical observations of digestive system , reproductive system and brain in fowl by diagram, model and ICT tools.

Anatomical observations of digestive system , reproductive system and brain in Rat by diagram, model and ICT tools.

4. Collection and study of different types of feathers: Quill, Contour, Filoplume, Down.

5. Mounting of striated muscles and cartilage procured from slaughter house.

Practical Examination Scheme

Distribution of Marks (for SEE)

Total Marks: 25

1.	Identification and comments on spots (6 Museum specimens + 4 bones)	10
2.	Draw and give labels of given systems of given animal	05
3.	Mounting of given material	02
4.	Submission of certified practical record	03
5.	Viva Voce	05

Reference Books:

1. Practical Zoology – Vertebrata.- S.S. Lal,
2. A manual of Practical Zoology – Chordata- P.S.Verma.
3. Chordate Zoology' - E.L.Jordan and P.S. Verma, S. Chand Publication.
4. Chordata – Mohan P.Arora, Himalaya Publishing House Pvt. Ltd.
5. Text book of Vertebrates- Marshal, Parker and Haswell, ELBS and McMillan, England.
6. The Vertebrate Body, Sixth edition,- Alfred Sherwood Romer. Thomas, S. Pearson, CBS College Publishing, Saunders College Publishing.
7. The Life of Vertebrates, 3rd edition, J.W. Young, d, Oxford University press.
8. Vertebrate Life, 6th edition- Harvey Pough F, Christine M. Janis, B. Heiser, , Pearson, Education Inc.
9. Modern textbook of Zoology Vertebrates – Kotpal R. L., Rastogi Publication.

