Outline of NEP 4-year undergraduate syllabus: Department of Zoology, University of Lucknow

Year	Semester	Major A (Subject 1) @4 credits (Zoology)	Major B(Subject 2) @4 credits (Another subject from any faculty)	Minor (Subject 3) @ 2 credits (anotherdepartment)	CC/ VC @ 2 credits	Total Credits	Degree
Year 1	Sem I	**P1** (Theory) Diversity and Biology of Non-Chordata	**P1**	Q1 Diversity of Non-Chordata	Curricular course 1 (CC1)	20	CERTIFICATE
		P2 (Theory) Biosystematics and Evolutionary Biology	**P2**				
	Sem II	**P3** (Theory) Ecology and Environmental Biology	**P3**	Q2 Ecology and Environmental Biology	Vocational course 1 (VC1)	20	
		P4 (Practical) Practical based on theory	**P4**				
Year 2	Sem III	**P5** (Theory) Diversity and Biology of Chordata	**P5**	Q3 Diversity and Biology of Chordata	Curricular course 2 (CC2)	20	DIPLOMA
		P6 (Theory) Animal Behaviour and Chronobiology	**P6**				
	Sem IV	**P7** (Theory) Animal Physiology	**P7**	Q4 Animal Physiology	Vocational course 2 (VC2)	20	
		P8 (Practical) Practical based on theory	**P8**				
Year 3	Sem V	**P9** (Theory) Cell Biology and Genetics	**P9**	Internship/ Term paper/ Minor project @ 4 credits		20	GRADUATION DEGREE
		P10 (Theory) Developmental Biology and Immunology	**P10**				
	Sem VI	**P11** (Theory) Molecular Biology and Biochemistry	**P11**			20	
		P12 (Practical) Practical based on theory	**P12**				
		P13A (Theory- Optional) Wildlife					
		P13B (Theory- Optional) Toxicology					
Year 4	Sem VII	**P14** (Theory) Biotechnology and Bioinformatics				20	GRADUATION HONOURS WITH RESEARCH
		P15 (Theory) Bioinstrumentation and Biostatistics					
		P16 (Theory) Economic Zoology					
		P17 (Practical) Practical based on theory					
		P18A/B/C/D (Optional) Specialization					
	Sem VIII	**P19** (Theory) Research Methodology	Major Research Project/ Dissertation (12 credits)			20	
		P20 Term paper					
Rashtra Gaurav (Compulsory Non credited)							
Total Credits						**160**	

B. Sc. in Zoology

Program Objectives (POs):
Zoology as one of the subjects at the undergraduate level, should be studied in an integrated and cross-disciplinary manner with a comprehensive understanding of all living systems and their relationship with the ecosystem. Within the broad-range skill sets related to the discipline, it is required to impart and assess the quality of critical thinking, analytical and scientific reasoning, and problem-solving capacity.
Our undergraduate program in Zoology is designed to prepare students to have:

Degree in Bachelor of Science		
Programme Outcomes (POs)		
PO 1	**Academic competence:**	Develop a deeper understanding of key concepts of Zoology at a biochemical, molecular, cellular, physiological, histological, and systematic level.
PO 2	**Inspire Knowledge:**	From classical descriptive to modern analytical disciplines of Zoology.
PO 3	**Impart Science-based Entrepreneurship:**	Impart knowledge and skills through applied disciplines like Sericulture, Apiculture, Aquaculture, etc.
PO 4	**Develop Competency:**	To make our students competent to excel in competitive examinations.
PO 5	**Research Competence:**	Integrate and explore biological data. Use current laboratory setup, instrumentation, statistical, and biological techniques in the collection, organization, analysis, interpretation, and manipulationof the data related to the Zoology discipline and allied branches.
PO 6	**Entrepreneurial and Social Competence:**	Empower the students by enhancing their self-sustainability capabilities through a thorough understanding of skill-based subjects and techniques by learning. Develop social competence including listening, speaking, observational, effective interactive skills, and presenting skills to meet global competencies.
PO 7	**Environment and Sustainability**:	Understand the issues of environmental contexts and sustainable development.
PO 8	**Ethics**:	Aware students about ethical principles and commit to professional ethics and responsibilities.

B. Sc. I (Semesters I and II)

Degree in Bachelor of Science	
B.Sc. I (Semesters I and II) Programme Specific Outcomes (PSOs)	
PSO 1	Students will have a comprehensive knowledge of the Kingdom Animalia.
PSO 2	Students will learn the distribution, diversity, classification, physiology, and form and function of each major animal lineage within Non-chordates and their evolution.
PSO 4	The basic concepts of biosystematics, evolutionary biology, and biodiversity will enable students to solve the biological problems related to the environment.
PSO 5	Students will be able to apply fundamental principles of Zoology to make informed decisions on socio-scientific issues.
PSO 6	Students will understand the basic biology and life cycles of vectors, pests, and parasites including epidemiology, diagnosis, and treatment.
PSO 7	Students will be able to apply for various positions in museums, wildlife/ biodiversity data collection, conservation programs, health care, zoos, etc. in both government and private labs/institutes including NGOs. The student will be offered a 'CERTIFICATE COURSE IN ZOOLOGY after completing the year or two semesters.

B. Sc. II (Semesters III and IV)

Degree in Bachelor of Science	
B.Sc. II (Semesters III and IV) Programme Specific Outcomes (PSOs)	
PSO 1	
PSO 2	Students will be able to analyze complex interactions among the various animals of different phyla, their distribution, and their relationship with the environment.
PSO 3	Students will be able to develop an understanding of environmental conservation processes and their importance, pollution control, biodiversity, and protection of endangered species.
PSO 4	The inclusion of Chronobiology and physiology will help students to understand the biological clocks of animals and their physiology.
PSO 5	Students will gain knowledge of Agro-based small-scale industries like sericulture, fish farming, apiculture, etc., which will help them in finding career opportunities.
PSO 7	At the end of the course, the students will be able to comprehend the reason behind maintaining the equilibrium between flora and fauna on Earth. Will be able to appreciate the environment and the interdependence between humans, wildlife, and nature for food production, maintaining clean air and water, and sustaining biodiversity in a changing climate.
PSO 8	Students can get subsidies and loans from the state government to start Poultry, Pisciculture, and Apiculture, under various schemes run by the state govt. and become "AATMNIRBHAR" and generate jobs for others.
PSO 9	This Diploma course will enable students to apply for various positions in museums, wildlife/biodiversity data collection, conservation programs, health care, zoos, etc. in both government and private labs/institutes including NGOs as environmental consultants, managers, educators, outreach specialists, wildlife law enforcement officer, zoo curator, museum curator. Besides this, the students can also take up higher studies and research as their career. The student will be offered 'DIPLOMA IN ZOOLOGY' after completion of 2 years of the program or 4 semesters.

B. Sc. III (Semesters V and VI)

Degree in Bachelor of Science	
B.Sc. III (Semesters V and VI) Programme Specific Outcomes (PSOs)	
PSO 1	This program aims to develop an understanding of the structural, functional, biochemical, and behavioral aspects of life.
PSO 2	The course in biosystematics is an integrative and unifying science and will help the students in studying the genotypic and phenotypic variation of species in the environments in which they occur.
PSO 3	This course will provide students with the basic knowledge of evolutionary biology, both presenting the general principles of the discipline and exploring in detail theoretical problems and case studies.
PSO 4	The students will understand the structure and function of the cell and the principles of genetics.
PSO 5	The course will provide an insight into the life processes at the subcellular and molecular levels
PSO 6	This course will provide theoretical and applied knowledge on the effects of chemical substances on human health.
PSO 7	The principles of genetic engineering, gene cloning, and related technologies will enable students to play an important role in the applications of biotechnology in various fields.
PSO 8	After completion of 3 years of the program or 6 semesters, the student will be offered the 'BACHELOR DEGREE IN SCIENCE'. This program will make our students competent to excel in competitive examinations. Also, will enable the students to go for higher studies like a Masters and then pursue Ph.D. in Zoology and allied subjects.

B. Sc. IV (Semesters VII and VIII)

Degree in Bachelor of Science	
B.Sc. III (Semesters VII and VIII) Programme Specific Outcomes (PSOs)	
PSO 1	The principles of genetic engineering, gene cloning and related technologies will enable students to play an important role in applications of biotechnology in various fields and the study of bioinformatics will enable them to use common computational tools and databases andintegrate and manage data from different genomic and proteomic research.
PSO 2	The course in Biostatistics and Bioinstrumentation will enable the students to analyze the different type of data using appropriate statistical software and also will help them in implying appropriate tools and techniques to solve the problems and figure out the downstream events in biological sciences.
PSO 3	The course in Economic Zoology will offer students an understanding ofapplication of zoological knowledge for the benefit of mankind. Also, this course will provide knowledge in the field of animal culture and its product marketing.
PSO 4	The course in Endocrinology aims to develop an understanding of the endocrine glands; their structure, function, disorders, and pathophysiology, which will be helpful for the student to pursue research and higher academic pursuits.
PSO 5	The course in Entomology will help the students to contribute in diverse fields such as agriculture, biology, human/animal health, molecular science, criminology, and forensics and will also help them to pursue research and higher studies.
PSO 6	The course in Fisheries has been designed in such a way that the student will get the knowledge of both theory and practical. It aims to enable the students to study Fish and Fisheries as an entrepreneur.
PSO 7	The course in Parasitology has been designed in such a way that the student gets a basic understanding of the diversity of parasites of medical and veterinary importance which will be helpful for further research and higher studies.
PSO 8	The Honours course will enable students to go for higher studies and research (Ph.D.) in specialized fields of Zoology and allied subjects.

Semester I

Course Code- P1
Diversity and Biology of Non-Chordata

Total Credits: 04 **Teaching Hours: 60**

Course objectives

- To create in the student an appreciation of non-chordate diversity
- To develop in the student an understanding of structural and functional diversity
- To develop in the student the understanding of evolutionary relationships amongst non-chordate groups

Unit I

Phylum Protozoa **5**
General characteristics and classification up to order level
Type study of *Paramecium caudatum*
Life cycle and pathogenicity of*Plasmodium vivax* and *Leishmaniadonovani*
Locomotion (pseudopodia, cilia, flagella, gliding)

Phylum Porifera **5**
General characteristics and classification up to order level
Type study of *Sycon*
Canal system
Skeleton in sponges

Phylum Cnidaria **5**
General characteristics and classification up to order level
Type study of*Obeliageniculata*
Polymorphism in hydrozoans
Corals and coral reefs

Unit II

PhylumPlatyhelminthes **7**
General characteristics and classification up to order level
Life cycle and pathogenicity of *Fasciolahepatica* and *Taenia solium*
Parasitic adaptations

PhylumNematoda **3**
General characteristics and classification up to order level
Life cycle and pathogenicity of*Wuchereriabancrofti*

PhylumAnnelida **5**
General characteristics and classification up to order level
Type study of *Nereisvirens*
Coelom
Excretion

Unit III

PhylumArthropoda **8**
General characteristics and classification up to order level
Type study of*Palaemonmalcolmsonii*
Types of vision, mouthparts, and metamorphosis in insects
Social organization in honey bees and termites

Phylum Mollusca **7**

General characteristics and classification up to order level
Type study of *Pilaglobosa*
Peral formation in bivalves
Torsion and detorsion in gastropods
Structure and significance of glochidium larva

Unit IV

Phylum Echinodermata **8**

General characteristics and classification up to order level
Type study of *Asteriasrubens*
Larval forms of Echinodermata and their significance

Phylum Hemichordata **7**

General characteristics and classification up to order level
Type study of*Balanoglossusclavigerous*
Affinities

Course learning Outcomes:

At the completion of the course, the student will be able to:

- understand and appreciate the diversity of life concerning non-chordate animals.
- describe the general characters of non-chordate animals.
- identify and classify non-chordate animals based on their form and structure and classification.
- understand the life cycle and control of various representatives of non-chordate animals.
- explain the evolutionary relationship amongst different non-chordate groups.

Suggested Reading:

1. Ruppert, EE, Fox R.S., Barnes R.D. (2004) *Invertebrate Zoology*, 7th Edition. Cengage Learning
2. Thomas Jeffrey Parker, William A. Haswell (2016*). Parker & Haswell's A Textbook of Zoology Volume 1*. WENTWORTH Press
3. Brusca (2016). *Invertebrates.* Sinauer
4. Pechenik Jan (2014). *Biology of the invertebrates*. McGraw Hill
5. Barnes R. S. K., Calow P. P., Olive P. J. W., Golding D. W., Spicer J. I. (2009). *The Invertebrates: A Synthesis*. Wiley Blackwell
6. Kotpal R.L. (2018) *Modern Text Book of Zoology: Invertebrates*. Rastogi Publications
7. Nigam H.C. (2013) *Biology of non-chordates.* Vishal Publishing Co

Assignments(anyone)

1. Project (500 words)/ presentation based on the above course content
2. Analytical MCQ based questions
3. Biological Crosswords
4. Charts
5. 500 words answer to analytical questions
6. Study based report of animals in nature

Course Code- P2
Biosystematics and Evolutionary Biology

Total Credits: 04 **Teaching Hours: 60**

Course objectives
To develop:

- understanding of animal taxonomy and systematic and their application
- molecular basis of animal taxonomy.
- basic knowledge of evolutionary biology, both presenting the general principles of the discipline and exploring in detail theoretical problems and case studies.
- understanding of various theories of evolution comprising Lamarckism, Darwinism, and Neo-Darwinism
- comprehensive knowledge regarding various sources of variations and their role in evolution
- understanding of key concepts of Population Genetics in terms of Hardy-Weinberg Law, Genetic Drift and Types of Natural Selection.

Unit I

Introduction to biosystematics and taxonomy

Definition, basic concepts, and importance of taxonomy and biosystematics	3
Types and operation of taxonomy	5
International Code of Zoological Nomenclature (ICZN)	3
Taxonomic (Linnean) hierarchy	4

Unit II

Biological Classification and Taxonomic Procedures

Theories of biological classification	3
Collection, preservation of specimens	4
Process of identification, Description	4
Molecular Techniques in Systematics	4

Unit III

Evolutionary concepts

Theories of evolution (Lamarckism, Darwinism, Modern synthetic theory)	3
Mechanism of evolution: mutation, genetic drift, gene flow, non-random mating, natural selection, molecular drive	5
Hardy-Weinberg law	2
Biological species concept, Mode of speciation (allopatric, parapatric and sympatric)	5

Unit IV

Evidence of Evolution

Paleobiological: Concept of Stratigraphy and geological timescale; fossil study (types, formation and dating methods).	5
Anatomical: Vestigial organs; Homologous and Analogous organs	2
Taxonomic: Transitional forms/evolutionary intermediates; living fossils.	4
Evolutionary patterns (Divergent, Convergent & Parallel evolution)	4

Courselearningoutcomes
At the completion of the course, the student will be able to:

- the fundamental principles of systematic,

- how to classify animals according to their characters, and
- what are the theories which have to followed to study the classification
- understand the concept, process and patterns of evolution.
- acquire knowledge and reasoning skills useful to interpret biological phenomena in the light of evolution.

Suggested Reading:

1. Alfred, J.R.B and Ramakrishna. 2004. Collection, Preservation and Identification of Animals. Zoological Survey of India Publications, Calcutta.
2. Anderson T.A.2001. Invertebrate Zoology (2edn). Oxford University Press, New
3. Kapoor V.C. 1991.Theory and Practice of Animal Taxonomy. Oxford and IBH Publishing Co., Pvt. Ltd. New Delhi.
4. Young J.Z. 1950. Life of Vertebrates. Clarendon Press, Oxford, UK.
5. Winston J.E.2000. Describing species: Practical Taxonomic Procedures for Biologists. Columbia University Press, Columbia, USA.
6. Simpson G.G. Principle of animal taxonomy. Oxford IBH Publishing company.
7. Mayer E. Elements of Taxonomy. Oxford IBH Publishing company.
8. Minnelli A. (1993). Biological Systematics. Chapman & Hall.
1. Futuyma, Douglas J. and Kirkpatrick Mark. Evolution (4th Edition) Sinauer
2. Veer Bala Rastogi (2017) Organic Evolution. Med Tech
3. Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger Pub. Co.
4. Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.
5. Dawkins, Richard. "The selfish gene: with a new introduction by the author." UK: Oxford University Press.
6. Dawkins, R. (1996). The blind watchmaker: Why the evidence of evolution reveals a universe without design. WW Norton & Company.
7. Darwin, Charles (2003). The Origin of Species: 150th Anniversary Edition
8. Huxley Julian. Evolution: The Modern Synthesis. Harper and Brothers
9. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India

Assignments (any one)

1. Project (500 words) highlighting recent advancements.
2. Presentation highlighting recent advancements.
3. Analytical MCQ based questions
4. Biological Crosswords
5. Charts
6. 500 words answer to analytical questions

Semester II

Course Code- P3
Ecology and Environmental Biology

TotalCredits: 04 **Teaching Hours:60**

Courseobjectives

- To develop in the student an understanding of ecosystem structure and function
- To understand community interactions and succession.
- To develop inthestudentanunderstanding ofenvironmentalstructureand function
- Todevelopinthestudentanunderstandingofglobalenvironmentalissues,policiesand practices.
- Tolearnaboutthefactorspollutingtheenvironment,theirimpactsandcontrolmeasures
- To learn about environmental management

UnitI

Concepts of Ecosystem

Ecology: Definition, ecological hierarchy	1
Ecosystem:concept,types and structural components	3
Ecosystem functions: Energy flow and Biogeochemical cycles	4
Trophiclevels, FoodchainandFoodweb	2
Population:characteristics,growthandregulation	5

Unit II

Ecological Features

Inter specificinteractions	3
Ecological succession	3
Ecologicalniche	2
r- andk-strategies	2
Ecological adaptations (aquatic,volant,arboreal,cursorial,fossorial and desert)	5

Unit III

Environmental pollution

Definition, consequences, management strategies.	1
Cause/source, consequences, preventive measures, and management of air, water, soil, radiation, noise and light pollution.	7
Environmental problems:	
The Green house effect: Cause, consequences, preventive measures.	2
Ozone depletion: Cause, consequences, preventive measures.	2
Acid rain: Cause, consequences, preventive measures.	2
Environmental Footprints	1

Unit IV

Environmental Management Strategies

Environmental awareness, including resource conservation and sanitation.	3
Environmental legislation: The Environment Protection Act (1986), The National Green Tribunal Act (2010).	2
United Nations Environment Programme (UNEP).	
Recent Conventions	2
Environmental Monitoring: Methods, components and significance	4
Waste management: Sanitary landfill, Composting, Incineration and pyrolysis.	4

Courselearningoutcomes:

At thecompletionofthecourse,thestudent willbeableto:

- Understandthebasicconceptofecology,structureandfunctionofecosystemandits management.
- Understand,interpret and explain how interactions between organisms and their environments drive the dynamics of individuals, populations, communities, and ecosystems.
- Applythescientificmethodandtechniquestodescribe,monitorandmanageenvironmental pollutions.
- Develop critical thinking for shaping strategies (scientific, social, and legal) for environmental protection and conservation of biodiversity and sustainable development.
- Understand the characteristics ofpopulationand its dynamics and illustrate how populationdata can be analyzed using statistics, graphs, life tables, and survivorship curves.

Suggested Reading:

1. OdumE.P.(2005)*FundamentalsofEcology*.CengageLearningIndiaPrivateLimited
2. SmithThomasM.SmithRobertLeo(2014)*ElementsofEcology*.PearsonEducation
3. Krebs, CharlesJ. 2009.*Ecology:theexperimentalanalysisofdistributionandabundance.* Pearson.
4. SharmaPD(2018).*FundamentalsofEcology*.RastogiPublications.
5. SharmaPD(2018).*Environmental BiologyandToxicology*.RastogiPublications.
6. Pepper,I.L.,Gerba,C.P.&Brsusseau,M.L.2006.*Environmental &PollutionScience*. Elsevier Academic Press.
7. Gupta, KR (2006).*EnvironmentalLegislationinIndia*. AtlanticPublishersandDistributors.
8. Purohit,S.S.&Ranjan,R. (2007).*Ecology,Environment&Pollution*.AgrobiosPublications.
9. Thangavel,P.&Sridevi,G. (2015).*EnvironmentalSustainability:Roleof Green Technologies*, Springer Publications.
10. Wooley,T.&Kimmins, S. (2002).*GreenBuildingHandbook*(Vol.1&2). SponPress
11. Darlington.P.J., (1957).*TheZoogeography: TheGeographicalDistributionofAnimals.* WileyPublication.
12. Caughley,G.,andSinclair,A.R.E.(1994). *WildlifeEcologyandManagement*.BlackwellScience.

Assignments(anyone)

1. Project(500words)/presentationbasedontheabovecoursecontent
2. AnalyticalMCQbased questions
3. BiologicalCrosswords
4. Charts
5. 500words answer toanalyticalquestions
6. Surveysoflocalecosystemsandsubmissionofreport.

Semester III

Course Code- P5
Diversity and Biology of Chordata

Total Credits: 04 **Teaching Hours: 60**

Course objectives

- To create in the student an appreciation of chordate diversity
- To develop in the student an understanding of structural and functional diversity
- To develop in the student the understanding of evolutionary relationship amongst chordates

Unit I

Phylum Chordata **3**
General characteristics and outline classification up to subclass level
Origin of chordata

Sub-phylum Urochordata **6**
General characters and classification up to order level
Type study of*Herdmania*
Affinities and systematic position

Sub-phylum Cephalochordata **6**
General characters and classification up to order level
Type study of*Branchiostoma*
Affinities and systematic position

Unit II

Agnatha **1**
General characters and classification up to order level

Pisces **9**
General characters and classification up to subclass level
Type study of *Scoliodonsorrakowah*
Accessory respiratory organs
Migration

Amphibia **5**
General characters and classification up to order level
Parental care
Neoteny/ Paedogenesis

Unit III

Reptilia **5**
General characters and classification up to order level
Affinities of *Sphenodon punctatus*
Venomous &non-venomous snakes of India and their biting mechanism
Dinosaurs

Aves **5**
General characters and classification up to order level
Archaeopteryx – a connecting link
Types of feathers
Flight adaptations

Migration

Mammalia **5**

General characters and classification up to order level
Dentition
Affinities of Prototheria
Adaptive radiation with reference to locomotory appendages

Unit IV

Comparative functional anatomy of vertebrates **15**

Integument, digestive system, circulatory system, urinogenital system, nervous system and sense organs

Course learning outcomes:

At the completion of the course, the student will be able to:

1. understand and appreciate the diversity of life with respect to chordate animals.
2. describe the general characters of chordate animals.
3. identify and classify chordate animals on the basis of their form and structure and classification.
4. explain evolutionary relationships amongst different chordate groups.
5. obtain an overview of economically important vertebrates.

Suggested Reading:

1. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford University Press.
2. Kenneth V. Kardong (2015). Vertebrates: Comparative Anatomy, Function, Evolution. McGraw Hill
3. Thomas Jeffrey Parker, William A. Haswell (2016) Parker & Haswell's A Textbook of Zoology Volume 2. WENTWORTH Press
4. Eroschenko, Victor P. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins
5. Kotpal R.L. (2018) Modern Text Book of Zoology: Vertebrates. Rastogi Publications
6. Nigam H.C. (2017) Biology of Chordates. Vishal Publishing Co

Assignments (Any one)

1. Project (500 words)/ presentation based on the above course content
2. Analytical MCQ based questions
3. Biological Crosswords
4. Charts
5. 500 words answer to analytical questions
6. Study based report of animals in nature
7. Outreach activities promoting dissolution of superstitions associated with animals
8. Photography, identification and listing of local fauna

Course Code- P6
Animal Behaviour and Chronobiology

Total Credits: 04 **Teaching Hours: 60**

Course objectives
The course is so designed that students will learn:

- animal behaviour in the context of evolutionary and ecological biology,
- historical background and theory for animal behaviour concepts,
- recent approaches in animal behaviour,
- how the rhythmic geophysical environment impacts the internal rhythms,how environmental cues are perceived by the organisms and modulate the circadian physiology at molecular, cellular and systems levels, and the relevance of biological clock

Unit I

Introduction, patternsand regulation of behaviour

What is Animal Behaviour?	1
Proximate/Ultimate Approaches to the Study of Behaviour	3
Classification and Description of Behaviours: stereotypic (orientation, reflexes), instinct, learning, memory, imprinting, habituation, sensitization, sensory filtering, responsiveness	7
Associative learning: classical and operant conditioning	4

Unit II

Social behaviour

Foraging Behaviour	2
Communication	2
Social Behaviour	2
Dominance and Territoriality	2
Sexual Selection	2
Mating Systems	2
Parental Care	2
Kin selection	1

Unit III

Biological clocks and rhythms

Biological clocks and adaptive significance	2
Biological rhythms: circadian, tidal, lunar, circannual rhythms and their characteristics	6
Zeitgebers	
Concept of entrainment and masking	5
Photoreception	2

Unit IV

Applications of biological clocks

Suprachiasmatic nucleus (SCN)	2
Molecular mechanism underlying clock function	3
Seasonal migration	4
Brain waves and Electro Encephalogram (EEG)	3
Jet lag, Seasonal Affective Disorder (SAD), Internal desynchronisation	3

Course learningoutcomes:

At the completion of the course, the student will be capable of:

- Understanding and identify behaviours in a variety of taxa
- discussing the proximate and ultimate causes of various behaviours
- designing and implementing experiments to test hypotheses relating to animal behaviour
- understanding about the molecules, cells, and systems of biological timing systems
- conceptualizing how species profitably inhabit in the temporal environment and space out their activities at different times of the day and seasons.
- studying and analysing the scientific literature contributing to public understanding of biological timing

Suggested Reading:

1. Alcock John (2013). Animal Behavior: An Evolutionary Approach. Sinauer
2. Manning & Dawkins: An Introduction to Animal Behaviour (5th ed. 1998, Cambridge).
3. Mcfarland : Animal Behaviour, Psychology, Ethology and Evolution (1985, Pitman).
4. Mathur Reena (2018). Animal Behaviour. Rastogi Publications
5. Dunlap Jay. C., Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004,Chronobiology: Biological Timekeeping: Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
6. Saunders, D.S., C.G.H. Steel, X., Afopoulou (ed.)R.D. Lewis. (3rdEd) 2002 Insect Clocks Barens and Noble Inc. New York, USA
7. Moore et al. 1982. The Clock that times us.

Assignments (any one)

1. Project (500 words) highlighting recent advancements.
2. Presentation highlighting recent advancements.
3. Analytical MCQ based questions
4. Biological Crosswords
5. Charts
6. 500 words answer to analytical question.
7. Ethological observations in the form of photographs or video with scientific background of the behaviour observed

Semester IV

Course Code- P7
Animal Physiology

Total Credits: 04 **Teaching Hours: 60**

Course objectives

- To develop in the student an understanding of functioning of an organisms' body
- To develop in the student an understanding of the various homeostatic systems of the body
- To develop in the student an understanding of regulation of function in the body

Unit I

Digestion **8**

Physiology of digestion and absorption of protein, carbohydrates and lipid
Role of Gastrointestinal hormones in digestion

Respiration

7Respiratory Pigments, Oxygen dissociation curves, and Bohr's Effect
Respiratory volumes and capacities
Transport of oxygen and carbon dioxide in blood

Unit II

Circulation **8**

Composition and constituents of blood
Blood groups and Rh factor
Factors and mechanisms of blood coagulation
Cardiac cycle

Excretion **7**

Structure of nephron
Urine formation
Osmoregulation

Unit III

Nerve Physiology **8**

Structure of neuron
Conduction of nerve impulse
Synapse and Synaptic transmission
Neurotransmitters

Muscles **7**

Types of muscles
Mechanism of contraction of skeletal muscles

Unit IV

Endocrine glands **8**

Structure and function of endocrine glands: pituitary, pineal, thyroid, parathyroid, pancreas, adrenal and gonads.

Reproduction **7**

Physiology of reproduction, puberty and menopause

Courselearning outcomes:

At the completion of the course, the student will be able to:

1. understand various functional components of the body
2. understand the mechanism underlying maintenance of homeostasis of the body
3. have an enhanced knowledge and appreciation of mammalian physiology;
4. understand the functions of important physiological systems including the cardio-respiratory, renal, reproductive and metabolic systems;
5. understand how these separate systems interact to yield integrated physiological responses to challenges such as exercise, fasting and ascent to high altitude, and how they can sometimes fail;

Suggested Reading:

1. Christopher D. Moyes, Patricia M. Schulte(2016). Principles of Animal Physiology. 3rd Edition, Pearson.
2. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
3. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons.
4. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, Mcgraw Hills.

Assignments (any one)

1. Project (500 words) highlighting recent advancements.
2. Presentation highlighting recent advancements.
3. Analytical MCQ based questions
4. Biological Crosswords
5. Charts
6. 500 words answer to analytical questions
7. Outreach activities promoting awareness of physiological and immunological diseases and disorders.
8. Surveys on health indices, disease spread in family, neighbourhood, communities.

Semester V

Course Code- P9
Cell Biology & Genetics

Total Credits: 04 **Teaching Hours: 60**

Course objectives

- To understand the structure and function of organelles in a cell
- To understand the DNA structure & types, chromatin structure and organization
- To understand the process of cell division and growth
- To understand the basics of heredity

Unit I

Structure and Function of Cell Organelles

Plasma membrane, Cell-cell interaction: cell adhesion molecules, cellular junctions	4
Endomembrane system: protein targeting and sorting	4
Cytoskeleton: microtubules, microfilaments, intermediate filaments	4
Mitochondria, Peroxisome, and ribosome	3

Unit II

Nucleus and Chromatin Structure

Structure and function of the nucleus in eukaryotes	2
Chemical structure and base composition of DNA and RNA	2
Chromatin organization, Structure of chromosomes	2
Cell cycle, Cell Division and cell cycle regulation	9

Unit-III

Genetics I

Basic principles of heredity: Mendel's laws of Inheritance	4
Complete and Incomplete Dominance	1
Linkage and Crossing over	3
Sex Determination; Sex-linked inheritance and Dosage compensation	5
Sex-Influenced and Sex-Limited traits	2

Unit IV

Genetics II

Multiple Alleles, Gene-gene interaction	5
Cytoplasmic Inheritance, Genetic Maternal Effects; Genomic Imprinting.	4
Interaction between Genes and Environment	3
Inheritance of continuous, meristic, and threshold characters	3

Course learningoutcomes:

The student after the course will be able to:

1. Understand the structure and function of all the cell organelles.
2. Know about the chromatin structure and its location.
3. To be familiar with the basic principle of life, how a cell divides leading to the growth of an organism and also reproduces to form new organisms.
4. Understand the basic laws of inheritance.

Suggested Reading:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Pierce B. Genetics. Freeman (2004).

Assignments (any one)

1. Project (500 words)/ presentation based on the above course content
2. Analytical MCQ based questions
3. Biological Crosswords
4. Charts
5. 500 words answer to analytical questions

Course Code- P10
Developmental Biology and Immunology

Total Credits: 04 **Teaching Hours: 60**

Course objectives
The objective of this course is to provide insight on:

- The key events related to early embryogenesis including fertilization, cleavage, compaction. implantation, gastrulation and formation of body plan.
- how the single cell formed at fertilization forms an embryo and then a fully formed adult organism.
- integration of genetics, molecular biology, biochemistry, cell biology, anatomy and physiology during embryonic development, and.
- To develop basic understanding about Immunity, its organization and their mechanisms.
- To understand in detail the basic immune mechanism related to different Immunological diseases & disorders.
- To create and develop the ideology about different vaccines, immune treatment mechanisms, autoimmunity and hypersensitivity.

Unit I

Early embryonic development

Gametogenesis (spermatogenesis and oogenesis)	2
Fertilization (external and internal)	1
Egg: structure and types	2
Morphogenesis and morphogens	1
Cleavage	2
Blastulation	1
Fate Maps	2
Gastrulation	2
Stem cells	1
Cell lineage	1

Unit II

Late embryonic development

Chick embryo development upto primitive streak formation	4
Embryonic induction and organizers	3
Extra embryonic membranes	2
Placenta: types and physiology	2
Modes and mechanisms of regeneration	2

Unit III

Overview of the immune system

Immunity: concept and types	3
Cells and organs of immune systems	3
Immunoglobulins: types and structure of different classes	3
Antigen and antibodies and their interactions	3
Autoimmunity	3

Unit IV

Immunpological mechanisms and applications

Major Histocompitability Complex	3
Cytokines: properties and functions	3
Vaccines of different diseases and immunological reactions	3

Hybridoma technology	3
Monoclonal antibodies	3

Course learning outcomes:

At the completion of the course, the student will be able to:

1. understand how the single cell formed at fertilization forms an embryo and then a full adult organism
2. a variety of interacting processes, which generate an organism's heterogeneous shapes, size, and structural features,
3. how a cell behaves in response to an autonomous determinant or an external signal, and
4. an in depth understanding about Immune System &it's elaborate mechanisms.

Suggested Reading:

1. Gilbert, Scott F. and Barresi, Michael J. F. Developmental Biology. Eleventh Edition. By. Sunderland (Massachusetts): Sinauer Associates
2. Carlson BM. (1988). Patten's Foundations of Embryology. 5th ed. New York: McGraw-Hill.
3. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby (2007) Kuby Immunology. W H Freeman
4. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. (2017). Roitt's Essential Immunology, 13th Edition. Wiley Blackwell
5. Nandini Shetty (2005) Immunology Introductory Textbook. New Age International.

Assignments (any one)

1. Project (500 words) highlighting recent advancements.
2. Presentation highlighting recent advancements.
3. Analytical MCQ based questions
4. Biological Crosswords
5. Charts
6. 500 words answer to analytical question
7. Outreach activities promoting awareness of developmental disorders
8. Projects observing metamorphosis in insects and amphibians

Internship/ Term Paper/ Minor Project

Total Credits: 4

Course objectives

- To allow the students to explore the realm of research that is being performed within the department.
- To strengthen the understanding of the fundamentals through effective application of theoretical concepts.
- To help the studentsdevelop writing and communication skills.
- Provide opportunity to gain real-world experience in their chosen fields.
- To organize their thoughts, develop their ideas, and present their findings in a clear and concise manner.

Semester VI

Course Code- P11
Molecular Biology and Biochemistry

Total Credits: 04 **Teaching Hours: 60**

Course objectives

- Toequipthestudentsto understandthe basicmechanismand molecularbasis ofheredity
- To appreciate the structure and function of biomolecules– proteins, lipids and carbohydrates
- To understand the structure and function of enzyme and enzyme thermodynamics

Unit I

DNA replication and Transcription

Fine structure of gene	1
Replication Enzymes involved in replication	2
Initiation, elongation and termination of replication in prokaryotes and eukaryotes	4
Transcription: RNA polymerases, Transcription factors	3
Initiation, elongation and termination of transcription in prokaryotes and eukaryotes	5

UNIT II

Translation and Gene Regulation

The genetic code, ribosome, tRNA	3
Initiation, elongation and termination of translation in prokaryotes and eukaryotes	3
Regulation of gene expression in prokaryotes	4
Regulation of gene expression in eukaryotes	4

Unit III

Biomolecules

Composition, structure and function of biomolecules (carbohydrates, lipids, proteins and nucleic acids).	5
Vitamins and co-enzymes	4
Classification and nomenclature of enzymes, Co-factors	2
Mechanism of enzyme action and regulation, enzyme kinetics (Michaelis-Menten equation, LB Plots, enzyme inhibition)	4

Unit IV

Metabolism

Concept of metabolism	1
Carbohydrates: glycolysis, citric acid cycle, glycogenesis, gluconeogenesis, glycogenolysis, phosphate pentose pathway.	6
Oxidative phosphorylation	2
Lipid metabolism	3
Amino acids: transamination & deamination and urea cycle	3

Course outcomes:

At the completion of the course, the student will be able to:

- A clear understanding of the processes of central dogma viz. transcription, translation etc. underlying survival and propagation of life at molecular level.
- Understanding of how genes are ultimately expressed as proteins which are responsible for the structure and function of all organisms.
- Learn how four sequences (3 letter codons) generate the transcripts of life and determine the phenotypes of organisms.
- How genes are regulated differently at different time and place in prokaryotes and eukaryotes.
- Evaluate and estimate biomolecules.

Suggested Reading:

1. Nelson & Cox: Lehninger's Principles of Biochemistry: McMillan (2000)
2. Zubay et al: Principles of Biochemistry: WCB (1995)
3. Voet&Voet: Biochemistry Vols 1 & 2: Wiley (2004)
4. Murray et al: Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott: Biochemistry and Molecular Biology: Oxford University Press
5. Cooper: Cell: A Molecular Approach: ASM Press (2000).
6. Karp: Cell and Molecular Biology: Wiley (2002).
7. Watson et al. Molecular Biology of the Gene. Pearson (2004).
8. Lewin. Genes VIII. Pearson (2004).
9. Pierce B. Genetics. Freeman (2004).

Assignments (any one)

1. Project (500 words)/ presentation based on the above course content
2. Analytical MCQ based questions
3. Biological Crosswords
4. Charts
5. 500 words answer to analytical questions
6. Study based report of animals in nature

Course Code- P13A
Wildlife

Total Credits: 04 **Teaching Hours: 60**

Course objectives

- To make the students aware of natural resources, their protection and conservation
- To learn about the factors polluting the environment, their impacts, and control measures
- To develop in the student an understanding of the significance and conservation of wildlife

Unit I

Classification and Features

Classification, morphological features, main differences and identifying features of Butterflies, Moths.	3
Caecilians, Salamanders, Frogs, Toads.	2
Venomous & Non- Venomous Snakes	3
Turtles, Tortoises & Terrapins.	2
Crocodiles, Alligators, Gharials.	2
Herbivore and Carnivore Mammals.	3

Unit II

Wildlife Conservation Rules and Regulations

IUCN, Red Data List	3
Wildlife Protection Act 1972, Central Zoo Authority, CITES, RAMSAR Convention.	4
Wildlife trafficking & Trade, Role of TRAFFIC, CAWT, MIKE.	4
Project: Cheetah, Tiger, Rhinoceros, Elephant	4

Unit III

Conservation Strategies

In-Situ (National Parks, Wildlife Sanctuaries, Biodiversity Reserves)	3
Ex-Situ Conservation (Gene banks, Rehabilitation centres, Zoological gardens)	4
Traditional Knowledge and Wildlife: Heritage sites & sacred grooves.	3
Man and Animal Conflict	3
Eco-tourism	2

Unit IV

Tools and Techniques

Survey and sampling techniques	4
Bio-telemetry, GPS & GIS mapping	4
Pugmark identification	3
Camera, camera traps, Binoculars, Laser Range finder	4

Course learningoutcomes:

At the completion of the course, the student will be able to:

- enable the student to understand, compare, think, and evolve strategies for wildlife management, conservation, and causes of wildlife depletion.
- evaluate the renewable and non-renewable resources, compile different measures for forest conservation, and determine different energy sources.

Suggested Reading:

1. Odum E.P. (2005) *Fundamentals of Ecology*. Cengage Learning India Private Limited
2. Smith Thomas M., Smith Robert Leo (2014) *Elements of Ecology*. Pearson Education
3. Krebs, Charles J. 2009. *Ecology: the experimental analysis of distribution and abundance.* Pearson.
4. Gupta, K.R. 2006. *Environmental Legislation in India*. Atlantic Publishers and Distributors.
5. Purohit, S.S. & Ranjan, R. 2007. *Ecology, Environment & Pollution*. Agrobios Publications.
6. Thangavel, P. & Sridevi, G. 2015. *Environmental Sustainability: Role of Green Technologies*, Springer Publications.
7. Wooley, T. &Kimmins, S. 2002. *Green Building Handbook* (Vol. 1&2). Spon Press
8. Darlington. P.J., 1957. *The Zoogeography: The Geographical Distribution of Animals.* Wiley Publication.
9. Caughley, G., and Sinclair, A.R.E. (1994). *Wildlife Ecology and Management*. Blackwell Science.

Assignments (any one)

1. Project (500 words)/ presentation based on the above course content
2. Analytical MCQ based questions
3. Biological Crosswords
4. Charts
5. 500 words answer to analytical questions
6. Surveys of local ecosystems and submission of report.

Course Code- P13B
Toxicology

Total Credits: 04 **Teaching Hours: 60**

Course objectives

- To provide theoretical and applied knowledge on the effects of chemical substances on human health.
- To introduce the students to the toxicological analysis and the signs and symptoms of important toxic syndromes.
- To learn and apply toxicity tests for terrestrial and aquatic animals
- To develop an understanding of xenobiotics, their mode of action, and the damage caused
- To explain specific responses to Toxicity

Unit I

Exposure to toxicants

Different routes/methods of exposure, frequency & duration of exposure	
Human exposure	2
Dose-response relationship	1
Selective toxicityconcept, significance, Basic mechanisms of selective toxicity	2

Toxicity Tests

Bioassay	2
Acute toxicity tests for terrestrial and aquatic animals	2
Chronic toxicity tests	2
Concept of maximum acceptable toxicant concentration (MATC) and safe concentration	2

Factors affecting toxicity

Factors related to the chemical exposure	1
Surrounding medium and the organisms	1

Unit II

Toxic effects of Xenobiotics

Local and systemic effects	1
Immediate and delayed effects	1
Reversible and irreversible effects	1
Biochemical and Physiological Effects	2
Nanotoxicology	1

Bioaccumulation of Xenobiotics

Concept of bioconcentration, bioaccumulation and biomagnification	
Bioconcentration factor	2
Process of bioaccumulation in the biological system	1

Biotransformation of Xenobiotics

Concept of biotransformation and metabolism	2
Sites of biotransformation	1
Biotransformation enzymes and general biotransformation reactions	1
Factors affecting biotransformation	1
Antidotal therapy	1

Unit III

Toxic effects on systems

Digestivesystem	2
Circulatory system	2
Respiratory system	2
Excretory system	2
Reproductive system	2
Endocrine system	3
Nervous system	2

Unit IV

Toxic effects

Mutagenicity	2
Teratogenicity	2
Carcinogenicity	2
Toxicogenomics	2
Safety evaluation of xenobiotics	2
Regulatory Toxicity	5

Course learning outcomes:

At the completion of the course, the student will be able to:

- examine the application how xenobiotics disrupt normal cellular processes of genomics, proteomics, and metabolomics data
- use clinical and laboratory findings in the treatment of acute toxic exposures
- understand the xenobiotics, their categories and effects on organisms
- understand mechanisms of systemic and organ toxicity induced by xenobiotics; and learn how to analyze and interpret complex data sets in toxicological research

Suggested Reading:

1. Sharma PD (2018). Environmental Biology and Toxicology. Rastogi Publications
2. Klaassen, C. & Watkins, J. (2005) Casarett&Doull's Essentials of Toxicology, 3rd edition. Lange Publications
3. Ernest Hodgson (2010) A Textbook of Modern Toxicology. Wiley
4. Beddows, C. (2017) Comprehensive Toxicology. Elsevier

Assignments (any one)

1. Project (500 words) highlighting recent advancements.
2. Presentation highlighting recent advancements.
3. Analytical MCQ based questions
4. Biological Crosswords
5. Charts
6. 500 words answer to analytical questions

Semester VII

Course Code- P15
Bioinstrumentation & Biostatistics

Total Credits: 04 **Teaching Hours: 60**

Courseobjectives:

- To know the principle and working of instruments in a biology laboratory
- To study the basics and application of Biostatistics

Unit- I

Bioinstrumentation - I

Microscopy: Light microscopy, phase-contrast microscopy, fluorescence microscopy, electron microscopy. 5

Chromatography: Paper, thin layer, Column: ion exchange, gel filtration and affinity chromatography. 5

Centrifugation: types of centrifuges and rotors 3

Colorimeter and Spectrophotometer 2

Unit-II

Bioinstrumentation - II

Gel Electrophoretic apparatus 2

Gel documentation system 1

ELISA Plate Reader 2

PCR-Thermocycler 2

SDS PAGE 2

Blotting Techniques (Southern, Northern and Western) 3

pH meter 1

Laminar flow 1

Weighing Balances 1

Unit-III

Biostatistics- I

Descriptive statistics: 5

Data summarizing: frequency distribution, graphical presentation-bar, pie, histogram

Monovariate analysis: 10

Mean, median, mode, variance, mean deviation, standard deviation and standard error

Coefficient of variation, Skewness, Kurtosis

Probability and its applications

Unit-IV

P15: Biostatistics - II

Bivariate analysis: 5

Correlation and regression

Tests of significance: 10

Null hypothesis

t-test, Chi-square test, ANOVA (one – way and two - way) and F-test

Courselearningoutcomes:

After successfully completing this course, students will be able to:

- Understand the principles and applications of basic laboratory methods and instruments
- Imply appropriate tools and techniques to solve the problems and figure out the downstream

events in biological sciences

- Understand and ensure uniformity, consistency, reliability and reproducibility of his experimental data

Suggested Reading:

1. John E. Havel, Raymond E. Hampton, Scott J. Meiner:s: Introductory Biological Statistics, Fourth Edition
2. Khan & Khanum:Fundamentals of Biostatistics
3. Webster, J. G. (2004). Bioinstrumentation. John Wiley & Sons Incorporated
4. Enderle, J. (2005). Bioinstrumentation. In Introduction to Biomedical Engineering (pp. 403-504). Academic Press
5. Reilly, M.J. (2016) Bioinstrumentation. CBS Publishers & Distributor
6. Ross, M.H. and Reith, E.J. (1995). Histology A Text and Atlas. Harper International Edition
7. Kiernan J.A. (2015) Histological and Histochemical Methods: Theory and Practice. Pergamon Press
8. Sundar Rao P.S.S. and Richard J. (2012). Introduction to Biostatistics and Research Methods. PHI Learning Private Limited
9. Sokal R.R. and Rohlf F.J. (2009). Introduction to Biostatistics. Dover Publications.

Assignments(anyone)

1. Project(500words)highlightingrecentadvancements.
2. Presentationhighlightingrecent advancements.
3. AnalyticalMCQbasedquestions
4. BiologicalCrosswords
5. Charts
6. 500wordsanswertoanalyticalquestions

Course Code- P16
Economic Zoology

Total Credits: 04 **Teaching Hours: 60**

Course objectives

- To analyse the relationships among animals, plants and microbes
- To understand the applications of biological sciences in Lac culture, Sericulture, Apiculture, Aquaculture, Poultry and Vermicomposting
- To explain the tools and techniques used in various cultures
- To explain the modifications and adaptations in animals

Unit I

Common Vectors and Pests

Description, Economic importance and Management of:	8
Vectors: House fly, Mosquitoes, Rat Flea	
Pests: Roaches, Sugarcane leaf hopper, Rice Weevil	7

Unit II

Common infectious and communicable diseases

The causative agents and prophylaxis of:	
Amoebiasis	2
Tuberculosis	2
AIDS	2
COVID	2
Malaria	3
Dengue	2
Filaria	2

Unit III

Applied Zoology – I

Concept, importance, products, producing insects: their host plants, life cycle, management of their diseases and pests	
Lac culture	5
Sericulture	5
Apiculture	5

Unit IV

Applied Zoology – II

Concept and Managementof:	
Aquaculture: Pisciculture, Prawn culture, Pearl cultureand their byproducts	6
Poultry	5
Vermiculture	4

Course learning outcomes:

At the completion of the course, the student will be able to:

- understand the life history of vectors and pests, the diseases caused and their control
- understand the life history of parasites of domestic animals
- gain knowledge of Agro based Small Scale industries
- study the culture of various organisms for economic benefit
- have a broad array of career options and activities in human medicine, biomedical research and allied health professions

Suggested Reading:

1. Nigam H C (2014) Emerging Trends in Biology & Economic Zoology. Vishal Publishing Co.
2. Shukla GS & Upadhyay VB (2017) Economic Zoology Rastogi Publications
3. Srivastava KP and Dhaliwal GS. Textbook of Applied Entomology Volume 1 & 2. Kalyani Publishers.
4. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
5. Simpson: Principles of Animal Taxonomy (1962, Oxford).
6. Mayer & Ashlock: Principles of Systematic Zoology (2nd Edition, McGraw Hill).
7. Kapoor: Theory and Practicals of Animal Taxonomy (1988, Oxford & IBH).
8. Zar JH (2010) Biostatistical Analysis. 5th Edition. Pearson.
9. Sokal, R. R., &Rohlf, F. J. (1981). Biometry: The principles and practice of statistics in biological research. San Francisco: W.H. Freeman

Assignments (any one)

1. Project (500 words) highlighting recent advancements.
2. Presentation highlighting recent advancements.
3. Analytical MCQ based questions
4. Biological Crosswords
5. Charts
6. 500 words answer to analytical questions

Course Code- P18A
Principles of Endocrinology

Total Credits: 04 **Teaching Hours: 60**

Course objectives
The objective of this course is to focus on:

- helping the students to understand the basics of endocrinology
- knowing the structure and function of endocrine glands.
- imparting knowledge about the endocrine regulation of different body functions.
- understanding the integrative working of signaling system in maintaining homeostasis.
- the endocrine disorders, their causes and symptoms

Unit I

Introduction to Endocrinology

Definition, classification and characteristics of chemical messengers (hormones, neurohormones, neurotransmitters)	4
Endocrine signaling: Endocrine, paracrine and autocrine modes	3
General mechanism of hormone action	4
Endocrine hypothalamus	4

Unit II

Hypothalamo-hypophysial system

Structure of the hypothalamo-hypophysial system	3
Hormones of the adenohypophysis	3
Hypothalamic control of adenohypophysis	3
Neurohypophysial hormones	3
Neuroendocrine integration of hormones	3

Unit III

Endocrine glands: their Structure and functions

Pituitary	2
Thyroid	2
Parathyroid	2
Endocrine pancreas	2
Adrenal	2
Gastrointestinal Tract	2
Sex glands	3

Unit IV

Endocrine disorders and pathophysiology

Diabetes insipidus	2
Dwarfism, gigantism and acromegaly	3
Hypopituitarism	1
Adrenal insufficiency	1
Hyperthyroidism and Hypothyroidism	1
Cushing's syndrome	1
Diabetes mellitus (Type I and II)	2
Osteoporosis	2
Polycystic ovary syndrome	2

Course learning outcome

The course will enable the students:

- To develop an understanding of the basic endocrinology
- To study the endocrine regulatory molecules mediating physiology and behavior
- To study the neural and endocrine components of physiological function and neuroendocrine regulation
- To understand the role of hormones in metabolic regulation, seasonality and maintaining homeostasis
- To understand the integrative working of signaling system

Suggested Reading:

1. Endocrinology: Mac E. Hadley, Jon E. Levine, 2009, 6th Edition, Pearson Education
2. Vertebrate Endocrinology: David O. Norris, James A. Carr, 2013, 5th Edition, Academic Press
3. Williams Textbook of Endocrinology: H. M. Kronenberg, S. Melmed, K. S. Polonsky and P. R. Larsen, 2008, 11th Edition, Saunders, Elsevier
4. An Introduction to Neuroendocrinology: Richard E. Brown, 2005, Cambridge University Press

Assignments (any one)

1. Project (500 words) highlighting recent advancements.
2. Presentation highlighting recent advancements.
3. Analytical MCQ based questions
4. Biological Crosswords
5. Charts
6. 500 words answer to analytical questions

Course Code- P18B
Fundamentals of Entomology

Total Credits: 04 **Teaching Hours: 60**

Course objectives

The objective of this course is to:

- Develop understanding of Insect taxonomy, diversity and identification
- Introduce students with the morphology, anatomy and physiology of insects
- Introduce students with the significance of insects
- Make students aware of pest management

Unit I

Insect taxonomy I

General organization of the insect body	4
General Organization of insect head, thorax and abdomen	6
Overview of insect classification with emphasis on economically important insects	5

Unit II

Insect Physiology I

Integument	3
Digestive system	3
Circulatory system	3
Respiratory system	3
Endocrine system	3

Unit III

Insect Physiology II

Nervous system and sense organs	3
Reproductive system	3
Various modes of reproduction	3
Insect Development	2
Communication in insects	4

Unit IV

Applied Entomology

Insects of Medical and Veterinary Importance	4
Components of Insect Pest Management including Mechanical, Physical, Cultural, Chemical,Legal, Ecological, Biological, Microbial, Recent trends.	5
Concept and Procedure of Integrated Pest Management	2
Mode of action of organochlorine, organophosphorus and carbamate pesticides,	2
Pyrethroids and neem products.	2

Course learning outcomes

At the end of the course the students will be able to demonstrate:

- Classification and identification of insects
- Understand morphology, anatomy & physiology of insects
- understanding of pest population dynamics
- understanding of pest management measures

Suggested Reading:

1. Richards, O. W., & Davies, R. G. (1997). Imms' General Textbook of Entomology, Volume I: Structure, Physiology and Development. London, Chapman and Hall.
2. Imms, A. D., Richards, O. W., & Davies, R. G. (Eds.). (2012). Imms' General Textbook of Entomology: Volume 2: Classification and Biology. Springer Science & Business Media.
3. B. Danforth& C. Marshall. 2003. Eickworth's Manual of Insect Morphology. (Posted PDF files on Carmen.osu.edu.
4. Snodgrass, R.E. 1993 (originally 1935). Principles of Insect Morphology (with new forward by George Eickwort). Cornell University Press. 667pp.
5. Grimaldi, D.A. and M.S. Engel. 2005. Evolution of the Insects. Cambridge University Press. 755 pp.
6. Triplehorn, C.A. and N.F. Johnson. 2005. Borror and DeLong's Introduction to the Study of Insects, 7th edition. Thomson Brooks/Cole, Belmont, CA.
7. McGavin: Essential Entomology (2001, Oxford Univ Press)
8. Srivastava: A Text Book of Applied Entomology (Vol. I & II, 2nd ed.) Kalyani Publ., 2001
9. A Textbook of Applied Entomology Vol. I and II by Srivastava and Dhaliwal

Assignments (any one)

1. Project (500 words) highlighting recent advancements.
2. Presentation highlighting recent advancements.
3. Analytical MCQ based questions
4. Biological Crosswords
5. Charts
6. 500 words answer to analytical questions

Course Code- P18C
Fisheries

Total Credits: 04 **Teaching Hours: 60**

Course objectives

- The course has been designed in such a way so that the students get the knowledge ofboth theory and practical. It aims to enable the students to study Fish and Fisheries as entrepreneurs.
- The professional areas such as fish farming, aquaria management, and integrated fish farming have been included to make the study more interesting and job-oriented.
- The course has been designed in such a way that it will act as a platform for research and development.

Unit-I

Fish Morphology, Anatomy and Physiology

Fins, Scales & Tail: Types, structure and function	2
Food, feeding habits and digestion	2
Excretion & osmoregulation	2
Respiratory system: gills, physiology of respiration, air breathing organ, swim bladder	3
Circulatory system	2
Nervous system	1
Reproductive system: Gonads, reproductive cycle	2
Endocrine glands: structure and functions	1

Unit-II

Fish Biodiversity & Ecology of Teleostean Fishes

Fish Biodiversity	3
Stock (concept and structuring)	3
Fish Chromosome, Karyotyping and Chromosome manipulation	3
Water quality requirements	2
Exclusive economic zone	1
Aquarium fish and their maintenance	1
Induced breeding and Bundh Breeding (Indigenous and Exotic)	2

Unit – III

Aquaculture and Fish Pond Management

Problems and prospects of aquaculture	1
Polyculture and Monoculture	2
Integrated fish farming and their management	2
Construction and lay-out of different types of ponds (Nursery, Rearing and Stocking)	2
Formulation and operation of different types of Hatcheries	2
Productivity of the pond (Planktons and Live food organism)	2
Stocking materials (Spawn, Fry and Fingerlings)and their Culture	2
Manuring, liming, eradication of predatory and weed fishes, predatory aquatic insects and their control	2

Unit – IV

Fisheries, Fish products and Fish diseases

Freshwater fisheries, Cold water fisheries and Brackish water fisheries	3
Marine fish resources of India	2
Crustacean and Molluscan Fisheries	2
Fish preservation and processing (traditional and advanced methods)	2

Fish by-products 2
Fish diseases: prevention, prophylaxis and treatment of Fungal, Bacterial, Viral and Protozoan Diseases 3
Fish in relation to Man and Human Welfare 1

Course learning outcomes

At the end of the course the students will be able to:

- know the basic concepts of fish biology and fisheries which will enable the students to utilize the knowledge in fish biology researches and also to manage the fish under controlled conditions.
- understand the status of fish resources of India.
- have the concept of fish stocks, which will be helpful to mark the fast-growing individuals of the fish after correlation of morphometric and meristic characters to the growth potential and fecundity of the different groups of the fish belonging to the same species in order to have higher yield under pond culture.
- culture the fish in ponds which would generate job and livelihood.

Suggested Reading:

1. Lagler KF, Bardach, JE, Miller, RR, Passino DRM. 1977. Freshwater Fishery Biology byIchthyology, 2nd Ed. John Wiley & Sons, New York
2. Santosh Kumar and Manju Tembhre. 2011. Fish and Fisheries.
3. Moyle PB. 1982. Fishes: An introduction to ichthyology. Prentice-Hall, Englewood cliffs.
4. Jayaram KC. 2008. Fundamentals of Fish Taxonomy.
5. Gopal Ji Srivastava. 1995. Fishes of U.P. and Bihar.
6. Paul J.B. Hart and John D. Reynolds. 1979. Handbook of Fish Biology and Fisheries.
7. Brown ME. 1966. Physiology of fishes. Vol. I and II Academic Press. New York.
8. Hoar WS, Randall DJ and Donaldson EM. 1983. Fish Physiology. Vol. IX. Academic Press, New York
9. Jhingran VG. 1991. Fish and Fisheries of India, Hindustan Publishing Corporation.
10. A Hatchery Manual for the Common, Chinese and Indian Major Carps by V.G. Jhingran and R.S.V. Pullin, Asian Development Bank, ICLARM, Manila, Philippines
11. Reid GR.1961. Ecology and Inland waters and Estuaries. Rein Hold Corp., New York.
12. Pilley, TVR and Dill, WMA. 1979. Advances in Aquaculture. Fishing News Books, Ltd. England. 11.
13. Pillay TVR and Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.
14. Nikolsky GV. 1963. Ecology of Fishes, Academic Press.
15. Norman JR and Greenwood PH. 1975. A History of Fishes, Halsted Press.
16. Potts GW and Wootten RJ. 1984. Fish Reproduction: Strategies and Tactics, Academic Press.
17. De Silva SS & Anderson TA. 1995. Fish Nutrition in Aquaculture. Chapman & Hall Aquaculture Series.
18. Ojha JS. 2005. Aquaculture Nutrition and Biochemistry. Daya Publ.
19. Rath RK. 2000. Freshwater Aquaculture. Scientific Publ.

Assignments (any one)

1. Project (500 words) highlighting recent advancements.
2. Presentation highlighting recent advancements.
3. Analytical MCQ based questions
4. Biological Crosswords
5. Charts
6. 500 words answer to analytical questions

Course Code- P18D
Parasitology

Total Credits: 04 **Teaching Hours: 60**

Course objectives

- To give the students a basic understanding of the diversity of parasites of medical and veterinary importance.
- To make the students familiar with the fundamentals of parasite physiology, immunology, and ecology

Unit I

Introduction to Parasitology

General introduction; Basic definitions and concepts	3
Types of hosts and parasites	4
Types of parasite associations (phoresy, symbiosis, mutualism, symbiosis, parasitism)	5
Classification of parasites	3

UnitII

Morphology, biology, lifecycle and control of protozoan and arthropod parasites

Parasitic protozoans	8
Entamoeba	
Giardia	
Plasmodium	
Trypanosoma	
Parasitic arthropods	7
Ticks and mites	
Sucking lice	
Crustaceans & parasitic castration	

UnitIII

Morphology, biology, lifecycle, and control of helminth parasites

Parasitic trematodes (*Fasciola, Schistosoma*)	5
Parasitic cestodes (*Taenia, Echinococcus*)	5
Parasitic nematodes (*Ascaris, Ancylostoma*)	5

UnitIV

Physiology, immunology, and ecology of parasites

Fundamentals of digestion, excretion, and respiration in parasites	3
General principles of parasitic immunity and immune response, Host Defense	3
Parasite immune evasion, Parasitic granuloma	2
General concepts on parasite ecology, co-evolution of hosts and parasites	3
Population and Community Ecology	2
Parasites as bioindicators	2

Course learning outcomes

By the end of the semester, students will be able to:

- identify the most common parasites of medical and veterinary importance.

- discuss the parasite-host relationship and describe the effects parasites have on their hosts.
- describe the basic biology, life history, physiology, immunology, and ecology of selected parasites.

Suggested Reading:

1. Animal Parasitology by JD Smyth. Cambridge University Press.
2. Essentials of Parasitology by GD Schmidt. Brown Publishers
3. Foundation of Parasitology by GD Schmidt LS Roberts. McGraw Hill Publishers.
4. General Parasitology by TC Cheng. Academic Press
5. Helminths, Arthropods and Protozoa of domesticated animals by EJL Soulsby. ELBS and Bailliere Tindall. London.
6. Human Parasitology by BJ Bogitsh, CE Carter, TN Oeltmann. Academic Press.
7. Parasitology by Chaterjee K.D. Medical Publisher Calcutta.

Assignments (any one)

1. Project (500 words) highlighting recent advancements.
2. Presentation highlighting recent advancements.
3. Analytical MCQ based questions
4. Biological Crosswords
5. Charts
6. 500 words answer to analytical questions

Semester VIII

Course Code- P19
Research Methodology

Total Credits: 04 **Teaching Hours: 60**

Course objectives

The objective of this course is to make students:

- study the basics of research and research methods
- learn and apply good laboratory practices as they are essential ingredients of a quality system
- learn report writing and framing research proposals
- aware of the ethical issues in research

Unit-I

Basics of Research

Literature survey	3
Types of study (Conventional, Experimental, Survey, Case)	4
Review of Literature	4
Rationale, Hypothesis, Objective	4

Unit-II

Experimental Data and Analysis

Research Methods and Data Collection	4
Experimental Design	3
Collection of data	4
Basic knowledge of software for data analysis	4

Unit-III

Writing skills

Types of research articles	3
Reviews, Research papers, Case reports	3
Dissertation, Thesis, Project reports	3
Journals, Citation, Referencing patterns	2
Research/Project Proposal	4

Unit-IV

Research Ethics and Funding

Good Laboratory Practices	3
Ethical guidelines in organismal research	4
Principles of Research Ethics	4
Plagiarism check	4

Course learning outcome

After completing this course, students will be able to:

- Understand and comprehend the basics of research methodology and apply them in research/ project work
- Imply appropriate tools and techniques to solve the problems
- Use the specific software for data analysis

- Demonstrate proficiency in fundamental laboratory practices and adherence to good laboratory practices.
- Develop skills in qualitative and quantitative data analysis and presentation.
- Understand the philosophy of research and ethics.

Suggested Reading:

- Chaddah, P. (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978- 9387480865.Seiler, J.P. (2005). Good Laboratory Practice: the Why and the How. Springer
- Resnik, D. B. (2011). What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10.
- Singh,M. L. (1998). Understanding Research Methodology, J. M. Singh.
- Kothari, C. R. (2004): Research Methodology: Methods and Techniques. New Delhi: New Age International.
- Cresswell J. W. and Cresswell J. D. (2017): Research Design, New Delhi: Sage.
- Leary Z. O. (2010): The Essential Guide to Doing Your Research Project, New Delhi: Sage.

Assignments (any one)

Practical work should be carried out in individual or group basis (The groups should contain no more than 5 students). Each group or an individual have to do at least 1 work from the following list.

- Sketching a research proposal
- Designing a questionnaire for a survey / Designing an experimental work (field or lab)
- Performing a study in related field (having small magnitude)
- Report preparation of a survey / Report preparation of field experiment or lab experiment
- Presentation of report in class seminar on related topic
- Analysis of references and citation for at least 10 documents (books, journals, reports, theses etc.) Sketching a research proposal

P20: Term paper

Total Credits: 4

Course objectives

Term paper at undergraduate level helps the students to:

- apply fundamental and disciplinary concepts and methods in ways appropriate to their principal areas of study
- develop independent critical thinking skills along with oral and written communication skills

Major Project

Total Credits: 12

Course objectives

Major Project/ research at undergraduate level helps the students to:

- apply fundamental and disciplinary concepts and methods in ways appropriate to their principal areas of study
- demonstrate skill and knowledge of current information and technological tools and techniques specific to the professional field of study
- develop independent critical thinking skills along with oral and written communication skills
- offer opportunities to gain hands-on experience in their fields of interest.
- choose the kinds of work they enjoy most and what career paths they wish to pursue.

Semester I
Minor Subject

Course Code- Q1
Diversity and Biology of Non-Chordata

Total Credits: 02 **Teaching Hours: 30**

Course objectives

- To create in the student an appreciation of non-chordate diversity
- To develop in the student an understanding of structural and functional diversity
- To develop in the student the understanding of evolutionary relationships amongst non-chordate groups

Unit I

Phylum Protozoa **2**
Type study of *Paramecium caudatum*

Phylum Porifera **2**

Type study of *Sycon*

Phylum Cnidaria **3**
Type study of*Obeliageniculata*

Unit II

Phylum Platyhelminthes **3**
Life cycle and pathogenicity of *Fasciola hepatica*

PhylumNematoda **2**
Life cycle and pathogenicity of *Wuchereriabancrofti*

Phylum Annelida **3**
Type study of *Nereisvirens*

Unit III

Phylum Arthropoda **4**
Type study of *Palaemonmalcolmsonii*

Phylum Mollusca **4**
Type study of *Pilaglobosa*

Unit IV

Phylum Echinodermata **4**
Type study of *Asteriasrubens*

Phylum Hemichordata **3**
Type study of*Balanoglossusclavigerous*

Course learning Outcomes:
At the completion of the course, the student will be able to:

- understand and appreciate the diversity of life concerning non-chordate animals.
- describe the general characters of non-chordate animals.
- identify and classify non-chordate animals based on their form and structure and classification.

- understand the life cycle and control of various representatives of non-chordate animals.
- explain the evolutionary relationship amongst different non-chordate groups.

Suggested Reading:

1. Ruppert, EE, Fox R.S., Barnes R.D. (2004) *Invertebrate Zoology*, 7th Edition. Cengage Learning
2. Thomas Jeffrey Parker, William A. Haswell (2016*). Parker & Haswell's A Textbook of Zoology Volume 1*. WENTWORTH Press
3. Brusca (2016). *Invertebrates.* Sinauer
4. Pechenik Jan (2014). *Biology of the invertebrates*. McGraw Hill
5. Barnes R. S. K., Calow P. P., Olive P. J. W., Golding D. W., Spicer J. I. (2009). *The Invertebrates: A Synthesis*. Wiley Blackwell
6. Kotpal R.L. (2018) *Modern Text Book of Zoology: Invertebrates*. Rastogi Publications
7. Nigam H.C. (2013) *Biology of non-chordates.* Vishal Publishing Co

Assignments(anyone)

1. Project (500 words)/ presentation based on the above course content
2. Analytical MCQ based questions
3. Biological Crosswords
4. Charts
5. 500 words answer to analytical questions
6. Study based report of animals in nature

Semester II
Minor Subject

Course Code- Q2
Ecology and Environmental Biology (Minor Subject)

TotalCredits: 02 **Teaching Hours:30**

Courseobjectives

- To develop in the student an understanding of ecosystem structure and function
- To understand community interactions and succession.
- To develop in the student an understanding of global environmental issues, policies and practices.
- To learn about the factors polluting the environment,their impacts and control measures

Unit I

Concepts of Ecosystem

Ecology: Definition, ecological hierarchy	1
Ecosystem:concept,types and structural components	2
Ecosystem functions: Energy flow and Biogeochemical cycles	3
Trophiclevels, Foodchain and Foodweb	2

Unit II

Ecological Features

Population:characteristics, growth and regulation	2
Inter specificinteractions	2
Ecological succession	2
Ecologicalniche	1

Unit III

Environmental pollution

Environmental pollution: Definition, consequences, management strategies	2
Environmental problems:	
The Green house effect: Cause, consequences, preventive measures.	2
Ozone depletion: Cause, consequences, preventive measures.	2
Acid rain: Cause, consequences, preventive measures.	2

Unit IV

Environmental Management Strategies

Environmental awareness, including resource conservation and sanitation.	3
Environmental Monitoring: Methods, components and significance	4

Courselearningoutcomes:

At thecompletion of the course, the student will be able to:

- Understand the basic concept of ecology,structure and function of ecosystem and its management.
- Understand,interpret and explain how interactions between organisms and their

environments drive the dynamics of individuals, populations, communities, and ecosystems.

- Apply the scientific method and techniques to describe, monitor and manage environmental pollutions.
- Develop critical thinking for shaping strategies (scientific, social, and legal) for environmental protection and conservation of biodiversity and sustainable development.
- Understand the characteristics of populationand its dynamics and illustrate how population data can be analyzed using statistics, graphs, life tables, and survivorship curves.

Suggested Reading:

1. OdumE.P.(2005)*Fundamentals of Ecology*.Cengage Learning India Private Limited
2. SmithThomas M.Smith Robert Leo(2014)*Elements of Ecology*.PearsonEducation
3. Krebs, Charles J. 2009.*Ecology:the experimental analysis of distribution and abundance.* Pearson.
4. SharmaPD(2018).*Fundamentals of Ecology*. RastogiPublications.
5. SharmaPD(2018).*Environmental Biology and Toxicology*. RastogiPublications.
6. Pepper,I.L.,Gerba,C.P.& Brsusseau,M.L.2006.*Environmental & Pollution Science*. Elsevier Academic Press.
7. Gupta, KR (2006). *Environmental Legislation in India*. Atlantic Publishers and Distributors.
8. Purohit,S.S. & Ranjan,R. (2007).*Ecology,Environment & Pollution*.AgrobiosPublications.
9. Thangavel,P.&Sridevi,G. (2015).*Environmental Sustainability:Roleof Green Technologies*, Springer Publications.
10. Wooley,T.&Kimmins, S. (2002).*GreenBuildingHandbook*(Vol.1&2). SponPress
11. Darlington.P.J., (1957).*TheZoogeography: TheGeographicalDistributionofAnimals.* WileyPublication.
12. Caughley,G.,andSinclair,A.R.E.(1994). *Wildlife Ecology and Management*.BlackwellScience.

Assignments(anyone)

1. Project(500words)/presentation based on the above course content
2. Analytical MCQ based questions
3. Biological Crosswords
4. Charts
5. 500 words answer to analytical questions
6. Surveys of local ecosystems and submission of report.

Semester III
Minor Subject

Course Code- Q3
Diversity and Biology of Chordata (Minor Subject)

Total Credits: 02 **Teaching Hours: 30**

Course objectives

- To create in the student an appreciation of chordate diversity
- To develop in the student an understanding of structural and functional diversity
- To develop in the student the understanding of evolutionary relationship amongst chordates

Unit I

Phylum Chordata **1**
General characteristics and outline classification up to subclass level

Sub-phylum Urochordata **3**
General characters and classification up to order level
Type study of*Herdmania*

Sub-phylum Cephalochordata **3**
General characters and classification up to order level
Type study of*Branchiostoma*

Unit II

Agnatha **1**
General characters and classification up to order level

Pisces **4**
General characters and classification up to subclass level
Type study of *Scoliodonsorrakowah*

Amphibia **3**
General characters and classification up to order level
Parental care
Neoteny/ Paedogenesis

Unit III

Reptilia **3**
General characters and classification up to order level
Venomous &non-venomous snakes of India and their biting mechanism
Dinosaurs

Aves **3**
General characters and classification up to order level
Archaeopteryx – a connecting link
Types of feathers

Mammalia **2**
General characters and classification up to order level
Dentition

Unit IV

Comparative functional anatomy of vertebrates **7**

Integument, nervous system and sense organs

Course learning outcomes:

At the completion of the course, the student will be able to:

1. understand and appreciate the diversity of life with respect to chordate animals.
2. describe the general characters of chordate animals.
3. identify and classify chordate animals on the basis of their form and structure and classification.
4. explain evolutionary relationships amongst different chordate groups.
5. obtain an overview of economically important vertebrates.

Suggested Reading:

1. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford University Press.
2. Kenneth V. Kardong (2015). Vertebrates: Comparative Anatomy, Function, Evolution. McGraw Hill
3. Thomas Jeffrey Parker, William A. Haswell (2016) Parker & Haswell's A Textbook of Zoology Volume 2. WENTWORTH Press
4. Eroschenko, Victor P. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins
5. Kotpal R.L. (2018) Modern Text Book of Zoology: Vertebrates. Rastogi Publications
6. Nigam H.C. (2017) Biology of Chordates. Vishal Publishing Co

Assignment (Any one)

1. Project (500 words)/ presentation based on the above course content
2. Analytical MCQ based questions
3. Biological Crosswords
4. Charts
5. 500 words answer to analytical questions
6. Study based report of animals in nature
7. Outreach activities promoting dissolution of superstitions associated with animals
8. Photography, identification and listing of local fauna

Semester IV
Minor Subject

Course Code- Q4
Animal Physiology (Minor Subject)

Total Credits: 02 **Teaching Hours: 30**

Course objectives

- To develop in the student an understanding of functioning of an organisms' body
- To develop in the student an understanding of the various homeostatic systems of the body
- To develop in the student an understanding of regulation of function in the body

Unit I

Digestion 8
Physiology of digestion and absorption of protein, carbohydrates and lipid

Respiration
Respiratory volumes and capacities
Transport of oxygen and carbon dioxide in blood

Unit II

Circulation **7**
Composition and constituents of blood
Blood groups and Rh factor
Blood coagulation

Excretion
Structure of nephron
Urine formation

Unit III

Nerve Physiology 8
Structure of neuron
Conduction of nerve impulse

Muscles
Types of muscles
Mechanism of contraction of skeletal muscles

Unit IV

Endocrine glands **7**
Structure and function of endocrine glands

Reproduction
Physiology of reproduction

Course Outcomes:
At the completion of the course, the student will be able to:

1. understand various functional components of the body
2. understand the mechanism underlying maintenance of homeostasis of the body

3. have an enhanced knowledge and appreciation of mammalian physiology;
4. understand the functions of important physiological systems including the cardio-respiratory, renal, reproductive and metabolic systems;
5. understand how these separate systems interact to yield integrated physiological responses to challenges such as exercise, fasting and ascent to high altitude, and how they can sometimes fail;

Suggested Reading:

1. Christopher D. Moyes, Patricia M. Schulte(2016). Principles of Animal Physiology. 3rd Edition, Pearson.
2. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
3. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons.
4. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, Mcgraw Hills.

Assignments (any one)

1. Project (500 words) highlighting recent advancements.
2. Presentation highlighting recent advancements.
3. Analytical MCQ based questions
4. Biological Crosswords
5. Charts
6. 500 words answer to analytical questions
7. Outreach activities promoting awareness of physiological and immunological diseases and disorders.
8. Surveys on health indices, disease spread in family, neighbourhood, communities.