

**MAJOR  
COMPULSORY  
ANIMAL TAXONOMY, SYSTEMATICS & BIostatISTICS  
Code: ZOO-2021  
Credit: 3 (T) + 1 (P)**

**Learning Objectives:**

1. To introduce and familiarize the basic concepts of animal systematics
2. To inculcate the importance of taxonomy and nomenclature in biology
3. To provide a framework on understanding interrelationship among taxa
4. To impart knowledge on the theory and practice of phylogeny

**Learning Outcomes:**

The students will be able to

1. Understand the general principles of taxonomy and systematics
2. Explain the importance of Zoological nomenclature and its rules
3. Understand the importance of systematics in biology and comprehend the taxonomic categories and explain the concept of species
4. Acquire basic knowledge of phylogeny and understand important terminologies to represent phylogenies

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**THEORY**

**Hours**

**Unit 1:**

30

Animal Taxonomy and Systematics; Taxon and Phenon; Chemotaxonomy and cytotoxonomy and concept of molecular taxonomy  
Taxonomic categories; concepts of species – typological, nominalistic, biological and evolutionary  
Taxonomic keys – various types; dichotomous nature of keys  
Taxonomic characters – morphological, behavioural, ecological, and geographical  
Zoological Nomenclature – International Code of Zoological Nomenclature (ICZN), Principles, functions, and importance of the Code of nomenclature; principle of priority, homonymy and synonymy, principle of typification and use of types for specimens

**Unit 2:**

Characters (ancestral vs. derived), homology and analogy, parallelism and convergence, monophyly, polyphyly, paraphyly; representing phylogenies – Rooted and unrooted phylogenetic trees; clades; Cladograms and Phenograms

**Unit 3:**

15

Concept, Importance and Application of Biostatistics

Collection and Classification of statistical data, Frequency distribution, Types of presentation of statistical data

Measures of central tendency - Mathematical average, Average of position

Measures of Partition values

Measures of Dispersion - Range, Quartile deviation, Mean deviation, Standard deviation, Co-efficient of Variation, Standard errors

Testing of Hypothesis; Confidence Intervals; Chi-square test, student's t-test, Analysis of variance.

## ANIMAL TAXONOMY, SYSTEMATICS & BIOSTATISTICS

PRACTICAL	Hours
1. To identify and distinguish species of insects/fishes/amphibians/reptiles/birds of NE India using appropriate taxonomic keys.	30
2. Morphometry and meristic study of insect and fish.	
3. Preparation and study of skeleton of fish.	
4. Preparation, mounting and stuffing of Indian Major Carps.	
5. Graphical representation of statistical data with the help of computer (e.g., MS-Excel).	
6. Calculation of two-sample t-test for a given set of data.	
7. Calculation of F value (ANOVA) for a given set of data.	
8. Calculation of Karl Pearson's Coefficient of Correlation for a given set of data.	
9. Field visit to any Natural History Museum/Zoo and scientific report preparation and submission.	

**Suggested Readings:**

1. Kapoor, V.C. (2019). Theory and Practice of Animal Taxonomy, 8<sup>th</sup> Edition, Oxford & IBH Publishing.
2. Simpson, G.G. (2012). Principles of Animal Taxonomy, Scientific Publishers (Indian Edition)
3. Mayr, E. (2022). Principles of Systematic Zoology, United Book Prints (Indian Edition)
4. Wiley, E. O. & Lieberman, B. S. (2011). Phylogenetics: Theory and Practice of Phylogenetic Systematics, Wiley Blackwell
5. Zar, J. H. (1999). Biostatistical Analysis, IV Edition, Pearson Education Inc and Dorling Kindersley Publishing Inc.USA.

6. Antonisamy, B., Christopher S. & Samuel, P. P. (2010). Biostatistics: Principles and Practice. Tata McGraw Hill Education Private Limited, India.  
Pagana,M.&Gavreau, K.(2000).Principles of Biostatistics, Duxberry Press, USA

**DSE-1**  
**ANIMAL PHYSIOLOGY AND ENDOCRINOLOGY**

**Code: ZOO-2022**  
**Credit: 3 (T) + 1 (P)**

**Learning Objectives:**

1. This course will offer an overview on the functioning of the animal body.
2. It will help students to understand the fundamentals of animal physiology and histological structures.
3. They will understand the concept of homeostasis in response to changes to the outside environment.
4. They will be provided with practical knowledge on investigating the physiological questions, collecting, analysing and interpreting experimental data and applying them in day-to-day life.
5. Further, the students will be encouraged to pursue further studies in physiology and other related courses.

**Learning Outcomes:**

Upon completion of the course, students will be able to:

1. Understand the principles of normal biological function of the animal body.
2. Understand basic animal physiology and correlate it with the various histological structures.
3. Understand the homeostasis in animals in response to changes in their external environment.
4. Perform practical related to animal physiology.

**DSE-2**  
**ANIMAL PHYSIOLOGY AND ENDOCRINOLOGY**

**Code: ZOO-2023**  
**Credit: 3 (T) + 1 (P)**

**THEORY**

**Hours**

**Unit 1:**

15

Structure and Function of Epithelial, Connective, Muscular tissues, Characteristics of Muscles, Mechanism of Muscle Stimulation and Contraction

Neurons Structure of neurons, Nerve Impulse, physiology of nerve impulse conduction and Propagation, Neuro - Muscular Junction and neurotransmitter in smooth muscle and cardiac muscle.

Anatomy of digestive system in mammals, digestive enzymes, digestion and absorption of food stuff.

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<b>Unit 2:</b>	15
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Respiratory Organs in Different Animals, Transport of Oxygen and Carbon dioxide, Respiratory Pigments, Types and structure of heart, Concepts of Neurogenic and Myogenic Hearts, Cardiac cycle, ECG patterns in Mammals, Homeostasis and Blood Clot Formation, Functions of Kidney, Types of Nitrogenous Wastes in Different Animal Groups and their Excretion Urea production – Hans Krebs and Kurt Henseleit cycle, Urine Formation.

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<b>Unit 3:</b>	15
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Endocrine glands of invertebrates and vertebrates, Structure and function of insects' neuroendocrine glands, Hypothalamus and pituitary structures, hormones and its functions. Hypothalamus-hypophyseal blood vessel. Thyroid and parathyroid gland structure in mammal. Endocrine pancreas structure and function Structural Organizations of Adrenals, Functions of Cortical and Medullary Hormones and mechanism of action. Male and female gonads in mammal structure and function.

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**ANIMAL PHYSIOLOGY AND ENDOCRINOLOGY**

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<b>PRACTICAL</b>	<b>Hours</b>
1. Preparation squamous epithelium and striated muscle fibres.	30
2. Preparation of blood smear and staining techniques	
3. Haemoglobin estimation using Sahli's haemoglobinometer.	
4. Dissection of insect neuroendocrine system in cockroach	
5. Dissect and display of pituitary glands and gonads of fish.	
6. Histological study using fish tissues-method of collection, preparation for microtome	
7. Examination and detailed study of permanent histological sections of lungs, stomach, duodenum, liver, kidney, pancreas, adrenal, pituitary, thyroid, parathyroid.	
8. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs	
9. Study of disarticulated skeleton of Frog, Fowl, Rabbit	

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**Suggested Readings:**

1. Tortora, G.J. and Derrickson, B.H. (2012). Principles of Anatomy and Physiology.XIIIth Edition, John Wiley and Sons, Inc.
2. Hill, R. (2021) Animal Physiology. Sinauer Associates Inc; 5th edition.
3. Widmaier E, Raff H and Strang K. (2013). Vander's Human Physiology: The Mechanism

- of Body Functions. XIIIth Edition, McGraw-Hill Education.
4. Guyton, A.C. and Hall, J.E. (2011) Textbook of Medical Physiology. XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
  5. Kesar, S. and Vashisht, N. (2007) Experimental Physiology. Heritage Publishers.
  6. Prakash, G. (2012) Lab Manual on Blood Analysis and Medical Diagnostics. S. Chand and Company Ltd
  7. Cinnamon, V., Regan J., Russo A.F. (2022) Seelay's Anatomy and Physiology. McGraw Hill Education.

**DSE 2**  
**PRINCIPLES OF ECOLOGY & EVOLUTION**  
**Code: ZOO-2023**  
**Credit: 3 (T) + 1 (P)**

**Course Objectives:**

The primary aim of the syllabus is to sensitize the students about the role and importance of nature and ecosystem functioning. The study of Ecology also provides the knowledge about the judicious use of existing ecological resources for sustainable development. Ecology is the only branch of science which explain the ways and means of surviving with nature for mutual benefit. Study of ecology will provide students opportunity to understand its practical aspects and helps them to solve many current ecological issues such as global warming, habitat degradation, habitat loss, desertification and pollution etc. The field training experiences will also enable students to understand the ecosystem functioning and ecology processes in a better way.

**Learning Outcomes:**

After completion of the course, students will be able to learn about the:

1. Understanding of key concepts in ecology with emphasis on historical perspective, role of physical factors and concept of limiting factors etc.
2. Figure out the population characteristics, population dynamics, growth models and interactions.
3. Recognize the community characteristics, ecosystem development and climax theories.
4. Know about the types of ecosystems, food chains, food webs, energy models, and ecological efficiencies.
5. Apply the basic principles of ecology in wildlife conservation and management.
6. Instill scientific quantitative skills, evaluate experimental design, read graphs, and analyse and use information available in scientific literature.

**DSE 2**  
**PRINCIPLES OF ECOLOGY & EVOLUTION**  
**Code: ZOO-2023**  
**Credit: 3 (T) + 1 (P)**

**THEORY**

**Hours**

**Unit1:**

12

Basic concept of ecology and ecosystem, Autecology, Synecology, Level of organization, Study of physical factors, Laws of limiting factors, Structural

components of Ecosystem, Functional attributes of Ecosystem-Trophic structure, food chain, food web, Energy flow, Ecological Pyramids, Ecological Efficiencies; Types of Ecosystems with examples.

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**Unit2:** 17

Definition, Unitary and Modular populations, Population attributes- Abundance, Density, Natality and Mortality, Life table and survivorship curve, Dispersion, Dispersal, Age distribution, Sex ratio, Biotic potential and Environmental resistance, Population growth form-Exponential and Logistic; Population regulation-density dependent and independent factors. Population interactions, Gauss's principle; Definition of community, Community characteristics, Community structure, Ecological succession and types, Theories pertaining to climax community Ecotone and Edge effect.

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**Unit3:** 16

Theories of origin of life – Chemogenesis, Biogenesis, Experimental evidences Evolutionary theories: Lamarckism, Darwinism and Neo-Darwinism Paleontological evidences of evolution, Geological timescale Natural selection – concept of fitness, selection coefficient, kin selection, sexual selection Population genetics – Concept of speciation and Hardy-Weinberg Law (statement and derivation), concept of gene flow, Natural selection and survival of the fittest – sources of variations and role in evolution, Genetic Drift (Founder's and Bottleneck effect), Role of migration and mutation in changing allelic frequencies Evolution of man

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**PRINCIPLES OF ECOLOGY & EVOLUTION**

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**PRACTICAL** **Hours**

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided
  2. Determination of population density by quadrat method and calculation of Shannon-Weiner diversity index in a natural/hypothetical community.
  3. Study of an aquatic ecosystem: the method of phytoplankton and zooplankton collection and identification, measurement of temperature, turbidity, determination of pH, and dissolved oxygen content (Winkler's method), free CO<sub>2</sub> determination in aquatic environment.
  4. Study of fossils from models/pictures
  5. Study of homology and analogy from suitable specimens (insects, birds and mammals)
  6. Study and verification of Hardy-Weinberg Law by Chi-square analysis
  7. Preparation and submission of scientific report on a visit to National Park/Biodiversity Park/Wildlife sanctuary/any other important ecosystems.
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**Suggested Readings:**

1. Colinvaux, P.A. (1973). Ecology. 2<sup>nd</sup> Edition. John Wiley and Sons Inc.
2. Krebs, C. J. (2001). Ecology. 6<sup>th</sup> Edition. Benjamin Cummings.
3. Odum, E.P. (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
4. Smith, R. L., Smith, T.M. (2000). Ecology and field biology Harper and Row publisher
5. Ricklefs, R.E. (2000). Ecology. V Edition. Chiron Pres
6. Hall B.K. & Hallgrímsson B. (2013). Strickberger's Evolution. 5<sup>th</sup> Edition, Jones and Bartlett Publishers, Inc.
7. Futuyama, D. J. (2017). Evolution. 4<sup>th</sup> Edition, Sinauer Associates
8. Ridley, M. (2020). Evolution. 2<sup>nd</sup> edition (South Asia Edition), Oxford University Press.

**DSE-3****COMPARATIVE ANATOMY OF VERTEBRATES****Code: ZOO-2024****Credit: 3 (T) + 1 (P)****Learning Objectives:**

This course aims to provide the undergraduate students a thorough knowledge of structural details and comparative account of the different organ systems of the body from lower to higher vertebrates, and protochordates, thus enabling them to appreciate the incredible vertebrate diversity. The course furnishes an understanding of evolutionary basis of morphological and anatomical differences as well as similarities that occur among vertebrates. It helps students propose possible homology between structures, and understand how they evolved as the vertebrates dwelled different habitats. The structural modifications of digestive, circulatory, respiratory and skeletal system relate to the distribution of animals in their different comfort zones of habitat and ecological niches. The understanding of anatomical details of organ systems of mammals like rat and mice aims to give the basic information for their use in research in different branches of Zoology.

**Learning Outcomes:**

Upon completion of the course, students should be able to:

1. Explain comparative account of the different vertebrate systems and understand the pattern of vertebrate evolution, organization.
2. Learn the comparative account of integument, skeletal components, their functions and modifications in different vertebrates.
3. Understand the evolution of brain, sense organs and excretory organs to a complex, highly evolved forms;
4. Learn to analyse and critically evaluate the structure and functions of vertebrate systems, which helps them to discern the developmental, functional and evolutionary history of vertebrate species.

**DSE-3****COMPARATIVE ANATOMY OF VERTEBRATES****Code: ZOO-2024**



**Credit: 3 (T) + 1 (P)**

<b>THEORY</b>	<b>Hours</b>
<b>Unit 1:</b> Integumentary System-Structure, functions and derivatives. Skeletal System- Overview of axial and appendicular skeleton, Jawsuspensorium, Visceral arches. Digestive track-Alimentary canals and associated glands in vertebrates, dentition in mammals.	15
<b>Unit 2:</b> Respiratory System-Skin, gills, lungs and air sacs; Accessory respiratory organs in vertebrates. Circulatory System-General plan of circulation, comparative anatomy of heart and aortic arches. Urinogenital System-Succession of kidney, Evolution of urinogenital duct	20
<b>Unit 3:</b> Nervous System-Comparative account of brain, Autonomic nervous system, Spinal cord, Cranial nerves in mammals. Sense Organs-Classification of receptors; Brief account of visual and auditory receptors in man	10

**COMPARATIVE ANATOMY OF VERTEBRATES**

<b>PRACTICAL</b>	<b>Hours</b>
1. Study of types scales in fishes (which is available) and preparation of permanent slides.	30
2. Study of disarticulated skeleton of Frog/Fowl/Rabbit	
3. Study of carapace plastron and skull of turtle/tortoise (which is available).	
4. Study of mammalian and avian skulls: One herbivorous and one carnivorous animal	
5. Preparation and submission of report on comparative study of internal and external anatomical structure of any vertebrate (excluding IUCN Red listed or scheduled species of W(P)A, 1972).	

**Suggested Readings:**

1. Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education
2. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies
3. Hilderbrand, M and Gaslow, G.E. Analysis of Vertebrate Structure, John Wiley and Sons
4. Walter, H.E. and Sayles, L.P. Biology of Vertebrates, Khosla Publishing House

**DSE-4**  
**ANIMAL BEHAVIOUR AND CHRONOBIOLOGY**  
**Code: ZOO-2025**  
**Credit: 3 (T) + 1 (P)**

**Course objectives**

1. To create a knowledge base on concepts of animal behaviour
2. To inculcate scientific enquiry on animal cognition and its application in conservation and welfare of animals
3. To develop skills on methods of studying animal behaviour
4. To offer a basic understanding of the subject of chronobiology
5. To highlight the adaptive significance of biological timekeeping in animals

**Learning Outcomes:**

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

1. Acquire a comprehensive understanding of the behaviour of animals and gain knowledge on profiles of behavioural biologists and their contributions to the field of animal behaviour.
2. Understand and analyse the causes and patterns of behaviour.
3. Understand the social nature of animals and communication among individuals of animal societies and utilise scientific methods of studying animal behaviour.
4. Understand basic terms and concepts of chronobiology and comprehend the significance of biological rhythms.

**DSE-4**  
**ANIMAL BEHAVIOUR AND CHRONOBIOLOGY**  
**Code: ZOO-2025**  
**Credit: 3 (T) + 1 (P)**

**THEORY**

**Hours**

**Unit 1:**

**20**

Origin and history of ethology

Patterns of behaviour - instinct vs. learned behaviour; Animal orientation-

Taxis vs. Kinesis; Navigation;

Proximate and ultimate causes of behaviour  
Methods of studying behaviour.

<b>Unit 2:</b>	10
Animal Communication-Dance Language in honey bees; Eusocial organization - honey bee, termite, and ant; Schooling behaviour in fishes; Social behaviour in monkeys.	
<b>Unit 3:</b>	15
Historical developments; biological oscillations - concept of average, amplitude, phase and period. Biological timekeeping-adaptive significance and importance; Concept of biological rhythms-Circadian, circalunar/infradian and circannual rhythms with example in animal models/humans Phenomenon of bird migration Concept of biological clock: functions in animal systems Concept of zeitgebers; photoperiod and Concept clock genes, sleep-wake cycle.	

### ANIMAL BEHAVIOUR AND CHRONOBIOLOGY

Practical	Hours
1. To study nest and nesting habits of birds/social insects	30
2. To study geotaxis behaviour in earthworm.	
3. To study scan and focal animal sampling in waterbirds/mammals.	
4. To study circadian functions in human with special reference to body temperature.	
5. To study behavioural activities of animals in home/backyard/locally available wild/domestic animals and prepare a short report.	

#### Suggested Readings:

1. Manning, A. & Dawkins, M. S. (2012). An Introduction to Animal Behaviour. Cambridge University Press, 6<sup>th</sup> edition.
2. Barnard, C. (2003). Animal Behaviour: Mechanism, Development, Function and Evolution. Pearson, 1<sup>st</sup> edition.
3. Lehner, P. N. (1996). Handbook of Ethological Methods. Cambridge University Press, 2<sup>nd</sup> edition
4. Kumar, V. (2017). Biological Timekeeping: Clocks, Rhythms and Behaviour. Springer, 1<sup>st</sup> edition

**DSE 5**  
**PARASITOLOGY**  
**Code: ZOO-2026**  
**Credit: 3 (T) + 1 (P)**

**Course Objectives:**

To skill the students to visualize, appreciate and understand the diversity of parasites in the animal kingdom.  
 To make the students aware about the possible scopes of the subject including research and applied aspects  
 To diagnose medical parasites correctly, understand their life cycle and effective control  
 To use some of parasites as possible biocontrol agents

**Learning Outcomes:**

After completion of the course the students will be able to:

1. Understand the variation among parasites, parasitic invasion with special reference to medical and agricultural aspects.
2. Help to know the stages of the life cycle of parasites and their respective infective stages.
3. Develop skills and realize significance of diagnosis of parasitic attack and treatment of host.
4. Mapping of the parasites available in regional/national importance/zoonotic diseases

**DSE 5**  
**PARASITOLOGY**  
**Code: ZOO-2026**  
**Credit: 3 (T) + 1 (P)**

**THEORY**

**Hours**

**Unit 1:**

12

Brief introduction of Parasitism; Parasite, Parasitoid and Vectors; Host-parasite relationship; types of parasites and hosts; evolution of parasitism  
 Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Trypanosoma gambiense*, *Leishmania donovani* and *Plasmodium*

**Unit 2:** 21  
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Schistosoma haematobium*, *Taenia solium* and *Hymenolepis nana*.

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis*

**Unit 3:** 12  
External parasites in domesticated animals with examples (cattle, goat, sheep, buffalo and dogs), control of ticks, mites, *Pediculus humanus* (Head and Body louse), *Xenopsylla cheopis* and *Cimex lectularius*  
A brief account of parasitic vertebrates – Candiru and Vampire bat

## PARASITOLOGY

Practical	Hours
1. Study of life stages of <i>Entamoeba histolytica</i> , <i>Giardia intestinalis</i> , <i>Trypanosoma gambiense</i> , <i>Leishmania donovani</i> and <i>Plasmodium vivax</i> through permanent slides/photographs.	30
2. Study of adult and life stages of <i>Fasciolopsis hepatica</i> , <i>Schistosoma haematobium</i> , <i>Taenia solium</i> and <i>Hymenolepis nana</i> through permanent slides/photographs.	
3. Study of adult and life stages of <i>Ascaris lumbricoides</i> , <i>Ancylostoma duodenale</i> , <i>Wuchereria bancrofti</i> and <i>Trichinella spiralis</i> through permanent slides	
4. Study and preparation of scientific report of any two common protozoan/helminth/arthropod parasites	
5. Study of <i>Pediculus humanus</i> (Head louse and Body louse), <i>Xenopsylla cheopis</i> and <i>Cimex lectularius</i> through permanent slides/photographs.	
6. Study of nematode/cestode parasites from fish or intestine of poultry birds/pigs.	
7. Submission of at least two arthropod parasites.	

### Suggested readings:

- Chernin, J. (2000). Parasitology. Taylor & Francis Group.
- Arora, D. R and Arora, B. B. (2018) Medical Parasitology. 5<sup>th</sup> Edition, CBS Publications and Distributors Pvt Ltd
- Noble, E.R. and Noble, G.A. (1982) Parasitology: The Biology of Animal Parasites. 5<sup>th</sup> Edition, Lea & Febiger
- Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) Biology of Disease. Taylor and Francis Group
- Taylor, M. A., Coop, R. L., & Wall, R. L. (2016). Veterinary Parasitology. 4<sup>th</sup> edition, Wiley Blackwell
- Loker, E. S. & Hofkin, B. V. (2015). Parasitology – A conceptual approach. Taylor & Francis Group