

As per the NEP 2020

Bachelor of Science

Zoology

(Effective from Academic Year 2024-2025 onwards)



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Semester – I**Learning Objectives**

- To make students aware about the diversity of Animals present on the planet and how are they possibly related to each other in light of evolution.

Learning outcomes

By studying this course students will gain basic knowledge on

- The diversity of animals
- Their general characteristics
- Various groups of animals and their evolutionary relationships
- Basic principles and concepts of evolution that contribute to animal diversity

Course Title:	Biology of Non-Chordates		Course Code: 24BZO5101T
Total Lecture hour	45		Hours
Unit I	Elementary Idea of Animal Taxonomy: General principles of taxonomy, Five-kingdom concept, Origin of Metazoa, Basis of classification of non-chordata: Level of Organization, Symmetry, coelom, segmentation and embryogeny. Salient features and classification of Protozoa and Porifera, Coelenterata, Ctenophora, Platyhelminthes, Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata and Hemichordata upto classes level.	12	
Unit II	Lower Non-Chordates Locomotion, Osmoregulation and Reproduction in Protozoa, Canal System in Porifera, Polymorphism in Hydrozoa, Coral reefs, Life history of Obelia & Taenia solium, Larval forms of Coelenterates & Platyhelminthes, Life history of Ascaris lumbricoides and parasitic adaptations in helminthes.	13	
Unit III	Higher Non-Chordates-I Locomotion, Digestion, Respiration, Blood Circulation, Reproduction in Neries, Metamerism in Annelida, Vermicomposting, Apiculture, Sericulture, Lac Culture. Metamorphosis in Insects, Larval form of Crustacea.	10	
Unit IV	Higher Non-Chordates-1 Torsion in Gastropods, Locomotion, Digestion, Respiration, Blood Circulation, Reproduction in Pila, Pearl Culture. Water-vascular system in Asteroidea, Larval forms of Mollusca, Echinodermata and Hemichordata	10	
Reference Books:			
1	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		
2	Barrington,E.J.W.(1979).Invertebrate Structure and Functions.II Edition,E.L.B.S.and Nelson		
3	Richard C Brusca,Gonzalo Giribet, Wendy Moore Invertebrates 4th Edition Oxford University Press		
4	Richard Fox , Robert D. Barnes, Edward E. Ruppert, Invertebrate Zoology: A Functional Evolutionary Approach, Brooks/Cole; 7th edition edition2003		
5	Hyman, L.H. Invertebrate Series (Recent edition)		
6	Parker JJ and WA Haswel Textbook of Zoology. Vol I and II		
7	Kotpal, R.L.2022 Modern text book of Zoology: Invertebrates. Rastogi Publication, Meerut.		


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Course Title:		Non-Chordate Laboratory	Course Code: 24BZO5101P
1	Microscopic Technique : 1. Organization and working of optical microscopes: dissecting and compound microscope. 2. General methods of microscopical permanent preparations: Narcotization: fixing and preservation: washing: staining: destaining: dehydration: clearing and dealcoholization: mounting. General idea of composition. preparation and use of: i. Fixatives : Formalin. Bouin's fluid. ii. Stains: Borax carmine. aceto-carmine, aceto-orcein. haematoxylin, eosin. iii. Common reagents: Normal saline, Ringer's solution, acid water. acid alcohol and Mayer's albumin. 3. Collection and Culture Methods. i. Collection of animals from their natural habitat during field trips. e.g.. Amoeba, Paramecium, Euglena. Planaria, Earthworm. Daphnia, Cyclops. etc. ii. Culture of Paramecium in the laboratory and study of its structure. life processes and behaviour in the living state.		
2	Anatomy : Earthorm: External features, general viscera and alimentary canal. reproductive system. nervous system. Cockroach: External features, appendages (wing and leg), mouth parts. alimentary canal. reproductive and nervous systems and salivary gland. Pila: Alimentary Canal, Nervous system, Gill Lamella, Osphradium Prawn: Appendages, Alimentary Canal, Nervous system, Statocyst, Hastate Plate		
3	Study of Specimen: Spongilla, Leucosolenia, Sycon, Euspongia, Euplectella, Hyalonema, Physalia, Porpita, Sea anemone (Metridium), Alcyonium ,Gorgonia, Pennetula, Renilla, Jelly Fish Beroe Cestum Ctenoplanea Dugesia/Plannaria Taenia solium Ascaris, Male& Female Ascaris, Aphrodite Arenicola Chaetopterus Sabella Polynoe Eunice Neries Heteronerics Acanthobdella Pantobdella Polygordius, Bonellia, Lingula Apus Balanus Crab Cray Fish Astacus Eupagarus Sacculina with Host Desert Locust Squilla Silk Moth with Development Stage Lac Insect with Development Stage Millipede Peripatus Aplysia Dentalium Chiton Doris, Limex Argonauta Nautilus Neopiliana Solen Mantis White Grub Pearl Oyester Cyprea, Pentaceros Echinus Ophiothrix Antedon Cucumaria, Star Fish, Balanoglossus		
4	Study of Permanent Slide: Radiolarian and Forminifera ooze, Euglena, and Paramecium, Binary fission and Conjugation in Paramecium, Monocystis, Nyctotherus Gemmule Sponge spicules,V.S. Sycon, T.S. Sycon, Obelia medusa, Miracidium, Redia and Cercaria larvae of Fasciola, Scolex of Taenia. Mature and gravid proglottids of Taenia solium, Dracanculus Enterobius Wucheria T.S. of Leech through crop pockets, Trochophore larva Daphnia Cyclopus Nauplius, Zoa and Megalopa , Veliger and Glochidium larva of Mollusca, T.S. of arm of star fish, Bipinnaria and Auricularia larva, T.S. Balanoglossus through collar and proboscis, Tornaria larva (Charts and Photographs can be used)		
5	Permanent Preparation and Study of the following Paramecium, Euglena, forminiferous shells, sponge spicules, spongin fibres, gemmul . Hydra, Obelia colony and medusa. Parapodium of Nereis and heteronereis, ovary, nephridia, nerve ring and setae of earthworm salivary glands and trachea of Cockroach, Cyclops and Daphnia (Any other as per the availability)		
6	Visit to local area and study of observed non-chordates,		
Reference Books:			
1	Verma P. S. A Manual of Practical Zoology: Invertebrates. S Chand Publication		
2	Kotpal,R.L.2022 Series From Phylum-Protozoa to Echinodermata, RastogiPublication,Meerut		


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Semester – II**Learning Objectives**

- To impart in-depth knowledge about the structural patterns and a comparative account of the different organ systems of vertebrates.
- To understand the account of the functional and comparative morphology provides a deep understanding of animal diversity and the adaptive changes the vertebrates have gone through during evolution from common ancestors
- To help students identify the body plan types of complex chordates and their systematic organization based on evolutionary relationships, structural and functional affinities.
- To provide an in-depth knowledge on the embryonic and post embryonic developmental processes.
- To apprise the students of the fascinating aspect of the development of a single fertilized egg to mature into a fully developed complex organism.
- To explain the basic principles and concepts the developmental processes from a single cell system to a multi-cellular system.
- To provide the undergraduate students an in-depth knowledge on the embryonic and post embryonic developmental processes.
- By understanding the developmental processes, the students can relate to errors occurring during development leading to congenital disorders and human diseases.
- To familiarize the students with the technique of IVF and pre-diagnostic methods to identify any abnormality arising during development.
- To make the students aware of the areas of great interest including stem cell therapy, tissue engineering and regenerative medicine.

Learning outcomes

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

- Have a better understanding of the evolutionary significance of comparative anatomy.
- Understand the importance of morphology and anatomy of organisms in relation to evolution.
- Appreciate the comparative anatomy among vertebrates that provides evolutionary evidences.
- Enhance collaborative learning and communication skills through practical sessions, teamwork, group discussions, assignments, and projects.
- Appreciate the events that lead to the formation of a multicellular organism from a single fertilized egg.
- Better understand the general patterns and sequential developmental stages during embryogenesis.
- Gain knowledge of the general mechanisms involved in morphogenesis.
- Comprehend the processes of ageing to improve the overall health and quality of life in aged people. Acquire basic knowledge and importance of latest techniques like stem cell therapy, in vitro fertilization and amniocentesis etc.

Course Title:	Comparative Anatomy and Development Biology of Vertebrates	Course Code: 24BZO5201T
Total Lecture hour 45		Hours
Unit I	Elementary Idea of Chordates: Classification and Salient feature of phylum Chordata up to orders (up to subclass in mammals), Salient Feature of Herdmania, Branchiostoma and Petromyzon (Sea Lamprey). Ascidian Tadpole Larva and its retrogressive Metamorphosis., Ammocete larva, Pisces;.	12

	swim bladder and accessory respiratory organs, parental care in Pisces and Amphibia	
Unit II	Comparative anatomy of Vertebrates: Structure of Integuments, Brief account of Alimentary canal, Evolution of Aortic Arches and Heart, Evolution of kidney and Urinogenital ducts, Difference between venomous and non venomous snakes, flight adaptation in birds, Adaptive radiation in mammals.	10
Unit III	Historical perspectives and basic concepts of Developmental Biology, Gametogenesis: Oogenesis, Spermatogenesis, Types of egg, Egg envelopes, Mechanism of Fertilization, Blocks to polyspermy; Cleavage; Types of Blastula; Fate maps; Gastrulation in frog and chick, Embryonic induction and organizers, Fate of Germ Layers.	13
Unit IV	Metamorphosis and its hormonal regulation in Amphibians, Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: concepts and theories. Teratogenesis: Teratogenic agents and their effects on embryonic development; IVF, Embryonic stem cell (ESC), Amniocentesis. Stem cell technology. Extra-embryonic membranes in birds; Structure, types, and functions of placenta.	10
Reference Books:		
1	Kotpal RL(2022) Modern Textbook of Zoology –Vertebrates; Rastogi Publications - Meerut; 2022	
2	Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford University Press.	
3	Tiwari SK (2006) Fundamentals of World Zoogeography, Sarup & Sons SUGGESTED	
4	Lewis Wolpert (2010). Principles of Development. II Edition, Oxford University Press.	
5	Verma PS. and Agarwal V.K (2014) Chordate Embryology, S Chand Publication.	

Course Title:	Comparative Anatomy and Development Biology of Vertebrates	Course Code: 24BZO5201P
Anatomy		
General viscera, afferent and efferent branchial blood \ vessels, eye.muscles and their innervation, brain, cranial nerves, and internal ear of any edible Fish. Blood vascular, Urinogenital and Nervous system (brain, cranial nerves, spinal nerves) of rat or any suitable mammal Permanent preparations and study of the following:(With the help of Chart and Model) Spicules and pharyngeal wall of Herdmania: Scales of Fish, Stripped muscle fibres. Osteology: A Comparative study of articulated and disarticulated bones of Frog, Varanus, Fowl and Rabbit (or any other mammal). Study of Microscopic slides: Whole mounts of oral hood velum and pharyngeal wall of Amphioxus, T.S. of Amphioxus through various regions; tadpole larva of Ascidia; whole mounts of Pyrosoma, Salpa, Doliolum and Oikopleura; V.S. of skin of fish; T.S. of body of fish through various regions, V.S. of Skin of frog; T.S. of cartilage, bone, testis and ovary of frog; V.S. of skin of bird; V.S. of mammalian skin, TS of Mammalian Bone. Study of museum specimens Ascidia, Ciona, Botryllus, Ammocoete, Petromyzon, Myxine, Zygeana (Sphyrna), Torpedo, Chimaera, Acipenser, Amia or Lepidosteus, Labeo, Clarias, Anguilla, Hippocampus, Exocoetus, Echenes, any flat-fish, Protopterus, Ichthyophis or any blind-worm. Proteus, Ambystoma, Axolotl, Siren, Alytes, Hyla, Tastudo, Chelone, and fresh water tortoise, Sphenodon, Hemidactylus. Phrynosoma, Draco, Chameleon, Eryx. Hydromphis. Naia. Viper. Bungarus.		
Laboratory		

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Unit II	Cytoskeleton Structure and Functions: Microtubules, Microfilaments and Intermediate filaments. Structure of Nucleus, Nuclear envelope, Nuclear pore complex, Transport of molecules across nuclear membrane, nucleolus; Chromatin: euchromatin, heterochromatin. Chromosome Structure, Giant Chromosomes. Cell cycle, Mitosis and its regulation. Meiosis Cell Signaling through G-protein coupled receptor (GPCR) and role of secondary messenger: cAMP and protein kinase A.	10
Unit III	DNA Replication & Transcription (Elementary Idea) DNA replication in prokaryotes and eukaryotes-replication machinery and mechanisms, semi-conservative, bidirectional and semi-discontinuous replication, Replication of circular and linear double stranded DNA, Replication of telomeres. Transcription and Machinery and mechanism of transcription in prokaryotes and eukaryotes, RNA polymerases, Transcription unit, Transcription factors,	12
Unit IV	Post Transcriptional Modifications ,Translation & Gene Regulation (Elementary Idea) Capping, Polyadenylation RNA Splicing Mechanism, Genetic code. Process of protein synthesis in prokaryotes,Transcription regulation in prokaryotes: Lac operon & Catabolic repression and Trp operon & attenuation.	8
Reference Books:		
1	Cooper, G.M., Hausman, R.E. (2019) The Cell: A Molecular Approach. VIII Edition, ASM Press and Sinauer Associates.	
2	Becker, Kleinsmith, and Hardin (2018) The World of the Cell, IX Edition, Benjamin Cummings Publishing, San Francisco.	
3	Karp, G. (2015). Cell and Molecular Biology: Concepts and Experiments, VIII Edition, John Wiley & Sons Inc.	
4	Lodish et. al., (2007), Molecular Cell Biology, W.H. Freeman and Company, New York, USA	
5	Alberts et. al., (2008), Molecular Biology of the Cell Garland Science, Taylor & Francis Group, New York, USA.	

Course Title:	Cell and Molecular Biology Laboratory	Course Code: 24BZO6301P
1. Microscopy: • Compound microscope: principle, components, and handling • Phase contrast microscope • Electron microscope • Differential Interference Contrast (DIC) Microscope 2. Principle and types of cell fixation and staining; Cell fractionation. 3. To study prokaryotic cells by Gram staining and eukaryotic cell (cheek cells) by hematoxylin/methylene blue. 4. To study the effect of hypotonic, isotonic, and hypertonic solutions on cell permeability. 5. Preparation of a temporary slide of squashed and stained onion root tip to study various stages of mitosis. 6. Study of Meiosis in testis of Grasshopper or Cockroach. 7. Study of Polytene chromosomes from Chironomous/Drosophila larva. 8. Study of various stages of meiosis through permanent slides. 9. Preparation of stained mount to show the presence of Barr body in human female blood cells/cheek cells. 10. Isolation of DNA from suitable sample. 11. Cytochemical demonstration of:		

	a. DNA by Feulgen reaction b. Mucopolysaccharides by PAS reaction c. Proteins by Mercuric Bromophenol Blue/Acid Fast Green
	Reference Books:
1	Gupta, R., Makhija, S. and Toteja, R. (2018). Cell Biology Practical Manual, Prestige Publishers, New Delhi-110003.
2	Sharma, V. K. (1991). Techniques in Microscopy and Cell Biology, Tata McGraw Hill Publishing Company Limited, New Delhi.

Semester – IV

Learning Objectives

Students will learn about the chemical properties of molecules, determine the ways in which they interact and react with each other and understand how body works at system level.

Learning outcomes

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

- Explain human anatomy and physiology: describe cellular levels of organization, and the basics of biochemistry and cell biology.
- Discuss system physiology and their control and regulation mechanisms.
- Explain and examine histological samples and basic laboratory practice in cell culture
- Discover the interaction between body systems and the outside environment for the exchange of materials, the capture of energy, the release of waste, and the overall maintenance of the internal systems that regulate the exchange.
- Will be able to undertake investigations and perform analyses that provide information about biochemistry and solve related problems.

Course Title:	Mammalian Physiology and Biochemistry	Course Code: 24BZO6401T
Total Lecture hour 45		
Unit I	Role of enzymes in Digestion, Water and Fat soluble Vitamines Respiration: Mechanism of gas exchange in lungs, Transportation of Carbon dioxide and oxygen via blood and control of breathing. Blood Composition, Mechanism of Blood Clotting Heart: Conduction and regulation of heart beat; nervous and chemical regulation of heart rate, Cardiac cycle and ECG.	12
Unit II	Structure of Nephron, Physiology of urine formation, osmoregulators and osmoconformers. Muscle: Types of muscles, ultrastructure of skeletal muscle, Types of Muscles, Chemical and Physiological basis of skeletal muscle contraction, Sliding filament theory of muscle contraction.	10
Unit III	Types of Neurons, structure of Neuron , Conduction of nerve impulse, Action Potential, Ultrastructure of striated muscle, Mechanism of Hormone action, Structure ,function and disorders of different Endocrine gland (Hypothalamus, Pineal gland,Pituitary gland, Thyroid gland, Parathyroid, Adrenal, and Pancreas) Functions and Regulation of Ovary and Testis	11
Unit IV	Enzyme Kinetics : Derivation of Michaelis-Menten equation, Concept of K_m and V_{max} .	12

	Lineweaver-Burk plot, Enzyme inhibition; Allosteric enzymes and their kinetics Carbohydrate Metabolism: Sequence of reactions and regulation of glycolysis, Citric acid cycle, Pentose Phosphate pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis. Lipid Metabolism : β-oxidation of saturated fatty acids ,Biosynthesis of Fatty acid and triglycerides Protein Metabolism : Catabolism of amino acids: Transamination, Deamination, and Decarboxylation, Urea cycle; Fate of C-skeleton of, Glucogenic and Ketogenic amino acids.
Reference Books:	
1	Marieb E.N. and Hoehn K.N. (2009) Human Physiology. Pearson Education Publication , 9th edition
2	Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons.
3	Guyton & Hall, (2016) Textbook of Medical Physiology. Elsevier, 12 th edition.
4	Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well,P.A. (2022). Harper's Illustrated Biochemistry, 32 nd Edition, International Edition, The McGraw-Hill Companies Inc.
5	Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.

Course Title:	Mammalian Physiology and Biochemistry Laboratory	Course Code: 24BZO6401P
- Determination of ABO Blood group, study of blood smear - Enumeration of red blood cells and white blood cells using haemocytometer - Estimation of haemoglobin using Sahli's haemoglobinometer - Preparation of haemin and haemochromogen crystals - Recording of blood pressure using a sphygmomanometer - Examination of sections of mammalian slides: Oesophagus, Stomach, Duodenum, Ileum, Rectum, Liver, trachea, lung, kidney, Pineal gland, Pituitary gland, Thyroid gland, Parathyroid, Adrenal, Pancreas, Testis and Ovary). - Estimation of total protein in given solutions - Detection of SGOT and SGPT or GST and GSH in serum/ tissue - To study the enzymatic activity of Trypsin/ Lipase. - To perform the Acid and Alkaline phosphatase assay from serum/ tissue. - Test for Reducing and Non-reducing Sugar(Carbohydrates), Protein and Lipid - Seperation of Amino Acids by TLC / Paper chromatography method.		
Reference Books:		
1	Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.	
2	S.P. Singh (2018) Practical Manual of Biochemistry 8th Edition, CBS Publishers	