



**Syllabi for
Four Years' Undergraduate Program (FYGP)
in Zoology
under
Gauhati University**

**As per instructions of the NEP Implementation Committee,
Gauhati University, the syllabicover02 (Two) CORE and 04(Four)
COMPULSORY Major papers and 15 (Fifteen) DISCIPLINE SPECIFIC
(DSE) major papers to be offered by the Department**

**Prepared by-
Department of Zoology
Gauhati University**

Structure of Four Years Undergraduate Programme (FYGP) in Zoology under Gauhati University

Subject: Zoology

Stream: Science

In all courses:

Theory credit: **3**/Practical credit: **1**

No. of contact hours in each theory paper: **45**

No. of contact hours in each practical paper: **30**

Existing base syllabi: **CBCS Syllabi ,2016, GU**

Semester	Course Name	Paper Code*	Credit
I	Core A1: Diversity of Non-chordates	CORE	3
	Practical	ZOO-1011	1
II	Core A2: Diversity of Chordates	CORE	3
	Practical	ZOO-1021	1
III	Compulsory: Principles of Genetics	MAJOR	3
	Practical	ZOO-2011	1
IV (Any three DSE papers)	Compulsory: Animal Taxonomy, Systematics & Biostatistics	MAJOR	3
	Practical	ZOO-2021	1
	DSE 1- Animal Physiology & Endocrinology	MAJOR	3
	Practical	ZOO-2022	1
	DSE 2- Principles of Ecology & Evolution	MAJOR	3
	Practical	ZOO-2023	1
	DSE 3- Comparative Anatomy of Vertebrates	MAJOR	3
	Practical	ZOO-2024	1
	DSE 4- Animal Behaviour and Chronobiology	MAJOR	3
	Practical	ZOO-2025	1
V (Any Three DSE papers)	Compulsory: Fundamentals of Biochemistry	MAJOR	3
	Practical	ZOO-3011	1
	DSE 6- Biochemistry of metabolic processes & regulation	MAJOR	3
	Practical	ZOO-3012	1
	DSE 7- Entomology & Fisheries	MAJOR	3
	Practical	ZOO-3013	1
	DSE 8- Immunology	MAJOR	3
	Practical	ZOO-3014	1
	DSE 9- Reproductive Biology	MAJOR	3
	Practical	ZOO-3015	1
VI (Any Three DSE papers)	Compulsory: Cell Biology	MAJOR	3
	Practical	ZOO-3021	1
	DSE 11- Developmental Biology	MAJOR	3
	Practical	ZOO-3022	1
	DSE 12- Wildlife Conservation & Management	MAJOR	3
	Practical	ZOO-3023	1
	DSE 13- Computational Biology	MAJOR	3
	Practical	ZOO-3024	1
	DSE 14- Advanced Entomology	MAJOR	3
	Practical	ZOO-3025	1
DSE 15- Animal Cell Culture & Genetic Engineering	MAJOR	3	
	Practical	ZOO-3026	1

*The paper code should be read as follows-ZOO-Zoology; 10-Year I; 20-Year II; 30-Year III; 1-Odd semester;2-Even semester; Last Digit-Serial Number; ZOO-1011 stands for Zoology first year, odd semester, first paper

CORE A1
DIVERSITY OF NON-CHORDATES
Code: ZOO-1011
Credit: 3 (T) + 1 (P)

Course Objectives:

1. T
 he course would provide an insight to the learner about the existence of different life forms on the Earth, and appreciate the diversity of animal life.
2. I
 It will help the student to understand the features of Kingdom Animalia and systematic organization of the animals based on their evolutionary relationships, structural and functional affinities.
3. T
 The course will also make the students aware about the characteristic morphological and anatomical features of diverse animals; economic, ecological and medical significance of various animals in human life; and will create interest among them to explore the animal diversity in nature.

Learning Outcomes:

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

1. Learn about the importance of systematics, taxonomy and structural organization of animals.
2. Understand evolutionary history and relationships of different non-chordates through functional and structural affinities.
3. Critically analyze the organization, complexity and characteristic features of non-chordates making them familiarize with the morphology and anatomy of representative of various animal phyla.
4. Comprehend the economic importance of non-chordates, their interaction with the environment and role in the ecosystem.
5. Enhance collaborative learning and communication skills through practical sessions, teamwork, group discussions, assignments and projects.

CORE A1
DIVERSITY OF NON-CHORDATES
Code: ZOO-1011
Credit: 3 (T) + 1 (P)

THEORY	Hours
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Unit1: General characteristics and Classification up to classes of Protista, Porifera, Cnidaria, Ctenophora, Platyhelminthes, Nematelminthes.	7
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Unit2: Evolution of coelom and metamerism General characteristics and Classification up to classes of Annelida,	8
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Arthropoda, Mollusca and Echinodermata.

Unit 3: 30

Locomotion and Reproduction in Protista

Evolution of symmetry and segmentation of Metazoa

Canal system and spicules in sponges

Polymorphism in Cnidaria

Corals and coral reef formation

Parasitic adaptations in helminths- *Fasciola hepatica* and
Wuchereria bancrofti

Excretion in Annelida

Vision and respiration in Arthropoda

Evolutionary significance of Onychophora

Torsion and detorsion in Gastropoda

Water vascular system of Echinodermata

DIVERSITY OF NON-CHORDATES

PRACTICAL	Hours
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|---|----|
| 1. Study of the whole mount of <i>Euglena</i> , <i>Amoeba</i> and <i>Paramecium</i> collected from different water sources. | 30 |
| 2. Study of minimum of two representatives (specimen/slide/model) of each phylum of non-chordates. | |
| 3. Study of larval forms of Arthropoda/Echinodermata | |
| 4. T.S. through pharynx, gizzard and typhlosolar intestine of earthworm. | |
| 5. To submit a Project Report on life cycle of helminth parasite by students | |
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Suggested Readings:

1. Ruppert, E.E. and Barnes, R.D. (2006). Invertebrate Zoology, 8th Edition. Holt Saunders International Edition.
2. Pechenik, J. (2015). Biology of the Invertebrates. 7th Edition, McGraw Hill
3. Schierwater, B. & DeSalle, R. (2021). Invertebrate Zoology: A Tree of Life Approach. 1st edition, CRC Press
4. Jordan, K. and P. S. Verma (2019). Invertebrate Zoology, S. Chand and Co. Ltd.
5. Kotpal, R. L. (2020). Modern text book of Zoology, Invertebrates, 12th Edition, Rastogi Publications

CORE A2
DIVERSITY OF CHORDATES

Code: ZOO-1021
Credit: 3 (T) + 1 (P)

Course Objectives:

The course is designed with an aim to provide scope and historical background of chordates. It will impart knowledge regarding basic concepts of origin of chordates and make the students understand the characteristics and classification of animals with notochord. The exclusive phenomenon in chordates like biting mechanism in snakes, flight adaptations in birds etc. will be explained. The adequate explanation to the students regarding various mechanisms involved in thriving survival of the animals within their geographic realms will create interest among students.

Learning Outcomes:

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

1. Understand different classes of chordates, level of organization and evolutionary relationship between different subphyla and classes, within and outside the phylum.
2. Study about diversity in animals making students understand about their distinguishing features.
3. Appreciate similarities and differences in life functions among various groups of animals in Phylum Chordata.
4. Comprehend the circulatory, nervous and skeletal system of chordates.
5. Know about the habit and habitat of chordates in marine, freshwater and terrestrial ecosystems.

CORE A2
DIVERSITY OF CHORDATES

Code: ZOO-1021
Credit: 3 (T) + 1 (P)

THEORY	Hours
Unit 1: Origin of Chordates-Dipleurula concept and Echinoderm theory General characteristics and outline classification	8
Unit 2: General characteristics of Hemichordata, Urochordata and Cephalochordata Study of larval forms of protochordates.	7
Unit 3: Advanced features of vertebrate over protochordata	30

Overview of axial and appendicular skeleton, Jaws suspensorium, Visceral arches
 General characteristics and classification of cyclostomes upto class
 General characteristics of Chondrichthyes and Osteichthyes, classification upto order.
 Origin of Tetrapoda
 General characteristics and classification of Amphibia, Reptilia, Aves and Mammalia upto order
 Migration in Fishes; Parental care in Amphibia; Biting mechanism in snakes; Archaeopteryx as a connecting link; Flight adaptation in birds; Affinities in Prototheria.

DIVERSITY OF CHORDATES

PRACTICAL	Hours
1. Study of museum specimens/ Models -Protochordata (<i>Balanoglossus</i> , <i>Herdmania</i> , <i>Amphioxus</i>), Agnatha (<i>Petromyzon</i> , <i>Myxine</i>), Fishes (<i>Scoliodon</i> , <i>Torpedo</i> , <i>Mystus</i> , <i>Heteropneustes</i> , <i>Labeo</i> , <i>Hippocampus</i> , <i>Tetraodon</i>), Amphibia (<i>Ichthyophis</i> , <i>Necturus</i> , <i>Bufo</i> , <i>Hyla</i>), Reptilia (<i>Chelone</i> , <i>Hemidactylus</i> , <i>Varanus</i> , <i>Chamaeleon</i> , <i>Bungarus</i> , <i>Naja</i>), Aves (ten different species of birds commonly found in Assam), Mammalia (Bat, common primates, common ungulates, Gangetic River Dolphin).	30
2. Study of T.S. of <i>Amphioxus</i> through pharyngeal, intestinal and caudal regions.	
3. Identification key of venomous and non-venomous snakes.	
4. PowerPoint presentation on the study of any two vertebrates from two different classes by students.	

Suggested Readings:

1. Young, J. Z. (2004). The Life of Vertebrates. 3rd Edition. Oxford University press.
2. Pough F. H. & Janis, C. M. (2018). Vertebrate Life. 10th Edition, Sinauer Associates
3. Verma, P. S. & Jordan, E. L. (2013). Chordate Zoology. 14th edition, S. Chand
4. Kotpal, R. L. (2019). Modern text book of zoology: Vertebrates (Z-3). 5th edition, Rastogi Publications

**MAJOR
COMPULSORY
PRINCIPLES OF GENETICS
Code: ZOO-2011
Credit: 3 (T) + 1 (P)**

Course Objectives:

Human beings had been applying the principles of genetics by engaging in selective breeding of domesticated animals for many centuries. However, it was only with the work of Mendel and advent of 20th century, that basic principles of the science of genetics were formulated. In about a century of its existence, this field has generated tremendous amount of knowledge through observational and experimental research. The information amassed in the last century has laid the foundation for more discoveries in this important field of life science. This course aims to provide an overview of genetics starting from the work of Mendel to the current understanding of various phenomena like gene mapping, sex determination and mutations. The course will help in building sound fundamental knowledge of the principles of genetics, to be used as a stepping stone for higher studies and research in this field.

Learning Outcomes:

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

1. Understand the basic principles of inheritance.
2. Analyze Mendelian Law and gene interactions leading to development of analytical skills and critical thinking enabling the students to present the conclusion of their findings in a scientific manner.
3. Know the mechanisms of mutations, the causative agents and the harmful impact of various chemicals and drugs being used in day-to-day life.
4. Gain knowledge on genetic and environmental basis of sex determination.

**MAJOR 1
PRINCIPLES OF GENETICS
Code: ZOO-2011
Credit: 3 (T) + 1 (P)**

THEORY	Hours
<p>Unit 1: Principles of inheritance, Incomplete dominance and co-dominance; Multiple alleles; Lethal alleles, penetrance and expressivity; Epistasis; Pleiotropy; Sex-linked, sex-influenced and sex-limited characters inheritance and concept of gene.</p> <p>Linkage and crossing over, Cytological basis of crossing over, Recombination frequency as a measure of linkage intensity; Two factor and three factor crosses; Linkage map; coefficient of coincidence and Interference; Gene mapping by Somatic cell hybridization.</p>	15
<p>Unit 2: Gene mutations; Chromosomal aberrations – Deletion, duplication, inversion, translocation, aneuploidy and polyploidy; Induced versus spontaneous</p>	20

mutations; Backward and forward mutations; Suppressor mutations; Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations in *Drosophila*: CLB method, attached X method.

Unit 3:

10

Basis of sex determination: Genetic and environmental; Sex determination in *Drosophila* and human; Mechanism of dosage compensation.

Comparison of nuclear and extra nuclear inheritance; Organelle inheritance: Antibiotic resistance in *Chlamydomonas*, Mitochondrial mutations in *Saccharomyces* and human disorders, Infective heredity in *Paramecium*. Maternal effects: Shell coiling in *Limnaea*, pigmentations in *Ephestia*.

Polygenic inheritance and Transgressive variation

PRINCIPLES OF GENETICS

Practical

Hours

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|---|----|
| 1. To study Mendelian laws and gene interactions and their verification by Chi-square analyses using seeds/beads/ <i>Drosophila</i> . | 30 |
| 2. Study of linkage maps based on data from <i>Drosophila</i> crosses. | |
| 3. Identification of various mutant types of <i>Drosophila</i> (through culture/photomicrograph) | |
| 4. Study of human karyotype (normal and abnormal) using photomicrograph. | |
| 5. Preparation of polytene chromosomes from <i>Chironomus/Drosophila</i> larvae. | |
| 6. Preparation of metaphase chromosome from fish/mammal. | |

Suggested Readings:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. 8thEdition. Wiley India.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. 5thEdition. John Wiley and Sons Inc
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2020). Concepts of Genetics. 10thEdition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. 3rdEdition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction to Genetic Analysis. 9thEdition. W. H. Freeman and Co.
6. Tamarin R. H. (2017). Principles of Genetics. Tata McGraw Hill Edition.
7. Brown, T. A. (2023). Genomes 5. 5th edition, CRC Press

**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

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

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, 8th 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.

Unit 2: 15

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.

Unit 3: 15

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.

ANIMAL PHYSIOLOGY AND ENDOCRINOLOGY

PRACTICAL	Hours
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| 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 | |

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: Basic concept of ecology and ecosystem, Autecology, Synecology, Level of organization, Study of physical factors, Laws of limiting factors, Structural	12

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

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.

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

PRINCIPLES OF ECOLOGY & EVOLUTION

PRACTICAL	Hours
1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided	30
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 ₂ 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.	

Suggested Readings:

1. Colinvaux, P.A. (1973). Ecology. 2nd Edition. John Wiley and Sons Inc.
2. Krebs, C. J. (2001). Ecology. 6th 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. 5th Edition, Jones and Bartlett Publishers, Inc.
7. Futuyama, D. J. (2017). Evolution. 4th Edition, Sinauer Associates
8. Ridley, M. (2020). Evolution. 2nd 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)

THEORY	Hours
Unit 1: 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
Unit 2: Respiratory System-Skin, gills, lungs and airsacs; Accessory respiratory organs in vertebrates. Circulatory System-General plan of circulation, comparative anatomy of heart and aortic arches. Urino-genital System-Succession of kidney, Evolution of urino-genital duct	20
Unit 3: 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

PRACTICAL	Hours
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.

Unit 2: 10
Animal Communication-Dance Language in honey bees; Eusocial organization - honey bee, termite, and ant; Schooling behaviour in fishes; Social behaviour in monkeys.

Unit 3: 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, 6th edition.
2. Barnard, C. (2003). Animal Behaviour: Mechanism, Development, Function and Evolution. Pearson, 1st edition.
3. Lehner, P. N. (1996). Handbook of Ethological Methods. Cambridge University Press, 2nd edition
4. Kumar, V. (2017). Biological Timekeeping: Clocks, Rhythms and Behaviour. Springer, 1st 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*, *Wuchereriabancrofti* 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>Fasciolopsishaepatica</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>Wuchereriabancrofti</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. 5th Edition, CBS Publications and Distributors Pvt Ltd
- Noble, E.R. and Noble, G.A. (1982) Parasitology: The Biology of Animal Parasites. 5th 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. 4th edition, Wiley Blackwell
- Loker, E. S. & Hofkin, B. V. (2015). Parasitology – A conceptual approach. Taylor & Francis Group

**MAJOR
COMPULSORY
FUNDAMENTALS OF BIOCHEMISTRY
Code: ZOO-3011
Credit: 3 (T) + 1 (P)**

Learning Objectives:

This course offers a basic insight about the biomolecules, its structure and function. Further the students will be provided with practical knowledge which can be applied to understand the chemistry of the biomolecules. It will also encourage students to pursue core biochemistry related fields as well as multi-disciplinary subject for better understanding of biochemistry in research.

Learning Outcomes:

Upon completion of this course, students will be able to understand the basic principle, structure and function of biomolecules like carbohydrates, proteins and nucleic acids. They will also be able to understand the role of these molecules in the functioning of animal systems. The students will learn about the characteristics, kinetics, regulation and inhibition of enzymes-the biological catalysts and as such will have a brief overview of the biochemical system of the body. Additionally, they will also gain practical knowledge about the different functional groups present in these molecules.

**MAJOR
COMPULSORY
FUNDAMENTALS OF BIOCHEMISTRY
Code: ZOO-3011
Credit: 3 (T) + 1 (P)**

THEORY

Hours

Unit1:

15

Carbohydrates: Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates

Lipids: Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids

Unit 2:

15

Amino acids: Structure, Classification and General properties of α - amino acids; Physiological importance of essential and non-essential α - amino acids.

Proteins: Bonds stabilizing protein structure; Levels of organization in proteins; Denaturation; Introduction to simple and conjugate proteins.

Nucleic Acids: Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids Cot Curves: Base pairing, Denaturation and Renaturation of DNA. Types of DNA and RNA, Complementarity of DNA.

Unit 3:

15

Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Regulation of enzyme action and Different types of Enzyme Inhibition (Competitive, Non-competitive and Uncompetitive Inhibition).

FUNDAMENTALS OF BIOCHEMISTRY

Practical

Hours

- | | |
|---|----|
| 1. Qualitative tests of functional groups in carbohydrates, proteins and lipids. | 30 |
| 2. To determine the iodine number of given oil/fat. | |
| 3. Estimation of a reducing sugar in a given sample. | |
| 4. To find the pKa value of acetic acid. | |
| 5. To study the activity of Salivary Amylase and Determination of Amylase Number. | |
| 6. To study the absorption spectrum of proteins and DNA. | |
| 7. Demonstration of proteins separation by SDS-PAGE. | |

Suggested Readings:

1. Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., NewYork.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell.
4. V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
5. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
6. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.
7. Das M, Dutta A and Kalita A (2022). Advanced Biochemistry. Kalyani Publications.

DSE 6
**BIOCHEMISTRY OF METABOLIC PROCESSES AND
REGULATION**
Code: ZOO-3012
Credit: 3 (T) + 1 (P)

Course Objectives:

1. This course will give the students a brief overview of both catabolic and anabolic processes.
2. It will give them a better understanding of the various reactions involved in the process of carbohydrate, protein and lipid metabolism.
3. It will help in understanding the process of energy production in our body by the mitochondrial respiratory chain.
4. Give them practical knowledge on the various methods and assays used to understand the metabolic processes.
5. Encourage them to take up further studies on understanding the metabolic processes of the body.

Learning Outcomes:

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

1. Understand the principles of catabolic and anabolic processes.
2. Understand carbohydrate, protein and lipid metabolism and correlate it practical observations.
3. Understand the process of energy production in the body.
4. Perform practicals related to metabolic processes.

DSE 6
**BIOCHEMISTRY OF METABOLIC PROCESSES AND
REGULATION**
Code: ZOO-3012
Credit: 3 (T) + 1 (P)

THEORY	Hours
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Unit 1: Catabolism vs. Anabolism, ATP as "Energy Currency of cell"; coupled	15
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reactions; Use of reducing equivalents and cofactors.

Unit 2: 20

Sequence of reactions and regulation of glycolysis, Citric acid cycle, Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis
Redox systems; Mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System

Unit 3: 10

β -oxidation and omega-oxidation of saturated fatty acids with even and odd number of carbon atoms; Ketogenesis
Catabolism of amino acids: Transamination, Deamination, Urea cycle.

BIOCHEMISTRY OF METABOLIC PROCESSES AND REGULATION

Practical	Hours
1. Estimation of total protein in given solutions by Lowry's method.	30
2. Extraction of lipids from insect.	
3. Spectrophotometric analysis of lipids using Sulpho-Phospho-Vaniline.	
4. Detection of SGOT and SGPT in serum/tissue	
5. To perform the Acid and Alkaline phosphatase assay from serum/tissue.	
6. Determination of Urea in Urine sample.	

Suggested Readings:

1. Cox, M.M and Nelson, D.L. (2008). Lehninger Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.
4. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.

DSE 7
ENTOMOLOGY AND FISHERIES
Code: ZOO-3013
Credit: 3 (T) + 1 (P)

Course objectives:

Insects are the most successful group of organisms on earth with some unique attributes. These diverse group of organisms alone comprises 80% of all animal species with 450 million years of existential history. They dominantly occupy all the spheres of earth except deep sea. The course will give an overview of diverse insects' species and their basis of classification, morphological structures and some beneficial and harmful role of insects.

1. To provide practical and academic skills in identifying important freshwater fish groups of northeast India
2. To provide basic concepts on the biology of fishes
3. To create a knowledge base on fisheries resources of India
4. To inculcate the scope and importance of aquaculture and fisheries in research as well as applied aspects

Learning Outcomes:

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

1. Identify different insects and classify them based on their morphological characters
2. Get an idea about diversity and causes of success of insects on earth
3. Familiar with the best body design in simpler form
4. Get concept on the common vectors of human diseases and common phytophagous pests
5. Identify and characterize economically important freshwater fishes of NE India
6. Acquire basic knowledge on morphology and physiology of fishes
7. Compare and contrast capture fisheries resources of India
8. Understand the utility and application of different fishing gears
9. Understand the rules and regulations governing Indian capture fisheries
10. Gain knowledge on the impact of climate change on fisheries
11. Understand methods and types of culture fisheries
12. Demonstrate the induced breeding of Indian Major Carps including collection and preservation of fish pituitary gland, and broodstock and hatchery management
13. Acquire practical knowledge on the role soil and water quality in aquaculture
14. Identify the importance of fish as a model organism in research

DSE 7
ENTOMOLOGY AND FISHERIES
Code: ZOO-3013
Credit: 3 (T) + 1 (P)

THEORY	Hours
<p>Unit 1: General Features of Insects, Classification of insects up to orders, causes of success of insects on earth, role of insects in pollination, Basic concept on collection, preservation and culture techniques of insects General Morphology of insects -compound Eyes, antennae, Mouth parts and legs. Structure of integument. Molting and metamorphosis. Insects as Vectors & Pest: Insects as mechanical and biological vectors of pathogens and parasites, Common insect vectors (Aedes, Culex, Anopheles, Phlebotomus, Musca domestica), Insects as plant pests.</p>	23
<p>Unit 2: Introduction to fish - General description of a fish; Account of systematic classification of freshwater teleosts of NE India (up to Order) Morphology and Physiology - Types of fins and their modifications; Locomotion in fishes; Types of Scales; Structure and functions of Gills, basic mechanism of gas exchange; Swim Bladder - types, role in Respiration and buoyancy; Osmoregulation in Elasmobranchs; Electric organs</p>	09
<p>Unit 3: Capture Fisheries - Inland Capture Fisheries resources of India; marine fisheries; Fishing crafts and Gears; Application of remote sensing and GIS in fisheries; Fisheries rules and regulations; Climate change and its impact on fisheries; Fishery by-products Culture fisheries - Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Induced breeding of Indian Major Carps; Management of hatcheries; Role of soil and water quality in aquaculture Fish in research - Transgenic fish, Zebrafish as a model organism in research</p>	13

ENTOMOLOGY AND FISHERIES

Practical	Hours
1. Study of different types of mouth parts/ antenna of insects through slides/specimens.	30
2. Study of insect vectors through permanent slides or photographs or model: <i>Aedes</i> , <i>Culex</i> , <i>Anopheles</i> , <i>Pediculus</i> , <i>Cimex</i> , <i>Phlebotomus</i> (sand fly), and <i>Musca domestica</i> (house fly).	
3. Preparation of project report on any one vector and diseases transmitted by the vector (<i>Aedes/Culex/Anopheles/ lice/ bed bug, sand fly/ house fly</i>).	
4. Identification of insects belonging to different orders, common insect pest of paddy, tea, stored grain, citrus and sugarcane.	
5. Classification and characterization of commercially important food and ornamental fishes of NE India.	
6. Study of different types of indigenous/locally available fishing gears.	
7. Estimation and interpretation of pH of pond soil; dissolved oxygen (D.O.) and free carbon dioxide (fCO ₂) in pond water.	
8. Dissection and display of Pituitary Gland of Indian Major Carp.	
9. Demonstration of induced breeding of IMCs (video)	

Suggested Readings:

1. Pradhan, S. (1969). Insect Pests of Crops. National Book Trust, India Book House.
2. Atwal, A.S. (1993) Agricultural pest of India and South East Asia. Kalyani Pub., New Delhi.
3. Chapman, R. F. The Insects: Structure and Function. Cambridge University Press, UK
4. S. Hill. (2005) Agricultural Insect pests of the tropics and their management, Cambridge University press.
5. Pedigo L. P. (2002). Entomology and Pest Management, Prentice Hall Publication
6. Tembhare, D.B. Modern Entomology
7. David, B.V. and Ananthkrishnan (2004). General and Applied Entomology.
8. Bone, Q. & Moore, R. H. (2008). Biology of Fishes. 3rd edition, Taylor & Francis
9. Evans, D. H., Claiborne, J. B. & Curie, S. (2014). The Physiology of Fishes. 4th edition, CRC Press
10. Handbook of Fisheries and Aquaculture (2013). Published by the Indian Council of Agricultural Research, New Delhi
11. Khanna, S. S. & Singh, H. R. (2014). Textbook of Fish Biology and Fisheries. 3rd edition, Narendra Publishing House
12. Jayaram, K. C. (2010). The Freshwater Fishes of the Indian Region. 2nd edition, Narendra Publishing House
13. Vishwanath, W. (2021). Freshwater Fishes of the Eastern Himalayas. 1st edition, Elsevier

DSE 8
IMMUNOLOGY
Code: ZOO-3014
Credit: 3 (T) + 1 (P)

Learning Objectives:

1. This course will give the students a brief overview on the cells and organs of the immune system.
2. It will give them a better understanding about antigens, antibodies and their use as tools for research.
3. It will help in better understanding the functioning of the immune system and the role of vaccines in preventing diseases.
4. Give them practical knowledge on the immune system and its functioning in mammals.
5. Encourage them to take up further studies on the topics related to immunology.

Learning Outcomes:

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

1. Understand about the various cells and organs of the immune system.
2. Understand the concepts of antigens, antibodies and their interactions.
3. Gain knowledge on the functioning of the immune system and the role of vaccines in preventing diseases.
4. Perform practicals related to immunology and its functioning in mammals.

DSE 8
IMMUNOLOGY
Code: ZOO-3014
Credit: 3 (T) + 1 (P)

THEORY	Hours
Unit 1: Introduction to basic concepts of immunology; components of immune system; principles of innate and adaptive immune system. Haematopoiesis, Cells of immune system and organs (primary and secondary lymphoid organs) of the immune system	15
Unit 2: Basic properties of antigens, B and T cell epitopes, haptens and adjuvants. Structure, classes and function of antibodies, monoclonal antibodies, antigen antibody interactions as tools for research and diagnosis	20
Unit 3: Structure and functions of MHC, exogenous and endogenous pathways of antigen presentation and processing, basic properties and functions of cytokines, Complement system: Components and pathways. General introduction to vaccines, various types of vaccines.	10

IMMUNOLOGY

Practical	Hours
1. Histological study of spleen, thymus and lymph nodes through slides/ photographs. 2. Preparation of stained blood film to study various types of blood cells. 3. ABO blood group and Rh factor determination. 4. Demonstration of- a) ELISA; b) Immunoelectrophoresis 5. Isolation of lymphocytes from blood.	30

Suggested Readings:

1. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). Immunology, VI Edition. W.H. Freeman and Company.
2. David, M., Jonathan, B., David, R. B. and Ivan R. (2006). Immunology, VII Edition, Mosby, Elsevier Publication.
3. Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology. V Edition. Saunders Publication.

DSE 9
REPRODUCTIVE BIOLOGY
Code: ZOO-3015
Credit: 3 (T) + 1 (P)

Course Objectives:

1. This course will give the students a brief overview on the reproductive endocrinology of mammals.
2. It will give them a better understanding about the functional anatomy of the male reproductive system and the various hormones and processes involved in it.
3. It will help in better understanding the functional anatomy of the female reproductive system and the various hormones and processes involved in it.
4. Give them practical knowledge on the reproductive biology of mammals.
5. Encourage them to take up further studies on the topics related to reproductive biology.

Learning Outcomes:

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

1. Understand about the process of reproductive endocrinology in mammals.
2. Understand the functional anatomy of male and female reproductive systems in mammals.
3. Gain knowledge on the various hormones involved in the process of reproduction

and also the roles that they perform in the body.

4. Perform practicals related to understanding the reproductive biology in mammals.

DSE 9
REPRODUCTIVE BIOLOGY
Code: ZOO-3015
Credit: 3 (T) + 1 (P)

THEORY	Hours
Unit 1: Gonadal hormones and mechanism of hormone action, steroids, glycoprotein hormones and prostaglandins, hypothalamo–hypophyseal–gonadal axis, regulation of gonadotrophin secretion in male and female; Reproductive System: Development and differentiation of gonads, genital ducts, external genitalia, mechanism of sex differentiation.	15
Unit 2: Outline and histological study of male reproductive system in rat and human; Testis: Cellular functions, germ cell, system cell renewal Spermatogenesis: kinetics and hormonal regulation; Androgen synthesis and metabolism; Epididymal function and sperm maturation; Accessory glands functions; Sperm transportation in male tract	20
Unit 3: Outline and histological of female reproductive system in rat and human; Ovary: folliculogenesis, ovulation, corpus luteum formation and regression; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (rat and human) and their regulation, changes in the female tract; Fertilization, implantation and pregnancy in mammals	10

REPRODUCTIVE BIOLOGY
Credit: 3 (T) + 1 (P)

Practical	Hours
1. Study of estrous cycle in rat/mice.	30
2. Study of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems.	
3. Study of histological sections from photomicrographs/ permanent slides of sections of ovary, fallopian tube, uterus (proliferative and secretory	

stages), cervix and vagina.

4. Total sperm count and determination of sperm motility in mammal

Suggested Readings:

1. Austin, C.R. and Short, R.V. *Reproduction in Mammals*. Cambridge University Press.
2. Degroot, L.J. and Jameson, J.L. (eds). *Endocrinology*. W.B. Saunders and Company.
3. Knobil, E. et al. (eds). *The Physiology of Reproduction*. Raven Press Ltd.
4. Hatcher, R.A. et al. *The Essentials of Contraceptive Technology*. Population Information Programme.
5. Johnson, M.H. (2018). *Essential Reproduction*, Wiley-Blackwell, 8th Edition
6. Zarrow, M. (1964). *Experimental Endocrinology-A source book of basic techniques*, Elsevier, 1st Edition

DSE 10
MOLECULAR BIOLOGY
Code: ZOO-3016
Credit: 3 (T) + 1 (P)

Course Objectives:

1. Students will learn about different types of nucleic acids, their structures and mechanism of DNA replication.
2. The students will learn about the mechanism of transcription and translation and processing of RNA in both prokaryotes and eukaryotes.
3. Students will be able to learn about the mechanism of transcriptional regulation and importance of RNA interference technology
4. Students will learn about different types of DNA damage and their repair mechanism.

Learning Outcomes:

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

1. Students will be able to appreciate how structure of DNA was discovered and how their structures are influenced by both internal and external factors.
2. Students will also be able to understand why DNA synthesis is always occurs in 5'-3' direction. The students will also understand how processing of RNA protects and regulate their translation.

- Students will understand the basic of interaction of different polymerase with the nucleic acids and how their functions are enhanced or suppressed by different cofactors.
- Students will understand what factors causes damages to the DNA and how cellular repair mechanism prevent and repair such damage to DNA.

DSE 10
MOLECULAR BIOLOGY
Code: ZOO-3016
Credit: 3 (T) + 1 (P)

THEORY

Hours

Unit 1:

15

Nucleic Acids: Structure and types of DNA and RNA, Watson and Crick model of DNA.

DNA Replication: Enzymes used in DNA Replication, DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi-discontinuous replication, Telomere and replication of telomeres

Unit 2:

15

Transcription: RNA polymerase structure and transcriptional Unit, mechanism of transcription in prokaryotes and eukaryotes

Post Transcriptional Modifications and Processing of Eukaryotic RNA: Split genes: concept of introns and exons, splicing mechanism and alternative splicing

Translation: Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Mechanism of translation, Inhibitors of protein synthesis

Unit 3:

15

Regulation of gene expression: Operon concept, Transcription regulation in prokaryotes (lac operon and tryptophan operon)

Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing and Genetic imprinting.

DNA Damage and Repair Mechanisms

RNA interference

MOLECULAR BIOLOGY

Practical

Hours

- Study of Polytene chromosomes from Chironomous / Drosophila larvae
- Preparation of metaphase chromosome from the bone marrow of mice
- Quantitative estimation DNA using colorimeter (Diphenylamine reagent)

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4. Quantitative estimation of RNA using Orcinol reaction
 5. Isolation of DNA from tissues and qualitative analysis by agarose gel electrophoresis.
 6. Study and interpretation of electron micrographs/ photograph showing: DNA replication, Transcription and Split genes
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Suggested Readings:

1. Cooper, G. M. (2018). 8th Edition. The cell: A molecular approach. Massachusetts, USA: Sinauer Associates. ISBN-13:978-1605357072
2. Alberts, B et al. (2014). 6th edition. Molecular Biology of the Cell. W. W. Norton & Company. ISBN-13 : 978-0815345244
3. Lodish H et al. (2003). 5th Revised edition. Molecular Cell Biology. W.H.Freeman& Co Ltd; ISBN13 : 978-0716743668
4. Karp, G. (2019). 9th Edition. Cell and molecular biology: New Jersey, USA: Wiley Publishers. ISBN-978—1-119-59816-9
5. Brown, T. A. (2020). 8thEdition. Gene cloning and DNA analysis: An introduction. New York, USA: John Wiley and Sons, ISBN-13: 978-1119640783.

**MAJOR
COMPUSORY
CELL BIOLOGY
Code: ZOO-3021
Credit: 3 (T) + 1 (P)**

Course Objectives:

1. Structure and functions of various cellular compartments and organelles
2. Cell growth, cell-division and cell-cycle control mechanisms.
3. Cell to cell communication and mechanism of signal transduction across the cellular target.
4. Cell death and mechanism

Learning Outcomes:

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

1. Students will learn about different cell types.
 2. Students will acquire knowledge about the composition of cells and cellular compartments and detail study about the functioning of these organelles.
 3. Students will acquire knowledge about cellular energetic and concept of protein sorting
 4. Students will learn about the different level of DNA packaging within the cells and also learn about different types of chromosomes.
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5. Students will learn about the growth and cellular division, communication among different cells and mode of cellular homeostasis by apoptosis and necrosis.

**MAJOR
COMPULSORY
CELL BIOLOGY
Code: ZOO-3021
Credit: 3 (T) + 1 (P)**

THEORY	Hours
Unit 1 Over view of Cells: Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions. Plasma Membrane: Various models of plasma membrane structure, Transport across membranes: Active and Passive transport, facilitated transport, Types of transporters Cell junctions: Structure and functions of Tight junctions, Desmosomes, Gap junctions Endomembrane System: Structure and Functions of Endoplasmic Reticulum, Golgi Apparatus and Lysosomes	15
Unit 2 Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis, Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis Peroxisomes: Structure and functions Cytoskeleton: Structure and Functions of Microtubules, Microfilaments and Intermediate filaments, Cilia and flagella Nucleus: Structure of Nucleus (Nuclear envelope, Nuclear pore complex, Nucleolus)	15
Unit 3 Chromosomes: Giant chromosome (Polytene and lampbrush), Types of eukaryotic chromosomes based on centromeres, Euchromatin and Hetrochromatin, DNA packaging within the nucleus (nucleosome model) Cell Division: Mitosis, Meiosis, Cell cycle and its regulation Cell to Cell communications: Types of signalling molecules, Cell surface receptors and its types, second messengers, Mechanism of signal transductions of peptide and steroid hormones. Cell Deaths: Necrosis and apoptosis, significance of apoptosis in cellular homeostasis, Mechanism of apoptosis	15

CELL BIOLOGY

Practical	Hours
1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis	30

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2. Study of various stages of meiosis in testis (Grasshopper/Cockroaches/Mice/Rat).
 3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.
 4. Preparation of permanent slide of blood and study of different types of blood cells
 5. Preparation of histological slides from tissues as liver, Lung, Stomach, Intestine, Kidney, Pancreas, Testes and Ovary.
 6. Preparation of permanent slide for cytochemical demonstration of
 - a. DNA by Feulgen reaction
 - b. Mucopolysaccharides and Glycogen by PAS reaction
 - c. Proteins by Mercurio bromophenol blue/FastGreen
 - d. Lipid by Sudan black B
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Suggested Readings:

1. Cooper, G. M. (2018). 8th Edition. The cell: A molecular approach. Massachusetts, USA: Sinauer Associates. ISBN-13:978-1605357072
2. Alberts, B et al. (2014). 6th edition. Molecular Biology of the Cell. W. W. Norton & Company. ISBN-13 : 978-0815345244
3. Lodish H et al. (2003). 5th Revised edition. Molecular Cell Biology. W.H.Freeman& Co Ltd; ISBN13 : 978-0716743668
4. Hardin, J. Bertoni, G. P. Kleinsmith, L.J. and Becker, W.M. (2016). 9th Edition. The world of the cell. San Francisco, USA: Benjamin Cummings Publishers, ISBN-13: 978 -0321934925.
5. Karp, G. (2019). 9th Edition. Cell and molecular biology: New Jersey, USA: Wiley Publishers. ISBN-978—1-119-59816-9

DSE 11
DEVELOPMENTAL BIOLOGY
Code: ZOO-3022
Credit: 3 (T) + 1 (P)

Course Objectives:

1. Students will be given an exposure to gametogenesis and different types of fertilization.
2. Students will learn about the course of development after fertilization and development of different organs.
3. Students will learn about the post embryonic development, metamorphosis and teratogenesis.

Students will learn about in vitro fertilization.

Learning Outcomes:

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

1. The students will be able to understand about the role of mitosis and meiosis cell division, cellular differentiation during gametogenesis.
 2. The students will be able to understand how fertilization happens and the factors that affect fertilization event.
 3. The students will be given exposure to understand the basic embryonic development and organogenesis.
 4. The students will be able to understand the role different hormones and of cellular
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- signalling during development through metamorphosis and teratogenesis.
5. The students will learn and appreciate the importance of IVF, amniocentesis and embryonic stem cells.

DSE 11
DEVELOPMENTAL BIOLOGY
Code: ZOO-3022
Credit: 3 (T) + 1 (P)

THEORY	Hours
<p>Unit 1: Spermatogenesis and Oogenesis Type of animal eggs, egg membrane and vitellogenesis, Fertilization: External and internal fertilization, sperm-egg interactions, biochemical events, post-fertilizations events. Parthenogenesis: Natural haploid, diploid and cyclic parthenogenesis. Artificial stimulus for parthenogenesis and its significance.</p>	15
<p>Unit 2: Planes and patterns of cleavage; Types of Blastula; Embryonic induction and Organizer, Fate map construction in frog and chick. Organogenesis: Development of heart and eye in vertebrates Development of chick embryo up to three germ layer formation. Extra embryonic membranes in bird and mammal.</p>	15
<p>Unit 3: Placenta: Types, function and physiology Metamorphosis: types of metamorphosis, metamorphic changes, hormonal regulations of metamorphosis in insects and amphibians. Teratogenesis: Teratogenic agents and their effects on embryonic development In vitro fertilization, Embryonic Stem cell (ESC), Amniocentesis.</p>	15

DEVELOPMENTAL BIOLOGY

Practical	Hours
<ol style="list-style-type: none"> 1. Collection and study of different type of eggs 2. Examination of gametes of frog/rat/mice: Sperm and ova through permanent slides or photomicrographs. 3. Study of developmental stages of Frog: Whole mounts and sections through permanent slides of cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages. 4. Study of developmental stages of Chick embryo: Whole mounts of chick through permanent slides (Hamburger and Hamilton Stages): Stage 3 (Intermediate Streak, 13 hours), Stage 4 (Definitive Streak, 18 hours), Stage 5 (Head Process, 21 hours), Stage 7 (24 hours), Stage 8 	30

- (28 hours), Stage 10 (33 hours), Stage 11 (40 hours), Stage 13 (48 hours), Stage 19 (72 hours) and Stage 24 (96 hours) of incubation
5. Study of different types of placenta: Histological sections through permanent slides or photomicrographs.
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Suggested Readings:

1. Gilbert, Scott F. *Developmental Biology*. 7th ed. Sunderland, MA: Sinauer Associates, 2003. ISBN: 9780878932580.
2. Wolpert, Lewis. *Principles of Development*. 2nd ed. New York, NY: Oxford University Press, 2001. ISBN: 9780198792918.
3. Kalthoff, Klaus. *Analysis of Biological Development*. 2nd ed. Boston, MA: McGraw-Hill, 2001. ISBN: 0071180788.
4. Slack, J. M. W. *Essential Developmental Biology*. Malden, MA: Blackwell Science, 2001. ISBN: 9780632052332.
5. Bier, Ethan. *The Coiled Spring: How Life Begins*. Plainview, NY: Cold Spring Harbor Laboratory Press, 2000. ISBN 9780879695637.
6. Gerhart, John, and Marc Kirschner. *Cells, Embryos, and Evolution: Toward a Cellular and Developmental Understanding of Phenotypic Variation and Evolutionary Adaptability*. Malden, MA: Blackwell Science, 1997. ISBN: 9780865425743.
7. Russo, V. E. A., et al., eds. *Development: Genetics, Epigenetics, and Environmental Regulation*. New York, NY: Springer, 1999. ISBN: 9783540627548.
8. Arias, Alfonso Martinez, and Alison Stewart. *Molecular Principles of Animal Development*. New York, NY: Oxford University Press, 2002. ISBN: 9780198792840.
9. Rao, Mahendra S., and Marcus Jacobson, eds. *Developmental Neurobiology*. 4th ed. New York, NY: Springer-Verlag, 2005. ISBN: 9780306483301.

DSE 12
WILDLIFE CONSERVATION AND MANAGEMENT
Code: ZOO-3023
Credit: 3 (T) + 1 (P)

Course Objectives:

The Discipline Specific Paper on Wildlife Conservation and Management is designed to acquaint students with varied aspects of wildlife conservation, including its importance, major threats, and management of their habitats and populations. The emphasis will be on developing interest and invoking a sense of responsibility among students toward wildlife conservation. The course also explores different techniques, perspectives, and approaches to both identify and achieve wildlife management goals. This course will motivate students to pursue careers in the field of wildlife conservation and management.

Learning Outcomes:

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

1. Become aware of the importance of wildlife in general, and its conservation and management in particular.
 2. Comprehend the application of the principles of ecology and animal behaviour to formulate strategies for the management of wildlife populations and their
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habitats.

3. Understand the management practices required to achieve a healthy ecosystem for wildlife populations along with an emphasis on conservation and restoration.
4. Know the key factors for the loss of wildlife and important strategies for their in-situ and ex-situ conservation.
5. Recognize the techniques for estimation, remote sensing, and Global Position Tracking for wildlife.
6. Gain knowledge about wildlife diseases and quarantine policies.
7. Know about the Protected Area Networks in India, Ecotourism, Ecology of perturbation, and Climax persistence.
8. Perform critical thinking, literature review; scientific writing as well as presentations; and participation in citizen science initiatives with reference to wildlife

MAJOR 12
WILDLIFE CONSERVATION AND MANAGEMENT
Code: ZOO-3023
Credit: 3 (T) + 1 (P)

THEORY

Hours

Unit 1:

13

Concepts of wildlife, wildlife definition, wildlife conservation, history of wildlife, and conservation ethics.

Values and importance of wildlife; Causes of depletion of wildlife in India; Wildlife habitat ecology and its management; Biological and ecological basis of wildlife management. Conservation vs. preservation, Wildlife population survey

Unit 2:

16

Concepts pertaining to wildlife population, density, types of density, natality, mortality sex ratio and age structure, population growth patterns and concept of carrying capacity; Habitat management of wildlife in a forested and aquatic ecosystem, the definition of wildlife cover and cover characteristics.

Wildlife habitat succession and management; Restoration of degraded habitats, Concepts of GIS and Remote sensing and their utility in wildlife habitat management.

Unit 3:

16

Concepts of protected areas, wildlife protected areas in India; Protected area network, National Parks, Sanctuaries, Man and Biosphere Reserve, Ecological

sensitive zones, Conservation reserves, Community reserves, Secret Groves. Concepts of elephant and tiger reserves, Ramsar sites; Recent challenges of the management of Tiger reserves and Ramsar sites. Concepts and management of renewable natural resources and wildlife's welfare factors.

WILDLIFE CONSERVATION AND MANAGEMENT

Practical	Hours
1. Identification of flora (Common plant species associated with wildlife) and fauna (Mammals, Birds, Herpetofauna, and Butterflies)	30
2. Demonstration and applicability of basic equipment needed for wildlife studies (Compass, Range finder, GPS, Camera Traps).	
3. Demonstrations of field study techniques: line transect and quadrat sampling.	
4. Importance of indirect evidences in wildlife survey and its identification [Animal Footprints (Pugmark & hoof mark), Animal Droppings (Scat, Dung, Pellet), Other animal signs, Antlers, Nests of birds]	
Animal trail survey or trail monitoring, use of plaster of Paris for wildlife survey (for the indirect survey).	

Suggested Readings

1. Caughly, G. and Sinclair, A. R. E. (1994). Wildlife Ecology and Management. Blackwell Scientific Publications, 1-334pp.
2. Shekhar, S. Kolipaka, (2014). A Field Guide to Tracks & Signs of Indian Wildlife. 1-385pp.
3. Sinclair, A.R. E., John M. Frysell, and Graeme Caughley (2006). Wildlife Ecology, Conservation, and Management, Blackwell Publishing, 1-463, pp.
4. Raj, M. (2012). Wildlife Ecology and Management (With special reference to Northeast India). Assam Book Depot, Panbazar, Guwahati-1, 1-294pp.
5. Berwick S. H. and Saharia, V. B. (1995). Development of International principles of Wildlife Research and Management (Asian and American approaches). Oxford University Press, Delhi, Bombay, Madras. 1-481. pp.
6. Vivek Menon, (2014). Indian mammals, A Field Guide; Hachetta Book Publishing India Pvt. Ltd. 4th and 5th Floor Corporate centre, Plot No. 94, Sector 44, Gurgaon, 122001, India.
7. Hunter M. L., Gibbs, J. B. and Sterling, E. J. (2008). Problem-Solving Conservation Biology and Wildlife Management: Exercise for class, Field and laboratory, Blackwell Publishing.
8. Southerland, W. J. (2000). The conservation handbook: Research management and Policy. Blackwell Sciences.
9. Bookhout, T. A. (1996). Research and management techniques for wildlife and habitats, 5th edition. The Wildlife Society, Allen Press.
10. Woodroffe, R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence? Cambridge University.

DSE 13
COMPUTATIONAL BIOLOGY
Code: ZOO-3024
Credit: 3 (T) + 1 (P)

Course Objectives:

Bioinformatics is the science of storing, extracting, analyzing, interpreting and using information. This course is designed for students interested in molecular biology, genetics, information technology and computer science. It helps in the analysis of organism genome, development of new algorithm, study of structural and functional relationship and molecular evolution.

Learning Outcomes:

The course helps to understand the basic principles of biology, computer science and mathematics. Existing software effectively helps students to extract information from

large databases and to use this information to solve biological problems. It also provides an understanding of the intersection of life and information science, the core of shared concepts, language of structure and function relationship, gene expression, phylogenetic analysis through database.

DSE 13
COMPUTATIONAL BIOLOGY
Code: ZOO-3024
Credit: 3 (T) + 1 (P)

THEORY	Hours
Unit I: Introduction to Bioinformatics and Biological Databases Importance, Goal, Scope; Genomics, Transcriptomics, Systems Biology, Functional Genomics, Metabolomics, Molecular Phylogeny; Applications and Limitations of Bioinformatics, Introduction to biological databases; Primary, secondary and composite databases; Nucleic acid databases (GenBank, DDBJ, EMBL and NDB); Protein databases (PIR, SWISS-PROT, TrEMBL, PDB); Metabolic pathway database (KEGG, EcoCyc, and MetaCyc); Small molecule databases (PubChem, Drug Bank, ZINC, CSD)	15
Unit 2: Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)	15
Unit 3: Basic Concepts of Sequence Alignment and Applications of Bioinformatics Scoring Matrices (PAM, BLOSUM), Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Local and global alignment, pair wise and multiple sequence alignments; Similarity, identity and homology of sequences. Structural Bioinformatics (3-D protein, PDB), Drug discovery method (Basic concepts)	15

COMPUTATIONAL BIOLOGY

Practical	Hours
<ol style="list-style-type: none"> 1. Retrieval of sequence data from Entrez, gene expression from GEO, structural data of protein using PDB, motif information of protein using Prosite. 2. Primer Designing 3. Perform pair-wise alignment of sequences (BLAST) and interpret the output. 4. Perform multiple sequence alignment using MEGA 5. Phylogenetic analysis using PHYLIP (rooted and unrooted). 	30

Suggested Readings:

1. Ghosh Z and Mallick B. (2008). Bioinformatics:
2. Principles and Applications, Oxford University Press.
3. Pevsner J. (2009). Bioinformatics and Functional Genomics, II Edition, Wiley Blackwell.
4. Zvelebil, Marketa and Baum O. Jeremy (2008). Understanding Bioinformatics, Garland Science, Taylor and Francis Group, USA.

DSE 14
ADVANCE ENTOMOLOGY
Code: ZOO-3025
Credit: 3 (T) + 1 (P)

Learning Objectives:

Insects are the most diverse and successful group of organisms inhabiting almost all spheres on earth. Learning of physiological system of insects gives an overview of how their bodies organize, function and work. This study also bears economic and toxicological importance as understanding the internal body system and mechanism only helps to tackle any insects and insects related measures. Insect pests are the common occurrence of crops, household etc. Therefore, learning pest, common pest of crops and pest control strategies help to develop an overall idea about insect pests, their damages and rational control strategies. Moreover, insects play tremendous beneficial role in ecosystem and to human being. Another learning objective is to introduce the most common beneficial insects and their products used by human being in diverse field.

Learning Outcomes:

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

1. Understand the basic physiological systems of Insects
2. Develop basic concept on pest and pest control strategies.

3. Develop concept on common insect pest of crops and stored grains
4. Develop idea on life history of the beneficial insects
5. Get knowledge on the diverse applications of insect products.
6. Get practical knowledge on visiting insect rearing field & preparing report/ studying and collecting and identifying common insects or pests/ physiological and anatomical structures performing dissections.

DSE 14
ADVANCE ENTOMOLOGY
Code: ZOO-3025
Credit: 3 (T) + 1 (P)

THEORY	Hours
Unit 1: Physiological systems of insects- Digestive System, Excretory System, Circulatory System, Respiratory System, Reproductive System, and Nervous system	30
Unit 2: Definition of pest, types of pests according to damage (sub economic, occasional, perennial), concept of economic injury level, economic threshold level, pest resurgence, secondary pest outbreak, cultural control, biological control of pest, pheromonal control of pest. Life history and control of following plant pests: Agricultural pests (<i>Papilio demoleus</i> , <i>Leucinodesorbonalis</i> , <i>Spodoptera litura</i>); Stored grain pests (<i>Callosobruchus chinensis</i> , <i>Sitophilus oryzae</i>), Tea pest (<i>Helopeltistheivora</i> , <i>Buzurasuppressaria</i>), Paddy pest (<i>Dicladispaarmigera</i> , <i>Leptocorisa</i> sp.), Host-plant selection by phytophagous insects	08
Unit 3: Life history of two silk producing insects in North East India. Life history of lac insects. Applications of lac, silk and honey.	07

ADVANCE ENTOMOLOGY

Practical	Hours
1. Collection, preservation, identification of common phytophagous pest	30
2. Submission of life cycle of silkworm/ lac insects	
3. Dissection of digestive and nervous system of cockroach/ grasshopper	
4. Study on biological agents- (identification, classification and	

significance): pathogens, parasites, predators

5. Visit to field and prepare a report (agriculture/ sericulture/ apiculture/ lac culture field)

Suggested Readings:

1. Pradhan, S. (1969). Insect Pests of Crops. National Book Trust, India Book House.
2. Atwal, A.S. (1993) Agricultural pest of India and South East Asia. Kalyani Pub., New Delhi.
3. Chapman, R. F. The Insects: Structure and Function. Cambridge University Press, UK
4. Dennis, S. Hill. (2005) Agricultural Insect pests of the tropics and their management, Cambridge University press.
5. Pedigo L. P. (2002). Entomology and Pest Management, Prentice Hall Publication
6. Tembhare, D.B. Modern Entomology, Himalaya Publishing House.
7. David, B.V. and Ananthkrishnan (2004). General and Applied Entomology. McGraw Hill India.
8. Ghosh, M.R. (1995). Concepts of Insect Control. New Age International Limited, New Delhi.
9. Srivastava, K.P. (1996) A Textbook of Applied Entomology. Kalyani Publisher.
10. Nation, J.L. (2008). Insect Physiology and Biochemistry. CRC Press, New York

DSE 15
ANIMAL CELL CULTURE AND GENETIC ENGINEERING
Code: ZOO-3026
Credit: 3 (T) + 1 (P)

Course Objectives:

1. The students will be given an idea of in vitro animal cell culture techniques and their utilization in modern biological research.
2. The students will be given exposure to frequently used modern biological techniques.
3. The students will learnt the basic concept of genetic engineering and their utilization.

Learning Outcomes:

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

1. Learn about basic cell culture techniques and key concepts that are used in isolation and culture of animal cells.
2. Develop basic understanding of the modern robust techniques with wide applications

- (such as PCR, DNA sequencing, DNA fingerprinting, DNA microarray and blotting techniques.
- The student will be able to understand the importance of gene cloning in biotechnology and utilization of different cloning vectors such as plasmids and bacteriophages.
 - Understand the importance of construction of genomic libraries and their specialized screening methods to identify gene of interest.

DSE 15
ANIMAL CELL CULTURE AND GENETIC ENGINEERING

Code: ZOO-3026
Credit: 3 (T) + 1 (P)

THEORY	Hours
<p>Unit 1: Basic requirement of animal cell culture, cell culture media Basic techniques of cell culture, Development of primary cell cultures: cell separation, harvesting and maintenance of cell lines; Transformation and differentiation of cell cultures, Types of cell culture: monolayer, suspension, Measurement of viability and parameters of growth. Cell culture Bioassays: Cell proliferation assays</p>	15
<p>Unit 2: Polymerase Chain Reaction DNA sequencing: Sanger's method, Next generation sequencing Southern, Northern and Western blotting DNA Finger Printing and DNA microarray,</p>	15
<p>Unit 3: Basic concept of gene cloning, Restriction enzymes and DNA modifying enzymes. Cloning vectors: Plasmids, Lambda Bacteriophage, M13, YAC and Expression vectors (characteristics). Cell Transformation techniques: Calcium chloride method, electroporation and biolistic method. Construction of genomic and cDNA libraries and screening by colony and plaque hybridization</p>	15

ANIMAL CELL CULTURE AND GENETIC ENGINEERING

Practical	Hours
<ol style="list-style-type: none"> Genomic DNA isolation from <i>E. coli</i> Plasmid DNA isolation (pUC 18/19) from <i>E. coli</i> Demonstration of Restriction digestion of Plasmid/Lambda DNA. To demonstrate following techniques: (Optional) Southern/ 	30

- Northern/Western blotting (Any one) PCR DNA fingerprinting DNA Sequencing (Sanger's Method)
5. Project report on animal cell culture OR on a visit to any biotechnology Institute
-

Suggested Readings:

1. Freshney, R. Ian Culture of Animal Cells: A Manual of Basic Technique, 4th Edition ISBN 13: 9780471348894
2. Leslie Wilson, Paul Matsudaira, (1998), Animal Cell Culture Methods, eBook ISBN: 9780080859552
3. Cooper, G. M. (2018). 8th Edition. The cell: A molecular approach. Massachusetts, USA: Sinauer Associates. ISBN-13:978-1605357072
4. Alberts, B et al. (2014). 6th edition. Molecular Biology of the Cell. W. W. Norton & Company. ISBN-13 : 978-0815345244
5. Lodish H et al. (2003). 5th Revised edition. Molecular Cell Biology. W.H.Freeman& Co Ltd; ISBN13 : 978-0716743668
6. Karp, G. (2019). 9th Edition. Cell and molecular biology: New Jersey, USA: Wiley Publishers. ISBN-978—1-119-59816-9
7. Brown, T. A. (2020). 8th Edition. Gene cloning and DNA analysis: An introduction. New York, USA: John Wiley and Sons, ISBN-13: 978-1119640783.
8. Cantor, C. R. and Smith, C. L. (2004). 1st Edition. Genomics: The science and technology behind the human genome project. New York, USA: John Wiley and Sons. ISBN-13: 978-0471461869.
9. Old, R. W. and Primrose, S. B. (1994). 7th Edition. Principles of Gene Manipulation: an Introduction to Genetic Engineering. Boston: Wiley. ISBN-13: 978-0632037124.
10. Joseph Sambrook, E.F. Fritsch, T. Maniatis. (1989). 2nd Edition. Molecular Cloning: A Laboratory Manual. New York, USA: Cold Spring Harbor Laboratory. Press ISBN- 978-0879693732.
11. Glick, B. R. and Patten, C. L. (2022). 6th Edition. Molecular Biotechnology: Principles and Applications of Recombinant DNA. USA: ASM press, ISBN-13: 978-1683673668.
12. Primrose, S. B. and Twyman, R. B. (2014). 7th Edition. Principles of Gene Manipulation and Genomics. New York, USA: John Wiley and Sons. ISBN-13: 978-1118653883.
13. Green, M. R. and Sambrook, J. (2012). 4th Edition. Molecular Cloning: A Laboratory Manual (three-volume set). New York, USA: Cold Spring Harbor Laboratory Press ISBN-13: 978- 1936113422