

B. Sc. In Zoology (Honours) syllabus (CBCS)

Department of Zoology

Programme Outcome (PO) : After completion of the programme students will be able to –

PO 1. Disciplinary Knowledge: Demonstrate comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate programme of study.

PO 2. Social Interaction: express thoughts and ideas effectively in writing and orally; listen and communicate with others using appropriate media. Work effectively and respectfully with diverse teams; act together as a group or a team in the interests of a common cause; Elicit views of others, mediate disagreements and help reach conclusions in group settings;

PO 3. Effective Citizenship: Demonstrate empathetic social concern and equity centred national development, and act with an informed awareness of issues and participate in civic life through volunteering; embrace moral/ ethical values in conducting one's life, possess knowledge of the values and beliefs of multiple cultures and a global perspectives; engage in a multicultural society and interact respectfully with diverse groups.

PO 4. Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.

PO 5. Information and Digital Literacy: Use ICT in a variety of learning situations; demonstrate ability to access, evaluate and use a variety of relevant information sources; and use appropriate software for analysis of data.

PO 6. Research –related skills: Critically evaluate practices, policies and theories by following scientific approach to knowledge development. Have a sense of inquiry and capability for asking relevant/ appropriate questions, problematizing, synthesizing and articulating; ability to recognize cause- and- effect relationships, define problems, formulate hypotheses, interpret and draw conclusions from data, ability to plan, execute and report the results of an experiment or investigation; ability to apply one's learning to real life situations.

Programme Specific Outcome (PSO)

After completion of the programme students will be able to -

PSO1: Identify and list out animals in and around our environment. Develop respect for nature , explain the role and impact of different environmental conservation programmes and develop skills to analyze the impact of environment

PSO2 : Understand various genetic abnormalities, identify animals beneficial to humans and explain various physiological changes in our bodies

PSO3: Develop scientific attitude and temperament among the students, which will be beneficial for the society

PSO4: Equip themselves to learn and know about different biological systems, their coordination and control as well as evolution, behavior and biological roles of the animals in the ecosystem.

PSO5: Acquire skills in diagnostic testing procedures used in clinical and research laboratories will provide them scopes to work in research laboratory.

PSO6 : Develop cognitive ability to Use tools of information technology for all activities related to higher studies.

PSO7: Enhance collaborative learning and communication skills through practical sessions, team work, group discussions, assignments and projects.

B.Sc. Zoology 1st Semester (Honours)

Paper Name: CORE COURSE 1 : Non-chordates I: Protista to Pseudocoelomates

Paper Code: ZOO-HC-1016

Course Outcome (CO)

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

CO1: Learn about the importance of systematics, taxonomy and structural organization of animals.

(Remember)

CO2: Understand the diversity of non-chordates living in varied habit and habitats. **(Understand)**

CO3: Understand evolutionary history and relationships of different non-chordates through functional and structural affinities. **(Understand)**

CO4: Critically analyse the organization, complexity and characteristic features of non-chordates making them familiarize with the morphology and anatomy of representatives of various animal phyla. **(Analyse)**

CO5: Comprehend the economic importance of non-chordates, their interaction with the environment and role in the ecosystem. **(Understand)**

CO6: Enhance collaborative learning and communication skills through practical sessions, team work, group discussions, assignments and projects. **(Create)**

Syllabus

NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES	(Credits 4)
THEORY	
Unit 1: Protista, Parazoa and Metazoa	19
General characteristics and Classification upto classes Study of <i>Euglena</i> , <i>Amoeba</i> and <i>Paramecium</i>	
Life cycle and pathogenicity of <i>Plasmodium vivax</i> and <i>Entamoeba histolytica</i>	
Locomotion and Reproduction in Protista	
Evolution of symmetry and segmentation of Metazoa	
Unit 2: Porifera	7
General characteristics and Classification upto classes Canal system and spicules in sponge	
Unit 3: Cnidaria	12
General characteristics and Classification upto classes Metagenesis in <i>Obelia</i>	
Polymorphism in Cnidaria Corals and coral reefs	
Unit 4: Ctenophora	4
General characteristics and Evolutionary significance	
Unit 5: Platyhelminthes	10
General characteristics and Classification up to classes	
Life cycle and pathogenicity of <i>Fasciola hepatica</i> and <i>Taeniasolium</i>	

Unit 6: Nematelminthes

General characteristics and Classification up to classes

Lifecycle, and pathogenicity of *Ascaris lumbricoides* and *Wuchereri bancrofti*

Parasitic adaptations in helminthes

Note: Classification to be followed from “Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition”

NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES**PRACTICALS (Credits 2)**

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*, Binary fission and Conjugation in *Paramecium*
2. Examination of pond water collected from different places for diversity in protista
3. Study of *Sycon* (T.S. and L.S.), *Hyalonema*, *Euplectella*, *Spongilla*
4. Study of *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, *Meandrina*, *Madrepora*
5. One specimen/slide of any ctenophore
6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/micro- photographs)
7. Study of adult *Ascaris lumbricoides* and its life stages (Slides/micro-photographs)
8. To submit a Project Report on any related topic on life cycles.

Note: Classification to be followed from “Ruppert and Barnes (2006) *Invertebrate Zoology*, 8th edition, Holt Saunders International Edition”

SUGGESTED READINGS

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II . Edition, E.L.B.S. and Nelson

CO-PO-PSO mapping

	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PSO 1	PSO2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	H			H		M	H						
CO2	H			H		H	H		M	H			
CO3	H			M	M	M	M	H		M	M		
CO4	H	L		L	M	L	H	L	M	H	M	M	
CO5	H		M	H			H	M	H	L		H	M
CO6		H	H	M							M	H	H

CORE COURSE II

CODE: ZOO-HC-1026 PRINCIPLES OF ECOLOGY

Course Outcome (CO)

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

CO1 Understand the community characteristics, ecosystem development and climax theories. **(Understand)**

CO2 Know about the types of ecosystems, food chains, food webs, energy models, and ecological efficiencies. **(Remember)**

CO3 Apply the basic principles of ecology in wildlife conservation and management. **(Apply)**

CO4 Demonstrate an understanding of key concepts in ecology with emphasis on historical perspective, role of physical factors and concept of limiting factors. **(Analyse)**

CO5 Comprehend the population characteristics, dynamics, growth models and interactions. **(Understand)**

CO6 Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and projects. **(Create)**

SYLLABUS:

THEORY (Credits 4)

Unit 1: Introduction to Ecology

6

History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors

Unit2: Population

24

Unitary and Modular populations

Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion Exponential and logistic growth, equation and patterns, r and K strategies Population regulation - density-dependent and independent factors

Population interactions. Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and Predation, functional and numerical responses

Unit3: Community

12

Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological succession with one example

Theories pertaining to climax community

Unit4: Ecosystem

14

Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies

Nutrient and biogeochemical cycle with one example of Nitrogen cycle Human modified ecosystem

Unit 5: Applied Ecology

4

Ecology in Wildlife Conservation and Management

PRINCIPLES OF ECOLOGY

PRACTICALS (Credits 2)

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method).
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary

SUGGESTED READINGS

- Colinvaux, P.A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
- Odum, E.P. (2003). Fundamentals of Ecology. Indian Edition. Brooks/Cole
Robert Leo Smith Ecology and field biology Harper and Row publisher Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Press

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	H	M	M	H			H	H	M	H			L
CO2	H		M	H			H	H	H				
CO3	H	M	M	H	H	H			H	H	H	M	H
CO4	H		M	H	L	H		H			H	M	H
CO5	H			H				H			M	M	
CO6	H	H	M	M	H	H				L	M	H	H

CORE COURSE III CODE: ZOO-HC-2016
NON-CHORDATES II: COELOMATES THEORY (Credits 4)

Course Outcome (CO)

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

CO1 Learn about the importance of systematics, taxonomy and structural organization of animals. **(Remember)**

CO2 Appreciate the diversity of nonchordates living in diverse habit and habitats. **(Understand)**

CO3 Understand evolutionary history and relationships of different non-chordates through functional and structural affinities. **(Understand)**

CO4 Critically think about the organization, complexity and characteristic features of nonchordates. **(Analyse)**

CO5 Getting familiarized with the morphology and anatomy of representatives of various animal phyla. **(Analyse)**

CO6 Comprehend the economic importance of non-chordates, their interaction with the environment and role in the ecosystem. **(Apply)**

CO 7 Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and projects **(Create)**

SYLLABUS

THEORY (Credits 4)

Unit 1: Introduction to Coelomates	2
Evolution of coelom and metamerism	
Unit 2: Annelida	10
General characteristics and Classification upto classes Excretion in Annelida	
Unit 3: Arthropoda	17
General characteristics and Classification upto classes Vision and Respiration in Arthropoda Metamorphosis in Insects Social life in bees and termites	
Unit 4: Onychophora	4
General characteristics and Evolutionary significance	
Unit 5: Mollusca	
General characteristics and Classification upto classes Respiration in Mollusca Torsion and detorsion in Gastropoda Pearl formation in bivalves Evolutionary significance of trochophore larva	
Unit 6: Echinodermata	12
General characteristics and Classification upto classes Water-vascular system in Asteroidea Larval forms in Echinodermata Affinities with Chordates	

NON-CHORDATES II: COELOMATES
PRACTICAL (Credits 2)

1. Study of following specimens:

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

2. Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm

3. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm

4. Mount of mouth parts and dissection of digestive system and nervous system of *Periplaneta**

5. To submit a Project Report on any related topic to larval forms (crustacean, mollusc and echinoderm)

Note: Classification to be followed from "Ruppert and Barnes (2006)
Invertebrate Zoology, 8th edition, Holt Saunders International Edition"

SUGGESTED READINGS

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
- Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson

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CO1	H			H			H						
CO2	M	M		H			H	L		H			
CO3	M			H		M							
CO4			H	M		H	M		H		M		
CO5			H			H		L	M	H			M
CO6		H			M			H			H	H	
CO7		H			M	M						H	H

CORE COURSE IV

CODE: ZOO-HC-2026 CELL BIOLOGY

COURSE OUTCOME:

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

CO1 Understand fundamental principles of cell biology. (**Understand**)

CO2 Understand defects in functioning of cell organelles and regulation of cellular processes can develop into diseases. (**Understand**)

CO3 Explain structure and functions of cell organelles involved in diverse cellular processes. (**Apply**)

CO4 Appreciate how cells grow, divide, survive, die and regulate these important processes. (**Understand**)

CO5 Comprehend the process of cell signalling and its role in cellular functions. (**Analyse**)

CO6 Learn the advances made in the field of cell biology and their applications. (**Remember**)

CO7 Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and projects. (**Create**)

SYLLABUS

THEORY (Credits4)

Unit 1: Over view of Cells Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions	3
Unit 2: Plasma Membrane Various models of plasma membrane structure Transport across membranes: Active and Passive transport, Facilitated transport Cell junctions: Tight junctions, Desmosomes, Gap junctions	7
Unit 3: Endomembrane System Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes	10
Unit 4: Mitochondria and Peroxisomes Mitochondria: Structure, Semi- autonomous nature, Endosymbiotic hypothesis Mitochondrial Respiratory Chain. Chemi-osmotichypothesis Peroxisomes	8
Unit 5: Cytoskeleton Structure and Functions: Microtubules, Microfilaments and Intermediate filaments	8
Unit 6: Nucleus Structure of Nucleus: Nucleare nvelope, Nuclear pore complex, Nucleolus Chromatin: Euchromatin and Hetrochromatin and packaging(nucleosome)	12
Unit 7: Cell Division Mitosis, Meiosis, Cell cycle and its regulation	8
Unit 8: Cell Signaling GPCR and Role of second messenger (cAMP)	4

CELL BIOLOGY

PRACTICAL (Credits 2)

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis
2. Study of various stages of meiosis.
3. Preparation of permanent slide to show the presence of Barrbody in human female blood cells/cheek cells.
4. Preparation of permanent slide to demonstrate:
 - i DNA by Feulgen reaction
 - ii Mucopolysaccharides by PAS reaction
 - iii Proteins by Mercurio bromophenol blue/FastGreen

SUGGESTED READINGS

- Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons.Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- 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.
- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Albert, Bray Dennis, Lewis Julian, Raff Martin, Roberts Keith and Watson James (2008). *Molecular Biology of the Cell*, V Edition, Garland publishing Inc., New York and London.

CO-PO-PSO mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	H						H	H		M			
CO2	H			M			M	H		M			
CO3	M	M								H	M		
CO4	M		H				H	H	M			M	
CO5				M	M		M	H					
CO6	H		H	M	H	H	M		H	H	H	H	M
CO7		H	M			H			M	H	H	M	H

CORE COURSE V

Paper Name : DIVERSITY OF CHORDATA

CODE: ZOO-HC-3016

COURSE OUTCOME

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

CO1 Understand different classes of chordates, level of organization and evolutionary relationship between different subphyla and classes, within and outside the phylum. (**Understand**)

CO2 Know about the habit and habitat of chordates in marine, freshwater and terrestrial ecosystems. (**Remember**)

CO3 Study about diversity in animals making students understand about their distinguishing features. (**Understand**)

CO4 Contrast the similarities and differences in life functions among various groups of animals in Phylum Chordata. (**Analyse**)

CO5 Comprehend the circulatory, nervous and skeletal system of chordates. (**Analyze**)

CO6 Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and projects. (**Apply**)

SYLLABUS

THEORY (Credits 4)

Unit 1: Introduction to Chordates

2

General characteristics and outline classification

Unit2:Protochordata

8

General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata

Unit 3: Origin of Chordata

3

Dipleurula concept and the Echinoderm theory of origin of chordates Advanced features of vertebrates over Protochordata

Unit4:Agnatha

2

General characteristics and classification of cyclostomes up to class

Unit5:Pisces

8

General characteristics of Chondrichthyes and Osteichthyes, classification upto order Migration, Osmoregulation and Parental care in fishes

Unit6:Amphibia

6

Origin of *Tetrapoda* (Evolution of terrestrial ectotherms); General characteristics and classification upto order; Parental care in Amphibians

Unit7:Reptilia

7

General characteristics and classification up to order; Affinities of *Sphenodon*; Poison apparatus and Biting mechanism in snakes

Unit8:Aves

8

General characteristics and classification up to order *Archaeopteryx*-- a connecting link; Principles and aerodynamics of flight, Flight adaptations and Migration in birds

Unit9:Mammals

8

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

Unit10:Zoogeography

8

Zoo geographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms

DIVERSITY OF CHORDATA

PRACTICAL (Credits 2)

1. Protochordata

Balanoglossus, *Herdmania*, *Branchiostoma*, Colonial Urochordata Sections of *Balanoglossus* through proboscis and branchio genital regions, Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions. Permanent slide of *Herdmania* spicules

2. Agnatha

Petromyzon, *Myxine*

3. Fishes

Scoliodon, *Sphyrna*, *Pristis*, *Torpedo*, *Chimaera*, *Mystus*, *Heteropneustes*, *Labeo*, *Exocoetus*, *Echeneis*, *Anguilla*, *Hippocampus*, *Tetrodon/Diodon*, *Anabas*, Flat fish

4. Amphibia

Ichthyophis/Ureotyphlus, *Necturus*, *Bufo*, *Hyla*, *Alytes*, *Salamandra*

5. Reptilia

Chelone, *Trionyx*, *Hemidactylus*, *Varanus*, *Uromastix*, *Chamaeleon*, *Ophiosaurus*, *Draco*, *Bungarus*, *Vipera*, *Naja*, *Hydrophis*, *Zamenis*, *Crocodylus* Key for Identification of poisonous and non-poisonous snakes

6. Aves

Study of six common birds from different orders. Types of beaks and claws

7. Mammalia

Sorex, Bat (Insectivorous and Frugivorous), *Funambulus*, *Loris*, *Herpestes*, *Erinaceous*.

Mount of weberian ossicles of fish

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

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

SUGGESTED READINGS

Young, J.Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press. Pough H. *Vertebrate life*, VIII Edition, Pearson International.

Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger Pub Co. Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*.

IV Edition. Jones and Bartlett Publishers Inc.

CO-PO-PSO mapping

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CO1	H		M				H	H		H			H
CO2	H	M		H			H		M				
CO3	H	H				M	H		H	M			
CO4		H				H							
CO5	H					H							
CO6			H		H	H					M	H	H

Paper Name: Animal Physiology: Controlling And Coordinating Systems

Paper Code: ZOO-HC-3026

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

CO1 Know the basic fundamentals and understand advanced concepts so as to develop a strong foundation that will help them to acquire skills and knowledge to pursue advanced degree courses.

(Remember)

CO2 Know the role of regulatory systems viz. endocrine and nervous systems and their amalgamation in maintaining various physiological processes. **(Remember)**

CO3 Recognize and explain how all physiological systems work in unison to maintain homeostasis in the body and use of feedback loops to control the same. **(Understand)**

CO4 Learn an integrative approach to understand the interactions of various organ systems resulting in the complex overall functioning of the body. Synthesize ideas to make connection between knowledge of physiology and real world situations, including healthy life style decisions and homeostatic imbalances. **(Understand)**

CO5 Comprehend and analyze problem and questions. **(Analyze)**

CO6 Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and projects. **(Apply)**

SYLLABUS

THEORY

(Credits

4)

Unit 1: Tissues

6

Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue

Unit 2: Bone and Cartilage

4

Structure and types of bones and cartilages, Ossification, bone growth and resorption

Unit 3: Nervous System

10

Structure of neuron. resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc; Physiology of hearing and vision.

Unit 4: Muscle

12

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus

Unit 5: Reproductive System

10

Histology of testis and ovary; Physiology of male and female reproduction; Puberty, Methods of contraception in male and female

Unit 6: Endocrine System

18

Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action; Classification of hormones; Regulation of their secretion; Mode of hormone action, Signal transduction pathways for steroidal and non-steroidal

hormones;Hypothalamus(neuroendocrinegland)- principalnucleiinvolved in neuro endocrine control of anterior pituitary and endocrines system;
Placental hormones

ANIMAL PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEMS PRACTICALS (Credits 2)

- *1. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
3. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nervecell,Pituitary,Pancreas,Testis,Ovary,Adrenal,ThyroidandParathyr oid
4. Microtomy: Preparation of permanent slide of any five mammalian(Goat/ rat/mice)tissues

(*Subject to UGC guidelines) SUGGESTED BOOKS

Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.

Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons

Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. &Wilkins.

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CO1	H					M	M						
CO2	H				M								
CO3	H					M				M	H		
CO4	H		M					H			M	M	H
CO5		M		L		H			H			H	
CO6		M	H	M	M	M						M	H

hormones;Hypothalamus(neuroendocrinegland)- principalnucleiinvolved in neuro endocrine control of anterior pituitary and endocrines system;
Placental hormones

ANIMAL PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEMS PRACTICALS (Credits 2)

- *1. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
3. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nervecell,Pituitary,Pancreas,Testis,Ovary,Adrenal,ThyroidandParathyr oid
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CO1	H					M	M						
CO2	H				M								
CO3	H					M				M	H		
CO4	H		M					H			M	M	H
CO5		M		L		H			H			H	
CO6		M	H	M	M	M						M	H

**CORE COURSE VII FUNDAMENTALS OF BIOCHEMISTRY
CODE: ZOO-HC-3036**

COURSE OUTCOME

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

CO1 Gain knowledge and skill in the fundamentals of biochemical sciences, interactions and interdependence of physiological and biochemical processes. **(Remember)**

CO2 Know about classical laboratory techniques, use modern instrumentation, design and conduct scientific experiments, and analyze the resulting data. **(Understand)**

CO3 Get exposed to various processes used in industries and gain skills in techniques of chromatography and spectroscopy. **(Apply)**

CO4 Demonstrate foundation knowledge in biochemistry; synthesis of proteins, lipids, nucleic acids, and carbohydrates; and their role in metabolic pathways along with their regulation. **(Apply)**

CO5 Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and projects. **(Apply)**

SYLLABUS

THEORY (CREDITS 4)

Unit1:Carbohydrates

8

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

Unit2:Lipids

8

Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Triacylglycerols, Phospholipids, Glycolipids, Steroids

Unit3:Proteins

14

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

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

Immunoglobulins: Basic Structure, Classes and Function, Antigenic Determinants

Unit 4:NucleicAcids

12

Structure:Purines and pyrimidines,Nucleosides,Nucleotides,Nucleicacids CotCurves: Base pairing, Denaturation and Renaturation of DNA

Types of DNA and RNA, Complementarity of DNA, Hpyo- Hyperchromaticity of DNA

Unit5:Enzymes

18

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 K_m and V_{max} , Lineweaver- Burk plot; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action

**FUNDAMENTALS OF BIOCHEMISTRY
PRACTICAL (CREDITS2)**

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Paper chromatography of amino acids.
3. Action of salivary amylase under optimum conditions.
4. Effect of pH, temperature on the action of salivary amylase.
5. Demonstration of proteins separation by SDS-PAGE.

SUGGESTED READING

Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., NewYork.

Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.

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.

Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.

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.

CO-PO-PSO mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	H						H			H			
CO2	M			M			M	M		H			
CO3						H			M	M	H	M	M
CO4		M			H					H			
CO5		H	H		M				H	H	H	H	H

Paper Name: Ornamental Fish and Fisheries (SEC)

Paper Code: ZOO-SE-3014

COURSE OUTCOME

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

- CO1** Define, comprehend, scope and significance of aquaculture (**Remember**)
- CO2** Acquire knowledge on taxonomy and morphology of fishes. (**Understand**)
- CO3** Understand food, feeding, growth, digestion and respiration in fishes. (**Understand**)
- CO4** Examine the types and practices of Aquaculture (**Analyse**)
- CO5** Construct aquariums and plankton cultures (**Apply**)
- CO6** Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and projects (**Apply**)

CORE COURSE VIII COMPARATIVE ANATOMY OF VERTEBRATES

CODE: ZOO-HC-4016

THEORY (CREDITS 4)

Unit 1: Integumentary System 8

Structure, functions and derivatives of integument

Unit 2: Skeletal System 8

Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches **8**

Unit 3: Digestive System

Alimentary canal and associated glands, dentition

Unit 4: Respiratory System 8

Skin, gills, lungs and air sacs; Accessory respiratory organs

Unit 5: Circulatory System 8

General plan of circulation, evolution of heart and aortic arches

Unit 6: Urinogenital System 6

Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri

Unit 7: Nervous System 8

Comparative account of brain

Autonomic nervous system, Spinal cord, Cranial nerves in mammals

Unit 8: Sense Organs 6

Classification of receptors

Brief account of visual and auditory receptors in man

COMPARATIVE ANATOMY OF VERTEBRATES

PRACTICAL (CREDITS 2)

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Disarticulated skeleton of Frog, Fowl, Rabbit
3. Carapace and plastron of turtle/tortoise
4. Mammalian skulls: One herbivorous and one carnivorous animal

5. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted)
6. Project on skeletal modifications in vertebrates (may be included if dissection not permitted)

SUGGESTED READINGS

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

CO-PO-PSO mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	H		M	H				H					
CO2	H			H			H		M				
CO3	M					H	M	H	M	H	H		
CO4				H		M			H				M
CO5		M				H				H	H		H
CO6		H	M		M	H			H		H	M	H

4th Semester (Honours)

Paper Name: Comparative Anatomy of Vertebrates

Paper Code: ZOO-HC-4016

Course Outcome	Unit/ Topic	Bloom's Taxonomy Level
After the completion of this course, the students will be able to:	Unit 1: Integumentary System > Structure, functions and derivatives of integument	Remember, Understand, Analyze,
CO1 > Understand the pattern of vertebrate evolution, organization and functions of various systems. <i>(Understand)</i>	Unit 2: Skeletal System > Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches	
CO2 > Learn the comparative account of integument, skeletal components, their functions and modifications in different vertebrates. <i>(Remember)</i>	Unit 3: Digestive System > Alimentary canal and associated glands, dentition	
CO3 > Understand the evolution of heart, modification in aortic arches, structure of respiratory organs used in aquatic, terrestrial, aerial vertebrates; and digestive system and its anatomical specializations with respect to different diets and feeding habits. <i>(Understand)</i>	Unit 4: Respiratory System > Skin, gills, lungs and air sacs; > Accessory respiratory organs	
CO4 > Learn the evolution of brain, sense organs and excretory organ to a complex, highly evolved form in mammals. <i>(Remember)</i>	Unit 5: Circulatory System > General plan of circulation > Evolution of heart and aortic arches	
CO5 > Analyze and critically evaluate the structure and functions of vertebrate systems, which helps them to discern the developmental, functional and evolutionary history of vertebrate species. <i>(Analyze)</i>	Unit 6: Urinogenital System > Succession of kidney, structure, function and derivatives > Evolution of urinogenital ducts, > Types of mammalian uteri	
CO6 > Understand the importance of comparative vertebrate anatomy to discriminate human biology. <i>(Understand)</i>	Unit 7: Nervous System > Comparative account of brain > Autonomic nervous system, > Spinal cord, > Cranial nerves in mammals	
CO7 > Explain comparative account of the different vertebrate systems. <i>(Analyze)</i>	Unit 8: Sense Organs > Classification of receptors > Brief account of visual and auditory receptors	
CO8 > Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and projects. <i>(Analyze)</i>	Practical > Study of placoid, cycloid and > Disarticulated skeleton of Frog, Fowl, Rabbit > Carapace and plastron of turtle/tortoise > Mammalian skulls: One herbivorous and one carnivorous animal > Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted) > Project on skeletal modifications in vertebrates (may be included if dissection not permitted)	

Course Outcome	Unit/ Topic	Bloom's Taxonomy Level
<p>After the completion of this course, the students will be able to:</p> <p>CO1 > Understand basic fundamentals and understanding of advanced concepts of physiology (Understand)</p> <p>CO2 > Learn interactions of various organ systems resulting in the complex overall functioning of the body. (Remember)</p> <p>CO3 > Comprehend and analyse problem-based questions on physiological aspects. (Analyze)</p> <p>CO4 > Recognize and explain how all physiological systems maintain homeostasis in the body; and use of feedback loops to control the same. (Analyze)</p> <p>CO5 > Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and projects</p>	<p>Unit 1: Physiology of Digestion</p> <ul style="list-style-type: none"> > Structural organization and functions of gastrointestinal tract and associated glands; > Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; > Hormonal control of secretion of enzymes in Gastrointestinal tract. <p>Unit 2: Physiology of Respiration</p> <ul style="list-style-type: none"> > Histology of trachea and lung; > Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; > Transport of oxygen and carbon dioxide in blood; Respiratory pigments, > Dissociation curves and the factors influencing it; > Carbon monoxide poisoning; > Control of respiration. <p>Unit 3: Renal Physiology</p> <ul style="list-style-type: none"> > Structure of kidney and its functional unit > Mechanism of urine formation; > Regulation of water balance; > Regulation of acid-base balance <p>Unit 4: Blood</p> <ul style="list-style-type: none"> > Components of blood and their functions > Structure and functions of haemoglobin > Haemostasis: Blood clotting system, Kallikrein- Kininogen system, > Complement system & Fibrinolytic system, Haemopoiesis > Blood groups: Rh factor, ABO and MN <p>Unit 5: Physiology of Heart</p> <ul style="list-style-type: none"> > Structure of mammalian heart; Coronary circulation, > Structure and working of conducting myocardial fibers. > Origin and conduction of cardiac impulses > Cardiac cycle; Cardiac output and its regulation, > Frank-Starling Law of the heart, nervous and chemical regulation of heart rate, > Electrocardiogram, Blood pressure and its regulation <p>Practical</p> <ul style="list-style-type: none"> > Determination of ABO Blood group > Enumeration of red blood cells and white blood cells using haemocytometer > Estimation of haemoglobin using Sahli's haemoglobinometer > Preparation of haemin crystals > Recording of blood pressure using a sphygmomanometer > Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney 	<p>Remember, Understand, Analyze</p>

Course Outcome	Unit/ Topic	Bloom's Taxonomy Level
<p>After the completion of this course, the students will be able to:</p> <p>CO1 ➤ Gain knowledge and skill in the interactions and interdependence of physiological and bio-molecules (Remember)</p> <p>CO2 ➤ Understand essentials of the metabolic pathways along with their regulation. (Understand)</p> <p>CO3 ➤ Apply knowledge to the scientific understanding of metabolism (Apply)</p> <p>CO4 ➤ Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and projects (Apply)</p>	<p>Unit 1: Overview of Metabolism</p> <ul style="list-style-type: none"> ➤ Catabolism vs Anabolism ➤ Stages of catabolism ➤ Compartmentalization of metabolic pathways ➤ Shuttle systems and membrane transporters ➤ ATP as "Energy Currency of cell"; coupled reactions ➤ Use of reducing equivalents and cofactors ➤ Intermediary metabolism and regulatory mechanisms <p>Unit 2: Carbohydrate Metabolism</p> <ul style="list-style-type: none"> ➤ Sequence of reactions and regulation of glycolysis ➤ Citric acid cycle ➤ Phosphate pentose pathway ➤ Gluconeogenesis, Glycogenolysis and Glycogenesis of Metabolism <p>Unit 3: Lipid Metabolism</p> <ul style="list-style-type: none"> ➤ β-oxidation and omega-oxidation of saturated fatty acids with even and odd number of carbon atoms ➤ Biosynthesis of palmitic acid ➤ Ketogenesis <p>Unit 4: Protein Metabolism</p> <ul style="list-style-type: none"> ➤ Catabolism of amino acids: Transamination, Deamination, Urea cycle ➤ Fate of C-skeleton of Glucogenic and Ketogenic amino acids <p>Unit 5: Oxidative Phosphorylation</p> <ul style="list-style-type: none"> ➤ Redox systems ➤ Review of mitochondrial respiratory chain ➤ Inhibitors and un-couplers of Electron Transport System <p>Practical</p> <ul style="list-style-type: none"> ➤ Estimation of total protein in given solutions by Lowry's method. ➤ Detection of SGOT and SGPT in serum/tissue ➤ To study the enzymatic activity of Trypsin and Lipase. ➤ Study of biological oxidation (SDH) [goat liver] ➤ To perform the Acid and Alkaline phosphatase assay from serum/tissue. 	<p>Remember, Understand, Apply</p>

Course Outcome	Unit/ Topic	Bloom's Taxonomy Level
After the completion of this course, the students will be able to:	Unit 1: Introduction > Sericulture: Definition, history and present status of Mulberry and Non-Mulberry Sericulture > Silk route Varieties of Silk > Types and distribution of non-mulberry or wild or vanya sericigenous insects in N-E India	Remember, Understand, Apply, Analyze, Create
CO1 > Understand overall aspects of Sericulture, namely, Mulberry and non-mulberry silkworms and their food plants. <i>(Understand)</i>	Unit 2: Biology of Non-mulberry Silkworm: > Life cycle of silkworm- Eri and Muga Structure of silk gland and Nature of Silk	
CO2 > Learn various technologies involved in Sericulture. <i>(Remember)</i>	Unit 3: Rearing of Silkworms > Eri and Muga Silkworm > Food plants of Eri and Muga Silkworm	
CO3 > Apply knowledge to rearing of the silkworm, Silkworm pathology, Process of silkworm seed production and silk technology. <i>(Apply)</i>	Rearing Operation: > Rearing house/Site and rearing appliances: Definition, history and applications > Disinfectants: Formalin, Bleaching powder > Rearing technology: Early age and Late age rearing > Environmental conditions in rearing: Temperature, Humidity, Light and Air > Types of mountages > Harvesting and storage of cocoons > Spinning and Reeling of silk	
CO4 > Apply knowledge learnt for Mulberry nursery management, Silkworm rearing, and Silk reeling. <i>(Apply)</i>	Unit 4: Pests and Diseases: > Pests of eri and muga silkworm > Pathogenesis of eri and muga silkworm diseases: Protozoan, viral, fungal and bacterial > Prevention and control measures of pests and diseases	
CO5 > Evaluate quality of silkworms and their products. <i>(Analyze)</i>	Unit 5: Entrepreneurship in Non-Mulberry Sericulture: > Varieties of Non-Mulberry Silk products and economics in India > Prospectus of Non-Mulberry Sericulture in India: Non-Mulberry Sericulture industry in different states, employment generation and potential	
CO6 > Create awareness on economic importance and suitability of Sericulture in Indian conditions. <i>(Create)</i>	Practical > Visit to various sericulture Govt./Private Farm/ Centers.	
CO7 > Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and field projects. <i>(Apply)</i>		

Paper: Molecular Biology

Code: Zoo - HC - 5016

Course Outcome	Unit/ Topic	Bloom's Taxonomy Level
	<p>Unit 1: Nucleic Acids</p> <ul style="list-style-type: none"> ➤ Salient features of DNA and RNA Watson and Crick model of DNA 	<p>Remember, Understand, Apply, Analyze</p>
	<p>Unit 2: DNA Replication</p> <ul style="list-style-type: none"> ➤ DNA Replication in prokaryotes and eukaryotes ➤ Mechanism of DNA replication ➤ Semi-conservative, bidirectional and semi-discontinuous replication ➤ RNA priming, Replication of circular and linear ds-DNA, replication of telomeres 	
	<p>Unit 3: Transcription</p> <ul style="list-style-type: none"> ➤ RNA polymerase and transcription unit ➤ Mechanism of transcription in prokaryotes and eukaryotes ➤ Synthesis of rRNA and mRNA, transcription factors 	
	<p>Unit 4: Translation</p> <ul style="list-style-type: none"> ➤ Genetic code, Degeneracy of the genetic code Wobble Hypothesis ➤ Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; ➤ Proteins involved in initiation, elongation and termination of Polypeptide chain; Inhibitors of protein synthesis; ➤ Difference between prokaryotic and eukaryotic translation 	
	<p>Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA</p> <ul style="list-style-type: none"> ➤ Structure of globin mRNA ➤ Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, ➤ Processing of tRNA 	
	<p>Unit 6: Gene Regulation</p> <ul style="list-style-type: none"> ➤ Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac operon and trp operon, Transcription. ➤ Regulation in eukaryotes: Activators, Repressor, Gene Silencing and Genetic imprinting 	
	<p>Unit 7: DNA Repair Mechanism</p> <ul style="list-style-type: none"> ➤ Pyrimidine dimerization and mismatch repair 	
	<p>Unit 8: Regulatory RNAs</p> <ul style="list-style-type: none"> ➤ Ribo-switches, RNA interference, miRNA, siRNA 	
	<p>Practical:</p> <ul style="list-style-type: none"> ➤ Study of Polytene chromosomes from Chironomus/ Drosophila larvae ➤ Preparation of liquid culture medium (LB) and raise culture of <i>E. coli</i> ➤ Estimation of the growth kinetics of <i>E. coli</i> by turbidity method ➤ Quantitative estimation DNA using colorimeter (Diphenylamine reagent) ➤ Quantitative estimation of RNA using Orcinol reaction ➤ Study and interpretation of electron micrographs/ photograph showing <ol style="list-style-type: none"> (a) DNA replication (b) Transcription (c) Split genes 	
CO1	➤ Describe the basic structure and chemistry of nucleic acids, DNA and RNA; molecular machinery and mechanism of information transfer processes, transcription and translation-in prokaryotes and eukaryotes, modification mechanisms for the processing of eukaryotic RNAs; (Remember, Understand)	
CO2	➤ Understand gene expression regulation in eukaryotes (Understand)	
CO3	➤ Explain the significance of DNA repair mechanisms in controlling DNA damage, role of RNAs (riboswitches, siRNA and miRNA) in gene expression regulation. (Apply)	
CO4	➤ Compare and contrast DNA replication machinery and mechanisms in prokaryotes and eukaryotes. (Analyze)	
CO5	➤ Estimate concentration of DNA and RNA by colorimetric methods. (Analyze)	
CO6	➤ Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and projects (Apply)	

Paper Name : Principles of Genetics

Code : Zoo- HC - 5026

Course Outcome	Unit/ Topic	Bloom's Taxonomy Level
<p>After the completion of this course, the students will be able to:</p> <p>CO1 ➤ Have a deeper understanding of the varied branches of the biological sciences like microbiology, evolutionary biology, genomics and metagenomics. (Understand)</p> <p>CO2 ➤ Gain knowledge of the basic principles of inheritance. (Knowledge)</p> <p>CO3 ➤ Analyse pedigree leading to development of analytical skills and critical thinking enabling the students to present the conclusion of their findings in a scientific manner. (Analyse)</p> <p>CO4 ➤ Know the mechanisms of mutations, the causative agents and the harmful impact of various chemicals and drugs being used in day to day life. (Knowledge)</p> <p>CO5 ➤ Find out the effects of indiscriminate use of various chemicals, drugs or insecticides in nature by studying their effect on various bacterial species in soil and water samples from different industrial or polluted areas (Apply)</p> <p>CO6 ➤ Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and projects (Analyse)</p>	<p>Unit 1: Mendelian Genetics and its Extension</p> <ul style="list-style-type: none"> ➤ Principles of inheritance, Incomplete dominance and co- dominance ➤ Multiple alleles, Lethal alleles, Epistasis, Pleiotropy ➤ Sex-linked, sex- influenced and sex-limited characters inheritance. <p>Unit 2: Linkage, Crossing Over and Chromosomal Mapping</p> <ul style="list-style-type: none"> ➤ Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination ➤ Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses ➤ Interference and coincidence ➤ Somatic cell hybridization. <p>Unit3: Mutations</p> <ul style="list-style-type: none"> ➤ Types of gene mutations (Classification) ➤ Types of chromosomal aberrations (Classification, figures and with one suitable example of each) ➤ Molecular basis of mutations in relation to UV light and chemical mutagens ➤ Detection of mutations: CLB methods attached X method. <p>Unit 4: Sex Determination</p> <ul style="list-style-type: none"> ➤ Chromosomal mechanisms of sex determination in <i>Drosophila</i> and Man <p>Unit 5: Extra-chromosomal Inheritance</p> <ul style="list-style-type: none"> ➤ Criteria for extra-chromosomal inheritance ➤ Antibiotic resistance in <i>Chlamydomonas</i> ➤ Mitochondrial mutations in <i>Saccharomyces</i> ➤ Infective heredity in <i>Paramecium</i> and Maternal effects <p>Unit 6: Polygenic Inheritance</p> <ul style="list-style-type: none"> ➤ Polygenic inheritance with suitable examples; simple numerical based on it. <p>Unit 7: Recombination in Bacteria and Viruses</p> <ul style="list-style-type: none"> ➤ Conjugation, Transformation, Transduction, Complementation test in Bacteriophage <p>Unit 8: Transposable Genetic Elements</p> <ul style="list-style-type: none"> ➤ Transposons in bacteria, Ac-Ds elements in maize and P elements in <i>Drosophila</i> ➤ Transposons in humans <p>Practical</p> <ul style="list-style-type: none"> ➤ To study the Mendelian laws and gene interactions. ➤ Chi-square analyses using seeds/ beads/ <i>Drosophila</i>. ➤ Linkage maps based on data from conjugation, transformation and transduction. ➤ Linkage maps based on data from <i>Drosophila</i> crosses. ➤ Study of human karyotype (normal and abnormal). ➤ Pedigree analysis of some human inherited traits. 	<p>Remember, Understand, Apply, Knowledge, Analyze</p>

Computational Biology and Biostatistics (DSE)

ZOO-HE-5016

Course Outcome	Unit/ Topic	Bloom's Taxonomy Level
<p>After the completion of this course, the students will be able to:</p> <p>CO1 ➤ Gain knowledge on history, definition, overview and scopes of Bioinformatics. <i>(Remember)</i></p> <p>CO2 ➤ Understand different types of Biological Databases: NCBI, EMBL, <i>(Understand)</i> PIR, SWISS-Prot, PubChem, and phylogenetic trees</p> <p>CO3 ➤ Gain concepts on sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues, Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series <i>(Knowledge)</i></p> <p>CO4 ➤ Apply and Evaluate sequence-based database searches, BLAST and FASTA algorithms, various versions of basic BLAST and FASTA <i>(Apply/Evaluate)</i></p> <p>CO5 ➤ Create Phylogenetic trees <i>(Create)</i></p> <p>CO6 ➤ Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and projects <i>(Analyze)</i> <i>(Evaluate)</i></p>	<p>Unit 1: Introduction to Bioinformatics</p> <ul style="list-style-type: none"> ➤ Importance, Goal, Scope ➤ Genomics, Transcriptomics, Systems Biology ➤ Functional Genomics, Metabolomics, ➤ Molecular Phylogeny ➤ Applications and Limitations of Bioinformatics <p>Unit 2: Biological Databases</p> <ul style="list-style-type: none"> ➤ Introduction to biological databases; Primary, secondary and compositedatabases; ➤ 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) <p>Unit 3: Data Generation and Data Retrieval</p> <ul style="list-style-type: none"> ➤ Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray) ➤ 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) <p>Unit 3: Basic Concepts of Sequence Alignment</p> <ul style="list-style-type: none"> ➤ 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. <p>Unit 4: Applications of Bioinformatics</p> <ul style="list-style-type: none"> ➤ Structural Bioinformatics (3-D protein, PDB) ➤ Functional genomics (genome-wide and high throughput approaches to gene and protein function) ➤ Drug discovery method (Basic concepts) <p>Unit 5: Biostatistics</p> <ul style="list-style-type: none"> ➤ Introduction ➤ Calculation of standard deviation, standard error, Co-efficient of Variance, Chi-square test, Z test, t-Test <p>Practical</p> <ul style="list-style-type: none"> ➤ Accessing biological databases ➤ Retrieval of nucleotide and protein sequences from the databases. ➤ To perform pair-wise alignment of sequences (BLAST) and interpret the output ➤ Predict the structure of protein from its amino acid sequence. ➤ To perform a —two-sample t- testI for a given set of data ➤ To learn graphical representations of statistical data with the help of computers (e.g. MS Excel) 	<p>Remember, Understand, Apply, Analyze, Evaluate, Create</p>

Endocrinology (DSE)

Zoo-HE-5036

Course Outcome	Unit/ Topic	Bloom's Taxonomy Level
<p>After the completion of this course, the students will be able to:</p> <p>CO1 ➤ Gain knowledge and Understand endocrine systems their functions and endocrine disorders (<i>Remember</i>)</p> <p>CO2 ➤ Understand Regulation of Hormone Action. (<i>Understand</i>)</p> <p>CO3 ➤ Apply knowledge to gain a general understanding of the approaches used to study endocrinology. (<i>Apply</i>)</p> <p>CO4 ➤ Classify and contrast different endocrine glands and their functions (<i>Analyze</i>)</p> <p>CO5 ➤ Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and projects (<i>Analyze Evaluate</i>)</p>	<p>Unit 1: Introduction to Endocrinology</p> <ul style="list-style-type: none"> ➤ History of endocrinology ➤ Classification, Characteristic and Transport of Hormones, Neuro secretions and Neuro hormones <p>Unit 2: Epiphysis, Hypothalamo-hypophysial Axis</p> <ul style="list-style-type: none"> ➤ Structure of pineal gland, Secretions and their functions in biological rhythm and reproduction. ➤ Structure of hypothalamus, Hypothalamic nuclei and their functions, ➤ Regulation of neuro endocrine glands, Feedback mechanisms ➤ Structure of pituitary gland, Hormones and their functions, ➤ Hypothalamo- hypophysial portal system, ➤ Disorders of pituitary gland. <p>Unit3: Peripheral Endocrine Glands</p> <ul style="list-style-type: none"> ➤ Structure, Hormones, Functions and Regulation of Thyroid gland, Parathyroid, Adrenal, Pancreas, Ovary and Testis ➤ Hormones in homeostasis, Disorders of endocrine glands <p>Unit4: Regulation of Hormone Action</p> <ul style="list-style-type: none"> ➤ Hormone action at Cellular level: Hormone receptors, transduction and regulation ➤ Hormone action at Molecular level: Molecular mediators ➤ Genetic control of hormone action <p>Practical</p> <ul style="list-style-type: none"> ➤ Dissect and display of Endocrine glands in laboratory bred rat* ➤ Study of the permanent slides of all the endocrine glands ➤ Demonstration of Castration/ovariectomy in laboratory bred rat* ➤ Designing of primers of any hormone 	<p>Remember, Understand, Apply, Analyze, Evaluate</p>

6th Semester (Honours)

Paper Name: Developmental Biology

Course Outcome	Unit/ Topic	Bloom's Taxonomy Level
After the completion of this course, the students will be able to:	Unit 1: Introduction > Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division	Remember, Understand, Apply, Analyze, Evaluate
CO1 > Understand the events that lead to formation of a multicellular organism from a single cell (Understand)	Unit 2: Early Embryonic Development > Gametogenesis, Spermatogenesis, Oogenesis > Types of eggs, Egg membranes > Fertilization (External and Internal): Changes in oocytes, Blocks to polyspermy; Planes and patterns of cleavage; > Types of Blastula; Fate maps (including Techniques); > Early development of frog and chick up to gastrulation; Embryonic induction and organizers	
CO2 > Understand the impact of Teratogenic agents and their effects on embryonic development (Understand)	Unit 3: Late Embryonic Development > Fate of Germ Layers; Extra-embryonic membranes in birds > Implantation of embryo in humans, > Placenta (Structure, types and functions of placenta)	
CO3 > Understand stem cells, and Amniocentesis and their implications in real life situations (Understand)	Unit 4: Post Embryonic Development > Metamorphosis: Changes, hormonal regulations in amphibians and insects > Regeneration: Modes of regeneration, epimorphosis, External morphallaxis and compensatory regeneration (with one example each) > Ageing: Concepts and Theories	
CO4 > Acquire basic knowledge of developmental process in frog, chick and mammals, the cellular processes of development and the molecular mechanisms underlying these. (Remember)	Unit 5: Implications of Developmental Biology > Teratogenesis: Teratogenic agents and their effects on embryonic development > In vitro fertilization > Stem cell (ESC) > Amniocentesis	
CO5 > Describe the general patterns developmental stages during embryogenesis. (Remember)	Practical > Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)	
CO6 > Elucidate the process of embryonic development (Apply)	> Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)	
CO7 > Contrast and compare between types of blastula, cleavage, and placenta (Analyze)	> Study of the developmental stages and life cycle of <i>Drosophila</i> from stock culture > Study of different sections of placenta (photo micrograph/slides)	
CO8 > Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and projects (Evaluate)	> Project report on <i>Drosophila</i> culture/chick embryo development	

Paper Name: Evolutionary Biology

Paper Code: ZOO-HC-6026

Course Outcome	Unit/ Topic	Bloom's Taxonomy Level
<p>After the completion of this course, the students will be able to:</p> <p>CO1 > Remember origin and evolution of life. Historical review of evolutionary concept, Geological time scale. <i>(Remember)</i></p> <p>CO2 > Gain knowledge evidences of evolution <i>(Remember)</i></p> <p>> Understand the variations, genetic drift to ensure that conservation for small threatened populations, origin and evolution of man, products of evolution and extinction <i>(Understand)</i></p> <p>CO3 > Use various software to generate interest towards the field of bioinformatics and coding used in programming language <i>(Apply)</i></p> <p>> Apply knowledge gained, on populations in real time, while studying speciation, behaviour and susceptibility to diseases. <i>(Apply)</i></p> <p>CO4 > Acquire problem solving and high order analytical skills by attempting numerical problems <i>(Apply)</i></p> <p>CO5 > Predict the practical implication of various evolutionary forces acting on the human population in the field of human health, agriculture and wildlife conservation. <i>(Analyse)</i></p> <p>CO6 > Create and interpret phylogenetic trees <i>(Create)</i></p> <p>CO7 > Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and projects <i>(Evaluate)</i></p>	<p>Unit1:</p> <ul style="list-style-type: none"> > Life's Beginnings: Chemogeny, RNA world, Biogeny, > Origin of photosynthesis > Evolution of eukaryotes <p>Unit2:</p> <ul style="list-style-type: none"> > Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism <p>Unit3:</p> <ul style="list-style-type: none"> > Evidences of Evolution: Fossil record (types of fossils) > Transitional forms, > Geological time scale, > Evolution of horse, > Molecular (universality of genetic code and protein synthesising machinery) three domains of life, neutral theory of molecular evolution, molecular clock, example of globin gene family, rRNA/cyt-c <p>Unit4:</p> <ul style="list-style-type: none"> > Sources of variations: Heritable variations and their role in evolution <p>Unit5:</p> <ul style="list-style-type: none"> > Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population) > Evolutionary forces upsetting H-W equilibrium > Natural selection (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load) > Mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. > Genetic Drift (mechanism, founder's effect, bottle neck phenomenon) > Role of Migration and Mutation in changing allele frequencies <p>Unit 6:</p> <ul style="list-style-type: none"> > Product of evolution: Micro evolutionary changes (inter-population variations, changes, races) > Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, > Adaptive radiation / macroevolution (exemplified by Galapagos finches) <p>Unit7:</p> <ul style="list-style-type: none"> > Extinctions, Background and mass extinctions (causes and effects), detailed example of K-T extinction and derivation of equation <p>Unit 8:</p> <ul style="list-style-type: none"> > Origin and evolution of man: H-W equ > Unique hominin characteristics contrasted with primate characteristics of one unit of selection > Primate phylogeny from <i>Dryopithecus</i> leading to <i>Homo sapiens</i> and types of selection > Molecular analysis of human origin <p>Unit 9:</p> <ul style="list-style-type: none"> > Phylogenetic trees, austin, Multiple effects, sequence alignment, construction of phylogenetic trees, interpretation of trees. Mutation in evolution <p>Practical</p> <ul style="list-style-type: none"> > Unit Study of fossils from models/pictures > Study of homology and analogy from suitable specimens (bones, teeth, etc.) > Study and verification of Hardy-Weinberg Law by chi square analysis > Graphical representation and interpretation of data of height/weight of a sample of 100 humans in relation to their age and sex. > Construction of phylogenetic trees with the help of bioinformatics tools (Clustal X, Phylip, NJ) and its interpretation. 	<p>Remember, Understand, Apply, Analyze, Evaluate, Create</p>

Paper Name: Fish and Fisheries

Paper Code: ZOO-HE-6026

Course Outcome	Unit/Topic	Bloom's Taxonomy Level
<p>After the completion of this course, the students will be able to:</p>	<p>UNIT 1: Introduction and Classification</p> <ul style="list-style-type: none"> ➤ General description of fish ➤ Account of systematic classification of fishes (up to classes) ➤ Classification based on feeding habit, habitat and manner of reproduction. 	<p>Remember, Understand, Apply, Analyze, Evaluate, Create</p>
<p>CO1 ➤ Gain knowledge on basics of classification of fish (Remember)</p> <p>➤ Identify fish based on their morphological feature. (Remember)</p>	<p>UNIT 2: Morphology and Physiology</p> <ul style="list-style-type: none"> ➤ Types of fins and their modifications ➤ Locomotion in fishes ➤ Hydrodynamics; Types of Scales; Use of scales in Classification and determination of age of fish ➤ Gills and gas exchange ➤ Swim Bladder: Types and role in Respiration, buoyancy ➤ Osmoregulation in Elasmobranchs ➤ Reproductive strategies (special reference to Indian fishes) ➤ Electric organs ➤ Bioluminescence; Mechanoreceptors; Schooling; Parental care; Migration 	
<p>CO2 ➤ Understand fish breeding and toxicology, fish morphology and physiology, aquaculture, fish diseases and fish preservation and processing of harvested fish (Understand)</p>		
<p>CO3 ➤ Elaborate the concept of fishery resources and need of their conservation. (Apply)</p> <p>➤ Make use of survey and identification tools and techniques for fish identification, conservation, processing and technology. (Apply)</p>		
<p>CO4 ➤ Gain knowledge on integrated fish forming to support income growth. (Remember)</p>	<p>UNIT 3: Fisheries</p> <ul style="list-style-type: none"> ➤ Inland Fisheries; Marine Fisheries ➤ Environmental factors influencing the seasonal variations in fish catches in the Arabian Sea and the Bay of Bengal ➤ Fishing crafts and Gears classification of fishes ➤ Depletion of fisheries resources ➤ Application of remote sensing and GIS in fisheries ➤ Fisheries law and regulations 	
<p>CO5 ➤ Compare and contrast different fishing gears (Analyze)</p>		
<p>CO6 ➤ Apply remote sensing and GIS in fisheries (Apply)</p>		
<p>CO7 ➤ Analyze and evaluate Fisheries law and regulations (Analyze)</p>		
<p>CO8 ➤ Design fishery management plans and gain knowledge on how to create brood stock management (Create)</p>	<p>UNIT 4: Aquaculture</p> <ul style="list-style-type: none"> ➤ Sustainable Aquaculture ➤ Extensive, semi-intensive and intensive culture of fish classification and determination of fish ➤ Pen and cage culture, Poly culture, Composite fish culture ➤ Types and role in Respiration ➤ Brood stock management ➤ Induced breeding of fish ➤ Management of finfish hatcheries ➤ Preparation and maintenance of fish aquarium; ➤ Preparation of compound diets for fish ➤ Role of water quality in aquaculture ➤ Fish diseases: Bacterial, viral and parasitic 	
<p>CO9 ➤ Enhance collaborative learning, communication and technical skills through practical sessions, team work, group discussions, assignments and projects (Evaluate)</p>		
	<p>UNIT 5: Fish in research</p> <ul style="list-style-type: none"> ➤ Transgenic fish ➤ Zebra fish as a model organism in research 	
	<p>Practical</p> <ul style="list-style-type: none"> ➤ Morphometric and meristic characters of fishes ➤ Study of <i>Petromyzon</i>, <i>Myxine</i>, <i>Pristis</i>, <i>Chimaera</i>, <i>Exocoetus</i>, <i>Hippocampus</i>, <i>Gambusia</i>, <i>Labeo</i>, <i>Heteropneustes</i>, <i>Anabas</i> 	
	<p>Unit 4</p> <ul style="list-style-type: none"> ➤ Study of different types of scales (through permanent slides/photographs). ➤ Study of crafts and gears used in Fisheries ➤ Water quality criteria for Aquaculture: Assessment of pH, conductivity, Total solids, Total dissolved solids ➤ Study of air breathing organs in <i>Channa</i>, <i>Heteropneustes</i>, <i>Anabas</i> and <i>Clarias</i> ➤ Demonstration of induced breeding in Fishes (video) ➤ Demonstration of parental care in fishes (video) ➤ Project Report on a visit to any fish farm /pisciculture unit/ Zebra fish rearing Lab. 	
	<p>UNIT 5: Fish in research</p> <ul style="list-style-type: none"> ➤ Transgenic fish ➤ Zebra fish as a model organism in research 	
	<p>Practical</p> <ul style="list-style-type: none"> ➤ Morphometric and meristic characters of fishes ➤ Study of <i>Petromyzon</i>, <i>Myxine</i>, <i>Pristis</i>, <i>Chimaera</i>, <i>Exocoetus</i>, <i>Hippocampus</i>, <i>Gambusia</i>, <i>Labeo</i>, <i>Heteropneustes</i>, <i>Anabas</i> 	
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	<p>UNIT 5: Fish in research</p> <ul style="list-style-type: none"> ➤ Transgenic fish ➤ Zebra fish as a model organism in research 	

Paper Name: Dissertation

Paper Code: ZOO-HE-6056

Course Outcome	Unit/ Topic	Bloom's Taxonomy Level
<p>After the completion of this course, the students will be able to:</p> <ul style="list-style-type: none">CO1 > Gather, form and critique knowledge from research studies (Remember)CO2 > Identify and investigate a research problem (Remember, Understand)CO3 > Apply an appropriate research design and associated methods rigorously (Apply)CO4 > Conduct the research project in an ethical fashion (Analyze)CO5 > Draw appropriate conclusions and indicate the significance of the findings for educational practice and research (Evaluate)CO6 > Report the research in a scholarly fashion appropriate to the disciplinary area (Create)	<p>Dissertation</p>	<p>Remember, Understand, Apply, Analyze, Evaluate, Create</p>

