NARAJOLE RAJ COLLEGE

(NAAC Accredited 'B' Grade Govt. Aided College)
NARAJOLE: PASCHIM MEDINIPUR: WEST BENGAL: Pin-721211
E-mail: narajolerajcollege@rediffmail.com
Website: http://www.narajolerajcollege.ac.in

Programme Specific Outcomes (PSOs)

Zoology (Hons.)

The students of Zoology (Hons.) will acquire an in-depth theoretical and experimental knowledge about the taxonomic position and biodiversity of Non-Chordates & Chordates, their relationships with the environmental ecology, the biology of cellular organelles, their physiology as well as different biochemical reactions at the cellular and system levels, comparative anatomical systems of Vertebrates and their metabolic activities, basic concept on health, diseases and the perspectives of immunology, central dogma of molecular biology and the gene interactions, fundamental mode of embryonic development and the different evolutionary concepts. This programme also opens up the career paths to select in many related and sub-related areas like Apiculture, Sericulture, Aquaculture and its management, values of wild life management and conservational ethics, basic concept of Parasitism and historical perspective of Microbiology and the different research works, scientific laboratories, instrumentation etc.

After completion of the programme, the graduates will be capable of-

PSO1: To understand the taxonomic position, general and identifying characteristics, classification, body organization, ecological role, life cycle, physiological mechanisms and biological significance of animals belonging to Protozoa, Metazoa, Porifera, Cnidaria, Ctenophora, Platyheminthes and Nematoda.

PSO2: To understand the interaction and relationship between abiotic and biotic factors of the environment, the different attributes of population and population interactions.

PSO3: To have a basic idea on wildlife in-situ and ex-situ conservation, the different management strategies for tiger conservation and the concept of Wild Life Protection Act (1972).

PSO4: To understand the taxonomic position, general and identifying characteristics, classification, body organization, ecological role, life cycle, physiological

mechanisms and biological significance of animals belonging to Phylum Annelida, Arthropoda, Onycophora, Mollusca, Echinodermata and Hemichordata.

PSO5: To understand how the cellular components are used to generate and utilize energy in cells, the underlying mitotic and meiotic cell division, structure of Prokaryotic and Eukaryotic cells and the different cell signalling pathways.

PSO6: To understand the taxonomic position, general and identifying characteristics, classification, body organization, ecological role, life cycle, physiological mechanisms and biological significance of animals belonging to Protochordata, Agnatha, Pisces, Amphibia, Reptilia, Aves and Mammals.

PSO7: To understand how mammalian body get nutrition from different macrobiomolecules and the structure, location, classification, and functions of different tissues, cells and systems.

PSO8: To understand the structure, function, classification, biological importance and metabolism of proteins, carbohydrates, lipids, and nucleic acids.

PSO9: To study the history, classification of honeybees, social organization of bee colony, the different bee keeping methods and equipment for the extraction of honey in Apiculture.

PSO10: To understand the structure, functions, and comparative anatomy of different body systems from fish to mammals.

PSO11: To understand the physiology of different body systems in different Vertebrate groups.

PSO12: To understand the different cells, organs, and molecules involved in immunology and basic concepts of health and disease.

PSO13: To study the different types of silkworms, and their life-cycles and the history, and present status of Sericulture.

PSO14: To understand the salient features and models of DNA and RNA and the different steps and mechanisms involved in the central dogma pathways of Molecular Biology.

PSO15: To study the principles of inheritance of Mendelian Genetics and its extension, and detailed understanding of the chemical basis of heredity.

PSO16: To enhance the students with an in-depth knowledge about the importance of sustainable fishing and protecting the marine environment and how fish adapt themselves to better survive their environment.

PSO17: To understand the basic concepts of the phases of development, cell-cell interaction, differentiation and growth, and differential gene expression.

PSC18: To understand the different evolutionary concepts and the basic ideas and theories behind the origin of life on earth.

PSC19: To understand the different Parasitological terms and the morphology, life cycle, prevalence, epidemiology, pathogenicity, diagnosis, prophylaxis and treatment of certain important parasites.

PSC20: To understand the different prokaryotic and eukaryotic pathogens and the different microbial diseases, their pathogens, symptoms, pathogenesis, mode of action and preventive measures.

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Paschim Medinipur
Estd.-1966

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Programme Specific Outcomes (PSOs)

Zoology (General)

The students of Zoology (Gen or DSC) will acquire their theoretical and experimental in-depth knowledge on the taxonomic position and animal diversity of Non-Chordate and Chordate animals, comparative anatomy and developmental biology of Vertebrates, the different life sustaining systems of the body and functions of the various macrobiomolecules in living organisms, gene interactions and their evolutionary concepts, basic concept and scope of Biotechnology and on the different techniques involved in gene manipulation, different non-infectious and infectious diseases and different medical diagnostics and its importance. This programme also opens up the career paths to select in many related and sub-related areas like academics in Aquaculture, Apiculture and Sericulture, different scientific laboratories, instrumentation etc.

After completion of the programme, the graduates will be capable of-

PSO1: To understand the details of animal kingdom, its classification and identifying features of both Non-Chordates and Chordates.

PSO2: To understand the structure and functions of different body systems in vertebrate groups.

PSO3: To understand the early and late embryonic development and the different fundamental processes in development.

PSO4: To understand the structure, function and physiological mechanisms of different systems of the body.

PSO5: To study the structural chemistry, metabolism and the different biosynthetic pathways and cycles of proteins, carbohydrates and lipids.

PSO6: To study the different diagnostics methods of different diseases.

PSO7: To study the principles of inheritance of Mendelian Genetics and its extension, and detailed understanding of the chemical basis of heredity.

PSO8: To study the basic techniques involved in animal cell culture and organs culture, the different recombinant DNA technology and isolation of genes.

PSO9: To gain knowledge on aquatic biomes, freshwater and marine ecosystem.

PSO10: To study the history, classification of honeybees, social organization of bee colony, the different bee keeping methods and equipment for the extraction of honey in Apiculture.

PSO11: To study the different types of silkworms, and their life-cycles and the history, and present status of Sericulture.

PSO12: To gain knowledge on aquatic biomes, freshwater and marine ecosystem.

PSO13: To study the causes, effects and control measures of pollution of aquatic resources, its management, and conservation.

PSO14: To understand the potential scope of aquarium fish industry, biology of different aquarium fishes and the maintenance of aquarium.

PSO15: To understand the various sources, effects and control measures of various environmental hazards and the fate of toxic and persistent substances in the environment.

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Course Outcome

Zoology (Hons.)

Semester	I
Title of Course	Non- Chordates-I (CC-1)
Paper Code	C1T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (H) of Semester-I will acquire an in-depth knowledge on the taxonomic position of Non-Chordate diploblastic acoelomate animals on the environment and on the Animal Diversity of Non-Chordate phyla by studying this course.

The theory paper (C1T) of this course (CC-1) provides the student with-

CO1: To understand the details of animal kingdom.

CO2: To understand the basics of animal classification.

CO3: To understand the definitions of classification, systematics, and taxonomy.

CO4: To understand the taxonomic types and hierarchy.

CO5: To understand the codes of zoological nomenclature, principle of priority, synonymy and homonymy and the six-kingdom concept of classification by Carl Woese.

CO6: To understand the taxonomic position of Protozoa, Metazoa, Porifera, Cnidaria, Ctenophora, Platyheminthes and Nematoda.

CO7: To understand the general and identifying characteristics of animals belonging to Protozoa, Metazoa, Porifera, Cnidaria, Ctenophora, Platyheminthes and Nematoda.

CO8: To understand the body organization of animals belonging to phylum Protozoa, Metazoa, Porifera, Cnidaria, Ctenophora, Platyheminthes and Nematoda.

CO9: To understand the life cycle, pathogenicity and control measures of certain important animals belonging to phylum Protozoa, Metazoa, Porifera, Cnidaria, Ctenophora, Platyheminthes and Nematoda.

CO10: To understand the physiological mechanisms of animals belonging to phylum from Protozoa, Metazoa, Porifera, Cnidaria, Ctenophora, Platyheminthes and Nematoda.

Semester	I
Title of Course	Non-Chordates I Lab (CC-1)
Paper Code	C1P (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (H) of Semester-I will acquire an in-depth concept on the identification, significance, staining and mounting of Non-Chordate animals by studying this course.

The theory paper (C1P) of this course (CC-1) provides the student with-

CO1: To study the whole mount of *Euglena*, *Amoeba* and *Paramoecium*.

CO2: To identify *Amoeba*, *Euglena*, *Entamoeba*, *Opalina*, *Paramecium*, *Plasmodium vivax* and *Plasmodium falciparum* (from the prepared slides).

CO3: To identify Sycon, Neptune's Cup, Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora.

CO4: To identify and acquire knowledge on the significance of adult *Fasciola hepatica*, *Taenia solium* and *Ascaris lumbricoides*.

CO5: To study the staining and mounting of protozoan animal from the gut of cockroach.

Semester	I
Title of Course	Ecology (CC-2)
Paper Code	C2T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (H) of Semester-I will acquire the concept on the relationships between the biotic and abiotic factors of the environment and its effect in living populations by studying this course.

The theory paper (C2T) of this course (CC-2) provides the student with-

CO1: Understanding the interaction between organisms and enviorment.

CO2: To understand the relation between abiotic and biotic factors.

CO3: To be able to describe various biological interactions.

CO4: To understand how change in population affect the ecosystem.

CO5: To understand the exchange of nutrients within the ecosystem.

CO6: To know the history of ecology, concept of autecology and synecology, different levels of organization, laws of limiting factors and study of physical factors and the Biosphere.

CO7: To understand the different attributes of population and population interactions, Gause's Principle with laboratory and field examples and Lotka-Volterra equation for competition.

CO8: To understand the community characteristics and the concept of ecotone, edge effect and ecological succession with examples.

CO9: To understand the different types of ecosystems with examples in detail, food chain, food web, ecological pyramids and ecological efficiencies.

CO10: To understand the nutrient and biogeochemical cycles with examples.

CO11: To have a basic idea on wildlife in-situ and ex-situ conservation, the different management strategies for tiger conservation and the concept of Wild Life Protection Act (1972).

Semester	I
Title of Course	Ecology Lab (CC-2)
Paper Code	C2P (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (H) of Semester-I will acquire practical knowledge on the different concepts of ecology and ecosystem by studying this course.

The lab paper (C2P) of this course (CC-2) provides the student with-

CO1: To study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.

CO2: To determine the population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community.

CO3: To study an aquatic ecosystem: phytoplankton and zooplankton and measurement of area, temperature, turbidity/penetration of light and determination of pH.

CO4: To determine dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO_2.

CO5: To study and prepare dissertation report on a visit to National Park/Biodiversity Park/Wild life sanctuary in a coastal area.

Semester	II
Title of Course	Non- Chordates-II (CC-3)
Paper Code	C3T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (H) of Semester-II will acquire an in-depth knowledge on the taxonomic position of Non-Chordate triploblastic coelomate animals on the environment and will help them to create a bridge between Non-Chordate and Chordate evolution by studying this course.

The theory paper (C3T) of this course (CC-3) provides the student with-

CO1: To describe understand the taxonomic position and unique characters animals belonging to Annelida, Arthropoda, Onycophora, Mollusca, Echinodermata and Hemichordata.

CO2: To understand the evolution of coelom and metamerism.

CO3: To recognize the general and identifying characteristic features of animals belonging to Phylum Annelida, Arthropoda, Onycophora, Mollusca, Echinodermata and Hemichordata.

CO4: To understand the classification of animals belonging to Phylum Annelida, Arthropoda, Onycophora, Mollusca, Echinodermata and Hemichordata.

CO5: To recognize life functions body organization of animals belonging to Phylum Annelida, Arthropoda, Onycophora, Mollusca, Echinodermata and Hemichordata.

CO6: To study the ecological role of animals belonging to Phylum Annelida, Arthropoda, Onycophora, Mollusca, Echinodermata and Hemichordata.

CO7: To recognize the diversity of animals belonging to Phylum Annelida, Arthropoda, Onycophora, Mollusca, Echinodermata and Hemichordata.

CO8: To understand the physiological mechanisms of animals belonging to Phylum Annelida, Arthropoda, Onycophora, Mollusca, Echinodermata and Hemichordata.

CO9: To understand the evolutionary significance of animals belonging to Phylum Annelida, Arthropoda, Onycophora, Mollusca, Echinodermata and Hemichordata.

CO10: To understand the relationships between Chordates and Non-Chordates.

CO11: To recognize the affinities of Non-Chordates with Chordates.

Semester	II
Title of Course	Non-Chordates II (CC-3)
Paper Code	C3P (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (H) of Semester-II will acquire the practical knowledge on the identification, study and significance of Chordate animals; and also have a vivid experience by learning the dissection, and mounting of different body systems of Chordate animals by studying this course.

The lab paper (C3P) of this course (CC-3) provides the student with-

CO1: To study some important specimens belonging to Phylum Annelida, Arthropoda, Mollusca and Echinodermata along with their systematic position and identifying characters.

CO2: To study the digestive system, septal nephridia and pharyngeal nephridia of earthworm.

CO3: To study the transverse section through pharynx, gizzard, and typhlosolar intestine of earthworm.

CO4: To study the mounting of mouth parts and dissection of digestive system and nervous system of *Periplaneta*.

CO5: To prepare a Project Report on larval forms of crustacean, mollusc and echinoderm.

Semester	II
Title of Course	Cell Biology (CC-4)
Paper Code	C4T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (H) of Semester-II will develop students' knowledge on the structures and purposes of basic components of prokaryotic and eukaryotic cells and also acquire an in-depth concept on the membrane macromolecules and cell organelles and principles of the cell theory by studying this course.

The theory paper (C4T) of this course (CC-4) provides the student with-

CO1: To understand how the cellular components are used to generate and utilize energy in cells.

CO2: To understand the cellular components underlying mitotic and meiotic cell division.

CO3: To study the basic structure of Prokaryotic and Eukaryotic cells, viruses, viroid, prion and mycoplasma.

CO4: To understand responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

CO5: To study the ultra structure and composition of Plasma membrane, Fluid mosaic model, Active and Passive transport across membrane, Facilitated transport and the concept of cell junctions which include tight junctions, gap junctions and desmosomes.

CO6: To understand the structure and functions of Endoplasmic Reticulum, Golgi Apparatus and Lysosomes.

CO7: To study the structure of mitochondria, its semi-autonomous nature, the endosymbiotic hypothesis of Mitochondrial Respiratory Chain and Chemi-osmotic hypothesis.

CO8: To understand the structure and functions of peroxisomes and centrosome.

CO9: To study the type, structure and functions of cytoskeleton, accessory proteins of microfilament & microtubule and have a brief idea about molecular motors.

CO10: To understand the structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus, Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome).

CO11: To develop a clear concept on cell cycle and its regulation, concept of oncogenes and tumor suppressor genes with special reference to p53.

CO12: To understand the process of cell division in both somatic and germ cell.

CO13: To study the different cell signalling transduction pathways and types of signaling molecules and receptors GPCR.

CO14: To understand the role of second messenger (cAMP), extracellular matrix-cell interactions and the concept of Apoptosis and Necrosis.

Semester	II
Title of Course	Cell Biology (Lab) (CC-4)
Paper Code	C4P (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (H) of Semester-II will acquire the practical knowledge on how to study the various stages of mitosis and meiosis and learn to prepare temporary and permanent stained slides.

The lab paper (C4P) of this course (CC-4) provides the student with-

CO1: Preparation of temporary stained squash of onion root tip to study various stages of mitosis.

CO2: Study of various stages of meiosis.

CO3: Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.

CO4: Preparation of permanent slide to demonstrate DNA by Feulgen reaction.

CO5: Preparation of permanent slide to demonstrate cell viability study by Trypan Blue staining.

CO6: Preparation of permanent slide to demonstrate mitochondria identification through vital staining.

Semester	III
Title of Course	Chordates (CC-5)
Paper Code	C5T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (H) of Semester-III will acquire enhance knowledge on the taxonomic position of Chordate animals and also on the Animal Diversity of Chordate phyla, their biology and role in the environment.

The theory paper (C5T) of this course (CC-5) provides the students with-

CO1: To understand what the chordates are and describe the unique characters Protochordates to mammals.

CO2: To understand the different categories of chordates and the general characters of chordates.

CO3: To study the outline classification of chordates.

CO4: To understand the ecological role of different groups of chordates.

CO5: To understand the diversity and the level of organization of chordates.

CO6: To understand the origin and evolutionary relationship in different subphylum of chordates.

CO7: To understand the different physiological mechanisms of different groups of chordates.

CO8: To study the advanced features of vertebrates over Protochordata.

CO9: To understand the Dipleurula concept and the Echinoderm theory of origin of chordates.

CO9: To study the identifying characters of animals belonging to Agnatha, Pisces, Amphibia, Reptilia, Aves and Mammals.

CO10: To study the classification of animals belonging to Agnatha, Pisces, Amphibia, Reptilia, Aves and Mammals.

CO11: To study the accessory respiratory organ, migration and parental care in fishes and swim bladder in fishes.

CO12: To understand the concept of metamorphosis and parental care in Amphibia.

CO13: To recognise the poison apparatus and study the biting mechanism in Snake.

CO14: To understand the exoskeleton and migration in Birds with special emphasis on the principles and aerodynamics of flight.

CO15: To study the exoskeleton derivatives of mammals, adaptive radiation in mammals with reference to locomotory appendages and echolocation in Micro chiropterans and Cetaceans.

CO15: To understand the different zoogeographical realms, plate tectonic and Continental drift theory.

CO16: To study the distribution of birds and mammals in different zoogeographical realms.

Semester	III
Title of Course	Chordates Lab (CC-5)
Paper Code	C5P (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (H) of Semester-III will acquire practical knowledge about the identifying characters of different species of Chordates and learn the dissection of animals from different Chordates.

The lab paper (C5P) of this course (CC-5) provides the students with-

CO1: Identification of different species of Protochordata, Agnatha, Fishes, Amphibia, Reptilia and Mammalia.

CO2: Dissection of Pecten from Fowl head.

CO3: Dissection of brain and pituitary of Tilapia.

CO4: Power point presentation on study of any two animals from two different classes.

Semester	III
Title of Course	Animal Physiology: Controlling & Coordinating Systems (CC-6)
Paper Code	C6T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (H) of Semester-III will acquire the knowledge about the physiology of vertebrates at the cellular and system levels and understand the various life sustaining systems of the body, its mechanisms and control in different vertebrates by studying this course.

The theory paper (C6T) of this course (CC-6) provides the students with-

CO1: To understand how mammalian body get nutrition from different macrobiomolecules.

CO2: To understand the structure, location, classification, and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue and, fixation and staining of tissues.

CO3: To study the structure and types of bones and cartilages and the concept of ossification.

CO4: To understand the types and mechanism of working of nerve cells.

CO5: To study the structure of neuron, resting membrane potential, origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers.

CO6: To study the types of synapse, synaptic transmission, and neuromuscular junction, reflex action and its types.

CO7: To study the histology of different types of muscle and ultra structure of skeletal muscle.

CO8: To study the molecular and chemical basis of muscle contraction and the basic characteristics of muscle fibre.

CO9: To understand the histology of testis and ovary and the physiology of reproductive system.

CO10: To understand the nature of endocrine glands and their secretion.

CO11: To study the histology, function, and classification of hormones.

CO12: To understand the mechanism of hormone action, signal transduction pathways for Steroidal and Non steroidal hormones.

CO13: To study the Hypothalamus (neuroendocrine gland) and the principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system and the role of Placental hormones.

Semester	III
Title of Course	Animal Physiology: Controlling & Coordinating Systems Lab (CC-6)
Paper Code	C6P (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (H) of Semester-III will acquire the practical knowledge about the demonstration and recording of muscle action and preparation of temporary and permanent slides of different organs in mammals. They will also understand the process and preparation of permanent slides by microtomy.

The lab paper (C6P) of this course (CC-6) provides the student with-

CO1: Recording of simple muscle twitch with electrical stimulation (or Virtual).

CO2: Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex).

CO3: Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells.

CO4: Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid.

CO5: Microtomy: Preparation of permanent slide of any five mammalian (Goat/white rat) tissues.

Semester	III
Title of Course	Fundamentals of Biochemistry (CC-7)
Paper Code	C7T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (H) of Semester-III will acquire the knowledge on the roles and functions of the various macro biomolecules in living organisms and the different biochemical reactions at cellular level required in order to gain body energy by studying this course.

The theory paper (C7T) of this course (CC-7) provides the student with-

CO1: To understand the structural chemistry of proteins, carbohydrates, lipids, and nucleic acids.

CO2: To understand the biological importance of proteins, carbohydrates, lipids, and nucleic acids.

CO3: To understand the metabolism of proteins, carbohydrates, lipids, and nucleic acids.

CO4: To understand the structure, function, and classification of amino acids and concept of protein metabolism.

CO5: To understand the structures of purines and pyrimidines, nucleosides, nucleotides and nucleic acids and to have the basic concept of nucleotide metabolism.

CO6: To understand the nomenclature and classification of enzymes and mechanism of enzyme kinetics.

CO7: To study the factors affecting rate of enzyme-catalyzed reactions and enzyme inhibition.

CO8: To understand the concept of allosteric enzymes and their kinetics and the strategy of enzyme action- Catalytic and Regulatory.

CO9: To understand the concept of Oxidative Phosphorylation and Redox systems.

CO10: To review mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System.

Semester	III
Title of Course	Fundamentals of Biochemistry Lab (CC-7)
Paper Code	C7P (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (H) of Semester-III will acquire the practical knowledge about the qualitative tests of functional groups in carbohydrates, proteins, and lipids and learns the demonstration of paper chromatography of amino acids and proteins separation by SDS-PAGE by studying this course. They will also study the enzymatic activity of Trypsin and Lipase and learn to perform the Acid and Alkaline phosphatase assay from serum/ tissue.

The lab paper (C7P) of this course (CC-7) provides the student with-

CO1: Qualitative tests of functional groups in carbohydrates, proteins and lipids.

CO2: Paper chromatography of amino acids.

CO3: Quantitative estimation of Lowry Methods.

CO4: Demonstration of proteins separation by SDS-PAGE.

CO5: To study the enzymatic activity of Trypsin and Lipase.

CO6: To perform the Acid and Alkaline phosphatase assay from serum/ tissue.

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Semester	III
Title of Course	Apiculture (SEC-1)
Paper Code	SEC1T (Theory)
Credits	02
Hours	02 hours/week

The students of Zoology (H) of Semester-III will acquire an enhanced regarding the biology and rearing of honeybees and to make them understand about the prospects and entrepreneurship in Apiculture by studying this course.

The theory paper (SEC1T) of this course (SEC-1) provides the student with-

CO1: To study the history, classification of honeybees and the social organization of bee colony.

CO2: To understand the different bee keeping methods and equipment for the extraction of honey.

CO3: To understand the basic concept regarding artificial bee rearing and construction of beehives – Newton and Langstroth.

CO4: To study the bee diseases and enemies, their control and preventive measures.

CO5: To gain knowledge on the products of Apiculture Industry and its uses.

CO6: To understand the Bee Keeping Industry and the recent modern methods in employing artificial beehives for cross pollination in horticultural gardens.

Semester	IV
Title of Course	Comparative Anatomy of Vertebrates (CC-8)
Paper Code	C8T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (H) of Semester-IV will acquire the knowledge about the different comparative anatomical systems of Vertebrates and on the mode of functions of the different systems in different vertebrates by studying this course.

The theory paper (C8T) of this course (CC-8) provides the students with-

CO1: To understand the structure, functions, and derivatives of integumentary systems in amphibian, birds, and mammals.

CO2: To understand the overview of axial and appendicular skeletal systems from fish to mammals.

CO3: To understand the comparative anatomy of stomach in digestive system and dentition in mammals.

CO4: To study the respiratory organs and systems from fish to mammals.

CO5: To understand the general plan of circulation and comparative account of heart and aortic arches from fish to mammals.

CO6: To understand the succession of kidney and structure, types and evolution of urinogenital system.

CO7: To study the comparative anatomy of brain and the cranial nerves in mammals.

CO8: To understand the different sense organs and the classification of receptors in vertebrates.

Semester	IV
Title of Course	Comparative Anatomy of Vertebrates (CC-8)
Paper Code	C8P (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (H) of Semester-IV will acquire the practical knowledge to study, identify and demonstrate the different scales and skeletal systems in vertebrates and to learn the dissection of different body systems of vertebrates.

The lab paper (C8P) of this course (CC-8) provides the student with-

CO1: To study the placoid, cycloid, and ctenoid scales through permanent slides/photographs.

CO2: To study the disarticulated skeleton of Toad, Pigeon and Guineapig.

CO4: To demonstrate Carapace and plastron of turtle.

CO5: To identify the mammalian skulls: One herbivorous (Guineapig) and one carnivorous (Dog) animal.

CO6: To study the dissection of Tilapia: Circulatory system, Brain, pituitary, urinogenital system.

Semester	IV
Title of Course	Animal Physiology: Life Sustaining Systems (CC-9)
Paper Code	C9T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (H) of Semester-IV will acquire the knowledge about the metabolic activities in mammalian body and have a vivid concept on different life sustaining systems of the body, its mechanisms and control in different vertebrates by studying this course.

The theory paper (C9T) of this course (CC-9) provides the student with-

CO1: To understand the physiology of digestion, structural organisation, and functions of Gastrointestinal tract and Associated glands.

CO2: To recognise the basic concept of mechanical and chemical digestion of food, absorption of Carbohydrates, Lipids, Proteins, and Nucleic Acids along with Digestive enzymes.

CO3: To understand the gaseous transport and the structure involved in gaseous transport.

CO4: To have basic ideas on the mechanism of respiration, respiratory volumes and capacities, dissociation curves and the factors influencing it, the respiratory pigments and carbon monoxide poisoning.

CO5: To understand the physiology of circulation, blood flow, components of blood, and their functions.

CO6: To study the structure and functions of haemoglobin, Haemostasis, Blood clotting system, Fibrinolytic system Haemopoiesis, Basic steps and its regulation Blood groups and ABO and Rh factor.

CO7: To understand the physiology of mammalian heart and the conduction of cardiac impulses.

CO8: To understand the physiological classification based on thermal regulation, osmoregulation in aquatic vertebrates and extrarenal osmoregulatory organs in vertebrates.

CO9: To understand the renal physiology, structure of kidney and its functional unit.

CO10: To study the mechanism of urine formation and regulation of acid-base balance.

Semester	IV
Title of Course	Animal Physiology: Life Sustaining Systems Lab (CC-9)
Paper Code	C9P (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (H) of Semester-IV will acquire the practical knowledge about the determination, estimation, preparation, and recording of various physiological conditions and parameters in mammalian bodies by hands on practical experiments.

The lab paper (C9P) of this course (CC-9) provides the student with-

CO1: Determination of ABO Blood group.

CO2: Enumeration of red blood cells and white blood cells using haemocytometer.

CO3: Estimation of haemoglobin using Sahli's haemoglobinometer.

CO4: Preparation of haemin and haemochromogen crystals.

CO5: Recording of blood pressure using a sphygmomanometer.

Semester	IV
Title of Course	Immunology (CC-10)
Paper Code	C10T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (H) of Semester-IV will acquire the knowledge about the basic concept on health, diseases and the perspectives of immunology and about the different pathogens of the environment and how to develop immunity against these pathogens.

The theory paper (C10T) of this course (CC-10) provides the student with-

CO1: To understand the different cells, organs, and molecules involved in immunology.

CO2: To have the basic concepts of health and diseases and the historical perspective of Immunology.

CO3: To understand the concept of antigenicity and immunogenicity, immunogens, adjuvants and haptens, B and T-Cell epitopes.

CO4: To study the various factors influencing immunogenicity.

CO5: To understand the structure and functions of different classes of immunoglobulins.

CO6: To understand the antigen- antibody interactions.

CO7: To understand the immunoassays (ELISA and RIA), hybridoma technology and monoclonal antibody production.

CO8: To understand the structure and functions of MHC molecules.

CO9: To have basic idea on the structure of T cell Receptor and its signalling and T cell development & selection.

CO10: To study the types, properties and functions of cytokines.

CO11: To understand the components and pathways of complement system.

CO12: To have the concepts of Gell and Coombs' classification and brief description of various types of hypersensitivities.

CO13: To understand the immunology of certain diseases like Malaria, Filariasis, Dengue and Tuberculosis.

CO14: To have basic concepts on the various types of vaccines and active & passive immunization both artificial and natural.

Semester	IV
Title of Course	Immunology Lab (CC-10)
Paper Code	C10P (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (H) of Semester-IV will acquire the practical knowledge about the preparation, demonstration, and histological study of various organs of mammals through slides and photographs by hands on practical experiments.

The lab paper (C10P) of this course (CC-10) provides the student with-

CO1: Demonstration of lymphoid organs.

CO2: Histological study of spleen, thymus, and lymph nodes through slides/ photographs.

CO3: Preparation of stained blood film to study various types of blood cells.

CO4: ABO blood group determination.

CO5: Demonstration of ELISA.

Semester	IV
Title of Course	Sericulture (SEC-2)
Paper Code	SEC2T (Theory)
Credits	02
Hours	02 hours/week

The students of Zoology (H) of Semester-IV will acquire the knowledge about the biology and rearing of silkworms and gain an enhanced concept on the history, present status, prospects and entrepreneurship in Sericulture by studying this course.

The theory paper (SEC2T) of this course (SEC-2) provides the student with-

CO1: To study the different types of silkworms, and mulberry and non-mulberry Sericulture.

CO2: To understand the definition, history, and present status of Sericulture.

CO3: To study the life cycle of *Bombyx mori*, structure of silk gland and secretion of silk.

CO4: To understand the selection of mulberry variety and establishment of mulberry garden, rearing house and rearing appliances.

CO5: To study the different disinfectants: Formalin, bleaching powder, RKO.

CO6: To understand the silkworm rearing technology: Early age and late age rearing, the types of mountages, spinning, harvesting, and storage of cocoons.

CO7: To gain knowledge on the different pests and diseases of silkworms, its control and preventive measures.

CO8: To understand the prospectus of Sericulture in India, Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture.

Semester	V
Title of Course	Molecular Biology (CC-11)
Paper Code	C11T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (H) of Semester-V will acquire the knowledge on the central dogma of molecular biology i.e. Replication, Transcription, and Translation of prokaryotes and eukaryotes and on the different biomolecules and genetic material and the coordination between them by studying this course.

The theory paper (C11T) of this course (CC-11) provides the students with-

CO1: To understand the salient features of DNA and RNA and Watson and Crick model of DNA.

CO2: To study the mechanism of DNA Replication in Prokaryotes, Semi-conservative, bidirectional and discontinuous Replication, RNA priming and Replication of telomeres.

CO3: To study the mechanism of Transcription in prokaryotes and eukaryotes, the different transcription factors and difference between prokaryotic and eukaryotic transcription.

CO4: To understand the mechanism of protein synthesis in prokaryotes, Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA.

CO5: To recognize the different proteins involved in initiation, elongation and termination of polypeptide chain.

CO6: To understand the Genetic code, Degeneracy of the genetic code and Wobble Hypothesis, inhibitors of protein synthesis and difference between prokaryotic and eukaryotic translation.

CO7: To understand the different post transcriptional modifications and processing of eukaryotic RNA.

CO8: To develop the concepts of capping and Poly A tail formation in mRNA.

CO9: To understand the concept of Split genes, introns and exons, splicing mechanism, alternative splicing, exon shuffling and RNA editing.

CO10: To understand the regulation of Transcription in prokaryotes: lac operon and trp operon.

CO11: To study the regulation of Transcription in eukaryotes: Activators, enhancers, silencer and repressors.

CO12: To understand the miRNA mediated gene silencing and the concept of Genetic imprinting.

CO13: To study the types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair and SOS repair.

CO14: To understand certain important molecular techniques such as PCR, Western and Southern blot, Northern Blot, Sanger DNA sequencing.

Semester	V
Title of Course	Molecular Biology (Lab) (CC-11)
Paper Code	C11P (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (H) of Semester-V will acquire the practical knowledge of isolation and quantification of genomic DNA using various methods and gain the concept of demonstrating the chromosomes from photograph.

The lab paper (C11P) of this course (CC-11) provides the student with-

CO1: Demonstration of polytene and lampbrush chromosome from photograph.

CO2: Isolation and quantification of genomic DNA using spectrophotometer (A260 measurement).

CO3: Agarose gel electrophoresis for DNA.

Semester	V
Title of Course	Genetics (CC-12)
Paper Code	C12T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (H) of Semester-V will acquire an in-depth knowledge on gene interactions, the role of genetics in evolution and the mode of transmission of different genetic diseases by studying this course.

The theory paper (C12T) of this course (CC-12) provides the student with-

CO1: To understand the behavior of chromosomes during meiosis and detailed understanding of the chemical basis of heredity.

CO2: To study the principles of inheritance of Mendelian Genetics and its Extension.

CO3: To have the basic concepts on incomplete dominance and co-dominance, epistasis, multiple alleles, lethal alleles, pleiotropy, sex-linked, sex- influenced and sex-limited inheritance and polygenic Inheritance.

CO4: To understand how inheritance patterns are affected by position on chromosomes.

CO5: To understand the concept of Linkage and Crossing Over, molecular basis of crossing over, measuring recombination frequency and linkage intensity using three factor crosses, interference, and coincidence.

CO6: To study the types of gene mutations, types of chromosomal aberrations with one suitable example of each, non-disjunction, and variation in chromosome number and molecular basis of mutations in relation to UV light and chemical mutagens.

CO7: To understand the similarities and differences between how genetic information is passed on in prokaryotes and eukaryotes.

CO8: To evaluate conclusions that are based on genetic data.

CO9: To understand the mechanisms of sex determination in *Drosophila* and mammals.

CO10: To study the dosage compensation in *Drosophila* & human.

CO11: To understand the criteria for extra chromosomal inheritance: Antibiotic resistance in *Chlamyadomonas*, Kappa particle in *Paramoecium* and Shell spiralling in snail.

CO12: To study the concepts of Conjugation, Transformation, Transduction, and Complementation test in Bacteriophage.

CO13: To understand results of genetic experimentation in animals.

CO14: To understand Transposable Genetic Elements in bacteria, Ac-Ds elements in maize and P elements in Drosophila, LINE, SINE, and Alu elements in humans.

Semester	V
Title of Course	Genetics (Lab) (CC-12)
Paper Code	C12P (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (H) of Semester-V will acquire the practical knowledge about the analysis of Chi-square, linkage mapping, pedigree analysis, and identification of chromosomal aberration in Drosophila and man by hands on practical experiments.

The lab paper (C12P) of this course (CC-12) provides the student with-

CO1: Chi-square analyses.

CO2: Linkage maps based on conjugation.

CO3: Identification of chromosomal aberration in *Drosophila* and man from photograph.

CO4: Pedigree analysis of some human inherited traits.

Semester	V
Title of Course	Fish and Fisheries (DSE-1)
Paper Code	DSE1T (Theory)
Credits	06
Hours	06 hours/week

The students of Zoology (H) of Semester-V will acquire the knowledge about the necessary basic information about aquaculture, its management, marketing, preservation, and future prospects of inland and marine fisheries.

The theory paper (DSE1T) of this course (DSE-1) provides the student with-

CO1: To enhance the students with an in-depth knowledge about the importance of sustainable fishing and protecting the marine environment and how fish adapt themselves to better survive their environment.

CO2: To discuss advantages and disadvantages with the two aquatic food primary production systems, fishery, and aquaculture.

CO3: To study the general description of fish, feeding habit, habitat and manner of reproduction and the classification of fish.

CO4: To understand the morphology and physiology of fins and their modifications, locomotion in fish with special emphasis to hydrodynamics.

CO5: To study the different types of scales, use of scales in determination of age of fish, Gills and gas exchange.

CO6: To understand the types of swim bladder and its role in respiration and buoyancy.

CO7: To study osmoregulation in Elasmobranchs and Reproductive strategies, electric organ, and bioluminescence.

CO8: To understand the concept of Inland Fisheries and Marine Fisheries.

CO9: To study the environmental factors influencing the seasonal variations in fish catches in the Arabian Sea and the Bay of Bengal, Fishing crafts and Gears.

CO10: To understand the causes of depletion of fisheries resources, application of remote sensing and GIS in fisheries and fisheries law and regulations.

CO11: To understand sustainable aquaculture, extensive, semi-intensive and intensive culture of fish.

CO12: To study the pen and cage culture, polyculture, composite fish culture, brood stock management, and induced breeding of fish.

CO13: To understand the management of finfish hatcheries, preparation and maintenance of fish aquarium, preparation of compound diets for fish and the role of water quality in aquaculture.

CO14: To study the bacterial, viral, and parasitic fish diseases, its preservation and processing of harvested fish and the different fishery by-products.

CO15: To understand the concept of transgenic fish and Zebrafish as a model organism in research.

Semester	V
Title of Course	Microbiology (DSE-2)
Paper Code	DSE2T (Theory)
Credits	06
Hours	06 hours/week

The students of Zoology (H) of Semester-V will acquire the knowledge on the historical perspective of Microbiology, the prokaryotic and eukaryotic pathogens and the different microbes by studying this course.

The theory paper (DSE2T) of this course (DSE-2) provides the student with-

CO1: To understand the bacterial taxonomy, its principles and modern approaches of bacterial taxonomy and have a basic idea about Hackel and Whittaker's kingdom concept and domain concept of Carl Woose.

CO2: To understand the morphology of bacteria and virus cell wall.

CO3: To understand the distribution of normal flora in the body and their harmful effects.

CO4: To study the infection of pathogens to human populations: Communicable, Non-communicable, Endemic, Epidemic, Pandemic and Sporadic.

CO5: To understand Koch's postulates and sensitivity and specificity of test results.

CO6: To understand the principles and applications of Simple staining, Gram-staining, and Acid-fast staining.

CO7: To study the collection of specimens, growth requirements and growth factors and oxygen requirement.

CO8: To understand the different culture media: Simple media, Complex media, Selective media and Enriched media.

CO9: To understand the pathogenicity of microorganisms and infection of pathogens to human populations.

CO10: To understand the genetic recombination in bacteria.

CO11: To gain knowledge on the different microbial diseases, pathogens, symptoms, pathogenesis, mode of action & preventive measures of different diseases.

Semester	VI
Title of Course	Developmental Biology (CC-13)
Paper Code	C13T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (H) of Semester-VI will acquire the knowledge about the fundamental mode of embryonic development and embryonic induction by studying this course.

The theory paper (C13T) of this course (CC-13) provides the student with-

CO1: To understand how organisms maintain gametic population.

CO2: To understand the basic concepts of the phases of development, cell cell interaction, differentiation and growth, and differential gene expression.

CO3: To understand the events that leads up to fertilization process.

CO4: To understand the early embryonic development: gametogenesis, spermatogenesis and oogenesis.

CO5: To study the types of eggs, egg membranes, the planes and patterns of cleavage and the types of blastula.

CO6: To understand the different techniques of fate maps.

CO7: To understand the early development of frog and chick up to gastrulation and the embryonic induction and organizers.

CO8: To describe the cell division in different groups.

CO9: To understand way of cleavage and different patterns to form zygote.

CO10: To describe the stages and cellular mechanisms for gastrulation.

CO11: To understand the late embryonic development and the complete process of formation of germ layers.

CO12: To study the extra-embryonic membranes in birds and implantation of embryo in humans.

CO13: To study the structure, types and functions of placenta.

CO14: To understand the post embryonic development of brain and Eye in Vertebrate.

CO15: To study the different modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration with one example of each.

CO16: To understand the concept of Teratogenesis, teratogenic agents and their effects on embryonic development.

CO17: To study the process of In vitro fertilization, Stem cell (ESC) and Amniocentesis.

Semester	VI
Title of Course	Developmental Biology Lab (CC-13)
Paper Code	C13P (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (H) of Semester-VI will acquire the practical knowledge about the study of whole mounts of developmental stages of chick through permanent slides, study of life cycle of Drosophila from stock culture and demonstration of different sections of placenta by hands on practical experiments.

The lab paper (C13P) of this course (CC-13) provides the student with-

CO1: To 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).

CO2: To study of the developmental stages and life cycle of *Drosophila* from stock culture.

CO3: To study of different sections of placenta (photomicropgraph/ slides).

CO4: To prepare a project report on *Drosophila* culture/chick embryo development.

Semester	VI
Title of Course	Evolutionary Biology (CC-14)
Paper Code	C14T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (H) of Semester-VI will acquire an in-depth knowledge on the different evolutionary concepts, speciation, sources of variations, population genetics, species concept and the concept of the phylogeny of different animals by studying this course.

The theory paper (C14T) of this course (CC-14) provides the student with-

CO1: To describe the different evolutionary concepts like theory of natural selection, Lamarkism, Darwinism and Neo Darwinism.

CO2: To understand the life's beginnings, the concept of chemogeny, RNA world, biogeny, origin of photosynthesis, and evolution of eukaryotes.

CO3: To study the geological time scale, fossil records of Hominids (from *Australopithacus* to *Homo sapiens*) and the evolution of horse.

CO4: To understand the neutral theory of molecular evolution and the concept of molecular clock.

CO5: To understand the sources of variations, heritable variations and their role in evolution.

CO6: To understand the concept of Population genetics with special reference Hardy-Weinberg Law and the evolutionary forces upsetting H-W equilibrium.

CO7: To study the concept of natural selection, concept of fitness, types of selection, selection coefficient, mode of selection heterozygous superiority, genetic drift mechanism (founder's effect, bottleneck phenomenon) and role of migration and mutation in changing allele frequencies.

CO8: To understand the species concept, how species evolve, and modes of speciation.

CO9: To understand the different isolating mechanisms, concept of adaptive radiation, and macroevolution as exemplified by Galapagos finches.

CO10: To describe origin of species on earth and the evolutionary history of man.

CO11: To understand the causes and effects of mass extinctions with a detailed example of K-T extinction.

CO12: To understand the concept of phylogenetic trees and their constructions and interpretation using the law of parsimony.

CO13: To study the concepts of Convergent & Divergent evolution.

Semester	VI
Title of Course	Evolutionary Biology Lab (CC-14)
Paper Code	C14P (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (H) of Semester-VI will gain the practical knowledge on the study of fossils and homological and analogical characters from specimens and pictures. They will also learn to study and verify Hardy-Weinberg Law by chi square analysis and graphical representation and interpretation from a set of data.

The lab paper (C14P) of this course (CC-14) provides the student with-

CO1: Study of fossils from models/ pictures.

CO2: Study of homology and analogy from suitable specimens.

CO3: Study and verification of Hardy-Weinberg Law by chi square analysis.

CO4: Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.

Semester	VI
Title of Course	Parasitology (DSE-3)
Paper Code	DSE3T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (H) of Semester-VI will acquire the knowledge about the basic concept of parasitism, host parasite relationship, the different modes of transmission of different parasites and the biology and control of different parasites on vertebrates by studying this course.

The theory paper (DSE3T) of this course (DSE-3) provides the student with-

CO1: To study the terms Parasite, Parasitoid and mechanical and biological vectors.

CO2: To study the morphology, life cycle, prevalence, epidemiology, pathogenicity, diagnosis, prophylaxis and treatment of parasitic Protists.

CO3: To study the morphology, life cycle, prevalence, epidemiology, pathogenicity, diagnosis, prophylaxis and treatment of parasitic Platyhelminthes.

CO4: To study the morphology, life cycle, prevalence, epidemiology, pathogenicity, diagnosis, prophylaxis and treatment of parasitic Nematodes.

CO5: To study the biology, importance and control of parasitic Arthropods.

CO6: To study a brief account on parasitic Vertebrates.

Semester	VI
Title of Course	Wild Life Conservation and Management (DSE-4)
Paper Code	DSE4T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (H) of Semester-VI will acquire an in-depth knowledge on the values of wild life management and conservation ethics and have a vivid concept on the roles and values of wild life in nature and human perspective by studying this course.

The theory paper (DSE4T) of this course (DSE-4) provides the student with-

CO1: To study the evaluation of wild life by different evaluation procedures.

CO2: To understand the values of wild life - positive and negative, conservation ethics and importance of conservation.

CO3: To study the causes of depletion and World conservation strategies.

CO4: To understand the management of habitats of wild life.

CO5: To analyse habitats by different physical and biological parameters, Standard evaluation procedures, remote sensing and GIS.

CO6: To estimate the population density, natality, mortality, fertility schedules and sex ratio.

CO7: To understand the aims and objectives of wildlife conservation and planning management of wild life in protected areas.

CO8: To have an idea about the causes and consequences of human-wildlife conflicts and management of excess population.

CO9: To have the basic concept of different protected areas.

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Course Outcome

Zoology (GE)

Semester	I
Title of Course	Animal Cell Biotechnology (GE-1)
Paper Code	GE1T (Theory)
Credits	04
Hours	04 hours/week

The students of other science subjects (H) of Semester-I will acquire an in-depth knowledge on the basic concept and scope of Biotechnology and on the different techniques involved in gene manipulation by studying this course.

The theory paper (GE1T) of this course (GE-1) provides the student with-

CO1: To study the basic techniques involved in animal cell culture and organs culture.

CO2: To understand the different recombinant DNA technology, isolation of genes, and the basic concept of restriction and modification.

CO3: To study the restriction endonucleases and DNA modifying enzymes.

CO4: To gain knowledge about the concept of Cloning Vectors, Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC, and HAC, Shuttle and Expression Vectors.

CO5: To understand the construction of Genomic libraries and cDNA libraries

CO6: To study the different transformation techniques in microbial, plants and animals.

CO7: To understand the cloning in mammalian cells, integration of DNA into mammalian genome- Electroporation and Calcium Phosphate Precipitation method.

CO8: To understand the preparation of different culture media- Natural and Synthetic, Stem cells, Cryopreservation of cultures.

CO9: To study the different technologies like Agarose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting, DNA sequencing: Sanger method, Polymerase chain reaction, DNA Fingerprinting and DNA microarrays.

CO10: To understand the different types of fermentation and develop the culture media.

CO11: To study the downstream processing: Filtration, centrifugation, extraction, chromatography, spray drying and lyophilization.

CO12: To gain knowledge on the concept of transgenic animals.

CO13: To understand the nuclear transplantation technique, Retroviral method and DNA microinjection method.

CO14: To understand the concept of Dolly and Polly.

CO15: To understand the development of recombinant vaccines, hybridoma technology and gene therapy.

CO16: To understand the production of recombinant proteins, Insulin and growth hormones.

CO17: To understand the bio safety physical and biological containment.

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Semester	I
Title of Course	Animal Cell Biotechnology Lab (GE-1)
Paper Code	GE1P (Lab)
Credits	02
Hours	04 hours/week

The students of other science subjects (H) of Semester-I will acquire the practical knowledge about the preparation of different culture media, packing and sterilization of glass and plastic wares required for cell culture. They will learn to isolate and quantify DNA and will gain knowledge on the different biotechnologies.

The lab paper (GE1P) of this course (GE-1) provides the student with-

CO1: Packing and sterilization of glass and plastic wares for cell culture.

CO2: Preparation of culture media.

CO3: Preparation of genomic DNA from E. coli/animals/ human.

CO4: Plasmid DNA isolation (p UC 18/19) and DNA quantitation using agarose gel electrophoresis (by using lambda DNA as standard).

CO5: Restriction digestion of lambda (λ) DNA using EcoR1 and Hind III.

CO6: Preparation of competent cells and Transformation of E. coli with plasmid DNA using CaCl2, Selection of transformants on X-gal and IPTG (Optional).

CO7: Techniques: Western Blot, Southern Hybridization, DNA Fingerprinting, PCR, DNA Microarrays.

Semester	II
Title of Course	Animal Diversity (GE-2)
Paper Code	GE2T (Theory)
Credits	04
Hours	04 hours/week

The students of other science subjects (H) of Semester-II will acquire knowledge on the taxonomic position of Non-Chordate and Chordate animals and have the concept of Animal Diversity of Non-Chordate and Chordate phyla, their biology and role in the environment by studying this course.

The theory paper (GE2T) of this course (GE-2) provides the students with-

CO1: To understand the details of animal kingdom and classification.

CO2: To understand the general and identifying characteristics of animals belonging to Protozoa, Porifera, Radiata, Acoelomates and Pseudocoelomates.

CO3: To understand the taxonomic position of animals belonging to Protozoa, Porifera, Radiata, Acoelomates and Pseudocoelomates.

CO4: To understand the body organization of animals belonging to Protozoa, Porifera, Radiata, Acoelomates and Pseudocoelomates.

CO5: To understand certain specific physiological adaptation and life cycle of animals belonging to Protozoa, Porifera, Radiata, Acoelomates and Pseudocoelomates.

CO6: To describe understand the general and identifying characteristic features of animals belonging to Phylum Annelida, Arthropoda, Mollusca, and Echinodermata.

CO7: To describe understand the taxonomic position of animals belonging to Phylum Annelida, Arthropoda, Mollusca, and Echinodermata.

CO8: To recognize the diversity of animals belonging to Phylum Annelida, Arthropoda, Mollusca, and Echinodermata.

CO9: To understand the physiological mechanisms of animals belonging to Phylum Annelida, Arthropoda, Mollusca, and Echinodermata.

CO10: To understand the relationships between Chordates and Non-Chordates.

CO11: To recognize the affinities of Non-Chordates with Chordates.

CO12: To understand what the chordates are and describe the unique characters Protochordates to mammals.

CO13: To understand the different categories, outline classification and the general characters of chordates.

CO14: To study the advanced features of vertebrates over Protochordata.

CO15: To study the general characters of animals belonging to Pisces, Amphibia, Reptilia, Aves, and Mammals.

CO16: To study the osmoregulation and migration of fishes.

CO17: To understand the concept of adaptations for terrestrial life of Amphibia and parental care in Amphibia.

CO18: To recognise the origin of Reptiles and terrestrial adaptation in Reptiles.

CO19: To understand the origin of Birds with special emphasis on the flight adaptations.

CO20: To study the early evolution of mammals and dentition in mammals.

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Semester	II
Title of Course	Animal Diversity Lab (GE-2)
Paper Code	GE2P (Lab)
Credits	02
Hours	04 hours/week

The students of other science subjects (H) of Semester-II will acquire the practical knowledge on the identification, significance, staining and mounting of different species of Non-Chordate and Chordate animals. They will also have a vivid experience by learning the dissection and mounting of different body systems of both Non-Chordate and Chordate animals by studying this course.

The lab paper (GE2P) of this course (GE-2) provides the student with-

CO1: To study the Non Chordates: *Euglena, Noctiluca, Paramecium, Sycon, Physalia, Tubipora, Metridium, Taenia, Ascaris, Nereis, Aphrodite, Leech, Peripatus, Limulus, Hermitcrab, Daphnia, Millipede, Centipede, Beetle, Chiton, Dentalium, Octopus, Asterias,* and *Antedon*.

CO2: To identify the Chordates: *Balanoglossus, Amphioxus, Petromyzon, Pristis, Hippocampus, Labeo, Icthyophis/Uraeotyphlus, Salamander, Rhacophorus, Draco, Uromastix, Naja, Viper,* model of Archaeopteryx, three common birds- (Crow, duck, Owl), Squirrel and Bat.

CO3: To study the permanent slides of cross section of *Sycon*, Sea anemone and *Ascaris* (male and female), T. S. of Earthworm passing through pharynx, gizzard, and typhlosolar intestine, Bipinnaria and Pluteus larva.

CO4: To prepare the temporary mounts of septal & pharyngeal nephridia of earthworm.

CO5: To prepare the temporary mounts of unstained mounts of placoid, cycloid and ctenoid scales.

CO6: To study the dissections of digestive and nervous system of Cockroach.

CO7: To study the dissection of urinogenital system of Rat.

Semester	III
Title of Course	Aquatic Biology (GE-3)
Paper Code	GE3T (Theory)
Credits	04
Hours	04 hours/week

The students of other science subjects (H) of Semester-III will acquire the knowledge on the freshwater and marine biology and on the management of aquatic resources by studying this course.

The theory paper (GE3T) of this course (GE-3) provides the student with-

CO1: To gain knowledge on the introduction of aquatic biomes.

CO2: To understand the freshwater ecosystem (lakes, wetlands, streams, and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone, and coral reefs.

CO3: To study the origin and classification of Lake as an Ecosystem and Lake morphometry.

CO4: To gain knowledge on the physico–chemical characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity, dissolved gases (Oxygen, Carbon dioxide) and Nutrient Cycles in Lakes (Nitrogen, Sulphur and Phosphorous).

CO5: To study the different stages of stream development, physico-chemical environment, and the adaptation of hill- stream fishes.

CO6: To understand the marine ecosystem, salinity and density of sea water, and continental shelf.

CO7: To understand the adaptations of deep sea organisms, coral reefs and sea weeds.

CO8: To study the causes of pollution of Aquatic Resources: agricultural, industrial, sewage, thermal and oil spills, its management and conservation.

CO9: To understand the sewage treatment and water quality assessment- BOD and COD.

Semester	III
Title of Course	Aquatic Biology Lab (GE-3)
Paper Code	GE3P (Lab)
Credits	02
Hours	04 hours/week

The students of other science subjects (H) of Semester-III will acquire the practical knowledge of how to determine the area of a lake, identify important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem, determine the different parameters in a water body and gain a vivid concept of the instruments used in limnology by studying this course.

The lab paper (GE3P) of this course (GE-3) provides the student with-

CO1: Determination of the area of a lake using graphimetric and gravimetric method.

CO2: Identification of the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.

CO3: Determination of the amount of Turbidity/transparency, Dissolved Oxygen, and Free Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from a nearby lake / water body.

CO4: Study of the instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.

CO5: Preparation of a Project Report on a visit to a Sewage treatment plant/Marine bio- reserve/Fisheries Institute.

Semester	IV
Title of Course	Environment and Public Health (GE-4)
Paper Code	GE4T (Theory)
Credits	04
Hours	04 hours/week

The students of other science subjects (H) of Semester-IV will develop enhanced knowledge on the different environmental hazards, its causes, and sources and have an in-depth concept on the effect of environment on public health by studying this course.

The theory paper (GE4T) of this course (GE-4) provides the student with-

CO1: To understand the various sources of environmental hazards and the fate of toxic and persistent substances in the environment

CO2: To study the dose response evaluation and exposure assessment.

CO3: To study the greenhouse gases and understand the concept of global warming, acid rain and ozone layer destruction.

CO4: To understand the effect of climate change on public health.

CO5: To understand the sources, effects and control measures of air, water, and noise pollution.

CO6: To understand the different waste management technologies.

CO7: To study the sources, types, and characteristics of waste.

CO8: To understand the sewage disposal and its management, solid waste disposal, biomedical waste handling, and disposal, nuclear waste handling, disposal, and waste from thermal power plants.

CO9: To study the causes, symptoms and control of tuberculosis, Asthma, Cholera, Minamata disease, typhoid, Filariasis.

Semester	IV
Title of Course	Environment and Public Health Lab (GE-4)
Paper Code	GE4P (Lab)
Credits	02
Hours	04 hours/week

The students of other science subjects (H) of Semester-IV will acquire the practical knowledge on how to determine the pH, Cl, SO_4 and NO_3 in soil and water samples from different locations.

<u>The lab paper (GE4P) of this course (GE-4) provides the student with-</u>

CO1: To determine pH, Cl, SO_4, NO_3 in soil and water samples from different locations.

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NARAJOLE RAJ COLLEGE

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Course Outcome

Zoology (DSC)

Semester	I
Title of Course	Animal Diversity (DSC-1A)
Paper Code	DSC1AT (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (Gen) of Semester-I will acquire knowledge on the taxonomic position of Non-Chordate and Chordate animals and have the concept of Animal Diversity of Non-Chordate and Chordate phyla, their biology and role in the environment by studying this course.

The theory paper (DSC1AT) of this course (DSC-1A) provides the student with-

CO1: To understand the details of animal kingdom and classification.

CO2: To understand the general and identifying characteristics of animals belonging to Protozoa, Porifera, Cnidaria, Platyhelminthes and Nemathelminthes.

CO3: To understand the taxonomic position and classification of animals belonging to Protozoa, Porifera, Cnidaria, Platyhelminthes and Nemathelminthes.

CO4: To understand the body organization of animals belonging to Protozoa, Porifera, Cnidaria, Platyhelminthes and Nemathelminthes.

CO5: To understand certain specific physiological adaptation and life cycle of animals belonging to Protozoa, Porifera, Cnidaria, Platyhelminthes and Nemathelminthes.

CO6: To describe understand the general and identifying characteristic features of animals belonging to Phylum Annelida, Arthropoda, Mollusca, and Echinodermata.

CO7: To describe understand the taxonomic position and classification of animals belonging to Phylum Annelida, Arthropoda, Mollusca, and Echinodermata.

CO8: To recognize the diversity of animals belonging to Phylum Annelida, Arthropoda, Mollusca, and Echinodermata.

CO9: To understand the physiological mechanisms of animals belonging to Phylum Annelida, Arthropoda, Mollusca, and Echinodermata.

CO10: To understand the relationships between Chordates and Non-Chordates.

CO11: To recognize the affinities of Non-Chordates with Chordates.

CO12: To understand what the chordates are and describe the unique characters Protochordates to mammals.

CO13: To understand the different categories, outline classification and the general characters of chordates.

CO14: To study the phylogeny of Protochordata.

CO15: To study the general characters and classification of animals belonging to Agnatha, Pisces, Amphibia, Reptilia, Aves, and Mammals.

CO16: To study the osmoregulation of fishes.

CO17: To understand the concept of adaptations for parental care in Amphibia.

CO18: To recognise the poisonous and non-poisonous snakes and biting mechanism in snakes.

CO19: To understand the mechanism of flight adaptations in Birds.

CO20: To study the origin of mammals.

Semester	I
Title of Course	Animal Diversity (Practical) (DSC-1A)
Paper Code	DSC1AP (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (Gen) of Semester-I will acquire the practical knowledge on the study, identification, and significance of different species of Non-Chordate and Chordate animals, their transverse and longitudinal sections, life history and sexes. They will also have a vivid experience by learning the key for identification of poisonous and non-poisonous snakes by hands on practical experiments.

The lab paper (DSC1AP) of this course (DSC-1A) provides the student with-

CO1: To study and identify several different species of both Non Chordates and Chordates.

CO2: To understand and study the identifying characteristic features of the several different species of both Non Chordates and Chordates.

CO3: To study the taxonomic position of several different species of both Non Chordates and Chordates.

CO4: To study the transverse and longitudinal sections of *Sycon*.

CO5: To study the life history stages of *Taenia*.

CO6: To study the male and female species of *Ascaris*.

CO7: To understand and demonstrate the key for identification of poisonous and non-poisonous snakes.

Semester	II
Title of Course	Comparative Anatomy and Developmental Biology of Vertebrates (DSC-1B)
Paper Code	DSC1BT (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (Gen) of Semester-II will acquire an in-depth knowledge on the different comparative anatomical systems and the modes of function of the different systems in different vertebrates and understand the fundamental modes of embryonic development by studying this course.

The theory paper (DSC1BT) of this course (DSC-1B) provides the student with-

CO1: To understand the structure, functions, and derivatives of integumentary systems in amphibian, birds, and mammals.

CO2: To understand the evolution of visceral arches of the skeletal systems in vertebrates.

CO3: To understand the anatomy of alimentary canal and digestive glands of the digestive system in vertebrates.

CO4: To study the respiratory organs and systems in vertebrates.

CO5: To understand the general plan of circulation and evolution of heart and aortic arches in vertebrates.

CO6: To understand the succession of kidney and structure, types and evolution of urinogenital system in vertebrates.

CO7: To study the comparative anatomy of brain and the cranial nerves in vertebrates.

CO8: To understand the different sense organs and the classification of receptors in vertebrates.

CO9: To understand the early embryonic development: gametogenesis, spermatogenesis and oogenesis w.r.t. mammals.

CO10: To study the vitellogenesis in birds and the events involved in fertilization.

CO11: To understand the different techniques of fate maps.

CO12: To understand the early development of frog and humans up to gastrulation.

CO13: To describe the cell division in different groups and fate of germ layers.

CO14: To understand way of cleavage and different patterns to form zygote.

CO15: To describe the stages and cellular mechanisms for gastrulation.

CO16: To understand the late embryonic development and the complete process of formation of germ layers.

CO17: To study the metamorphic events in frog life cycle and its hormonal regulation.

CO18: To study the structure, types and functions of human placenta.

CO19: To understand the different types of morphogenetic movements.

CO20: To study the different fundamental processes in development which include gene activation, determination, induction, differentiation, morphogenesis, intercellular communication, cell movements and cell death.

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Semester	II
Title of Course	Comparative Anatomy and Developmental Biology of Vertebrates (Practical) (DSC-1B)
Paper Code	DSC1BP (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (Gen) of Semester-II will acquire the practical knowledge to study, identify, and demonstrate the different skeletal systems in vertebrates and to learn the developmental stages of frog from whole mounts and sections, the different types of placenta and its development and examination of gametes by hands on practical experiments.

The lab paper (DSC1BP) of this course (DSC-1B) provides the student with-

CO1: To study, identify, and demonstrate the different skeletal systems in vertebrates.

CO2: To study the developmental stages of frog from whole mounts and sections through permanent slides.

CO3: To study the different types of placenta and its development through histological sections of permanent slides.

CO4: To study placental development in humans by ultrasound scans.

CO5: To examine the gametes of frog and rat sperm and ova through permanent slides.

Semester	III
Title of Course	Physiology and Biochemistry (DSC-1C)
Paper Code	DSC1CT (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (Gen) of Semester-III will acquire the knowledge about the metabolic activities in mammalian body, different life sustaining systems of the body, its mechanisms and control in different vertebrates and gain enhanced concept on the different roles and functions of the various macro biomolecules in living organisms by studying this course.

The theory paper (DSC1CT) of this course (DSC-1C) provides the students with-

CO1: To understand the structure of a neuron and nerve impulse propagation in myelinated and non-myelinated nerve fibres.

CO2: To study the ultra-structure of skeletal muscle and molecular and chemical mechanism of muscle contraction.

CO3: To describe the physiology of digestion in the alimentary canal.

CO4: To understand the absorption of proteins, carbohydrates and lipids in the body.

CO5: To understand the pulmonary ventilation and transport of oxygen and carbon dioxide in blood.

CO6: To understand the structure of nephron and mechanism of urine formation.

CO7: To understand the counter-current mechanism of urine formation.

CO9: To study the cardiovascular system, composition of blood, structure of heart and cardiac cycle.

CO10: To understand the physiology of male and female reproduction and its hormonal control.

CO11: To study the structural chemistry and metabolism of proteins, carbohydrates and lipids.

CO12: To study the different biosynthetic pathways and cycles of proteins, carbohydrates and lipids.

CO13: To understand the mechanism and action of enzyme kinetics.

Semester	III
Title of Course	Physiology and Biochemistry (Practical) (DSC-1C)
Paper Code	DSC1CP (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (Gen) of Semester-III will acquire the practical knowledge about determination, estimation and preparation of various parameters, study of permanent histological slides and qualitative tests of functional groups in carbohydrates, proteins, and lipids by hands on practical experiments.

The lab paper (DSC1CP) of this course (DSC-1C) provides the students with-

CO1: Study of preparation of hemin and hemochromogen crystals.

CO2**:** Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, and adrenal gland.

CO3: Study of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone, and cartilage.

CO4: Qualitative tests to identify functional groups of carbohydrates in certain solutions.

CO5: Estimation of total protein by Lowry's method.

CO6: Study of activity of salivary amylase under optimum conditions.

Semester	III
Title of Course	Apiculture (SEC-1)
Paper Code	SEC1T (Theory)
Credits	02
Hours	02 hours/week

The students of Zoology (Gen) of Semester-III will acquire an enhanced knowledge regarding the biology and rearing of bees and gain vivid concept on the prospects and entrepreneurship in Apiculture by studying this course.

The theory paper (SEC1T) of this course (SEC-1) provides the student with-

CO1: To study the history, classification, and biology of honeybees.

CO2: To understand the social organization of bee colony.

CO3: To understand the different bee keeping methods and equipment for the extraction of honey.

CO4: To understand the bee diseases and enemies, their control and preventive measures.

CO5: To gain knowledge on the products of Apiculture Industry and its uses.

CO6: To understand the bee keeping industry and the modern methods involved in employing artificial beehives for cross pollination in horticulture gardens.

Semester	IV
Title of Course	Genetics and Evolutionary Biology (DSC-1D)
Paper Code	DSC1DT (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (Gen) of Semester-IV will acquire an in-depth knowledge on gene interactions, the role of genetics in evolution and the major events in the path of evolution. by studying this course.

The theory paper (DSC1DT) of this course (DSC-1D) provides the student with-

CO1: To understand the behavior of chromosomes during meiosis, detailed understanding of the chemical basis of heredity and molecular basis of genetic information.

CO2: To study the principles of inheritance of Mendelian Genetics and its Extension.

CO3: To have the basic concepts on incomplete dominance and co-dominance, epistasis, multiple alleles, lethal alleles, pleiotropy, sex-linked, sex- influenced and sex-limited inheritance and extra-chromosomal inheritance.

CO4: To understand how inheritance patterns are affected by position on chromosomes.

CO5: To understand the concept of Linkage and Crossing Over, molecular basis of crossing over, measuring recombination frequency and linkage intensity using three factor crosses, interference, and coincidence.

CO6: To study the types of gene mutations, types of chromosomal aberrations with one suitable example of each, non-disjunction, and variation in chromosome number and molecular basis of mutations in relation to UV light and chemical mutagens.

CO7: To understand the somatic cell genetics- an alternative approach to gene mapping.

CO8: To understand the mechanisms of sex determination in *Drosophila* and mammals.

CO9: To study the dosage compensation in *Drosophila* & human.

CO10: To describe the different evolutionary concepts like theory of natural selection, Lamarkism, Darwinism and Neo Darwinism.

CO11: To understand the life's beginnings and the major events in history of life.

CO12: To study the types of fossils, incompleteness of fossil record and dating of fossils.

CO13: To understand the phylogeny of horse.

CO14: To understand the sources of variations, heritable variations and their role in evolution.

CO15: To study the concept and types of natural and artificial selection.

CO16: To understand the species concept, how species evolve, and modes of speciation.

CO17: To understand the different isolating mechanisms, concept of adaptive radiation, and macroevolution as exemplified by Darwin's finches.

CO18: To understand the causes, roles, and effects of mass extinctions with a detailed example of K-T extinction.

Semester	IV
Title of Course	Genetics and Evolutionary Biology (Practical) (DSC-1D)
Paper Code	DSC1DP (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (Gen) of Semester-IV will acquire the practical knowledge about the study of Mendelian inheritance and interactions, analysis of Chi-square, linkage, recombination, gene mapping, study of fossils and homological and analogical characters from specimens and pictures. They will also learn to study the phylogeny of horse and Darwin's Finches from charts and diagrams.

The lab paper (DSC1DP) of this course (DSC-1D) provides the student with-

CO1: Study of Mendelian inheritance and gene interactions with suitable examples.

CO2: Study and verification of results by chi square analysis.

CO3: Study of Linkage maps, recombination, gene mapping from data.

CO4: Study of Human Karyotypes (normal and abnormal).

CO5: Study of fossil evidences from models and pictures.

CO6: Study of homology and analogy from suitable specimens and pictures.

CO7: Study the phylogeny of horse and Darwin's Finches from charts and diagrams.

CO8: Prepare a report on natural history museum.

Semester	IV
Title of Course	Aquarium Fish Keeping (SEC-2)
Paper Code	SEC2T (Theory)
Credits	02
Hours	02 hours/week

The students of Zoology (Gen) of Semester-IV will acquire the knowledge on the basic information on aquarium fish keeping, its maintenance, construction, and develop an enhanced concept on the importance of aquarium fishes by studying this course.

The theory paper (SEC2T) of this course (SEC-2) provides the student with-

CO1: To discuss the potential scope of aquarium fish industry.

CO2: To understand the biology of aquarium fishes which include exotic, endemic, fresh water and marine aquarium fishes.

CO3: To study the biology, characters and sexual dimorphism of fresh water and marine aquarium fishes.

CO4: To provide knowledge on the food and feeding of aquarium fishes.

CO5: To understand the transportation, handling, packing and forwarding techniques of fishes.

CO6: To understand the maintenance of aquarium.

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Semester	V
Title of Course	Aquatic Biology (DSE-1)
Paper Code	DSE1T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (Gen) of Semester-V will acquire the knowledge on the freshwater and marine biology and management of aquatic resources by studying this course.

The theory paper (DSE1T) of this course (DSE-1) provides the student with-

CO1: To gain knowledge on the introduction of aquatic biomes.

CO2: To understand the freshwater ecosystem, estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone, and coral reefs.

CO3: To study the freshwater biology highlighting lakes and streams, their stages, classification and physico-chemical characteristics.

CO4: To understand the marine biology, salinity and density of sea water, continental shelf, adaptations of deep-sea organisms, coral reefs, and sea weeds.

CO5: To study the causes of pollution of aquatic resources, its management, and conservation.

CO6: To understand the sewage treatment water quality assessment- BOD and COD.

Semester	V
Title of Course	Aquatic Biology (Practical) (DSE-1)
Paper Code	DSE1P (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (Gen) of Semester-V will acquire the practical knowledge about the determination, identification, and demonstration of different parameters associated with aquatic biology based on different methods by hands on practical experiments.

The lab paper (DSE1P) of this course (DSE-1) provides the student with-

CO1: Determination of the area of a lake using graphimetric and gravimetric method.

CO2: Identification of important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.

CO3: Determination of the amount of Turbidity/transparency, Dissolved oxygen, carbon dioxide, alkalinity (carbonates & bicarbonates) in water collected from a nearby lake/ water body.

CO4: Study of instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.

CO5: Prepare a Project Report on a visit to Sewage treatment plant/Marine bioreserve/Fisheries Institutes.

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Semester	V
Title of Course	Medical Diagnostics (SEC-3)
Paper Code	SEC3T (Theory)
Credits	01
Hours	01 hour/week

The students of Zoology (Gen) of Semester-V will acquire an enhanced knowledge on different medical diagnostics and its importance and gain a vivid concept on the non-infectious and infectious diseases by studying this course.

The theory paper (SEC3T) of this course (SEC-3) provides the student with-

CO1: To study the diagnostics methods used for analysis of blood.

CO2: To know the diagnostics methods used for urine analysis.

CO3: To understand the causes, types, symptoms, complications, diagnosis and prevention of non-infectious diseases.

CO4: To understand the causes, types, symptoms, diagnosis and prevention of infectious diseases.

CO5: To develop a clear concept on the detection and types of tumour cells.

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Semester	VI
Title of Course	Animal Biotechnology (DSE-1)
Paper Code	DSE1T (Theory)
Credits	04
Hours	04 hours/week

The students of Zoology (Gen) of Semester-VI will acquire an in-depth knowledge on the basic concept and scope of Biotechnology and on the different techniques in gene manipulation by studying this course.

The theory paper (DSE1T) of this course (DSE-1) provides the student with-

CO1: To study the basic techniques involved in animal cell culture and organs culture.

CO2: To understand the different recombinant DNA technology, isolation of genes, and the basic concept of restriction and modification.

CO3: To study the restriction endonucleases and DNA modifying enzymes.

CO4: To gain knowledge about the concept of Cloning Vectors, Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC, and HAC, Shuttle and Expression Vectors.

CO5: To understand the construction of Genomic libraries and cDNA libraries

CO6: To study the different transformation techniques in microbial, plants and animals.

CO7: To understand the cloning in mammalian cells, integration of DNA into mammalian genome- Electroporation and Calcium Phosphate Precipitation method.

CO8: To understand the preparation of different culture media- Natural and Synthetic, Stem cells, Cryopreservation of cultures.

CO9: To study the different technologies like Agarose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting, DNA sequencing: Sanger method, Polymerase chain reaction, DNA Fingerprinting and DNA microarrays.

CO10: To understand the different types of fermentation and develop the culture media.

CO11: To study the downstream processing: Filtration, centrifugation, extraction, chromatography, spray drying and lyophilization.

CO12: To gain knowledge on the concept of transgenic animals.

CO13: To understand the nuclear transplantation technique, Retroviral method and DNA microinjection method.

CO14: To understand the concept of Dolly and Polly.

CO15: To understand the development of recombinant vaccines, hybridoma technology and gene therapy.

CO16: To understand the production of recombinant proteins, Insulin and growth hormones.

CO17: To understand the bio safety physical and biological containment.

Semester	VI
Title of Course	Animal Biotechnology (Practical) (DSE-1)
Paper Code	DSE1P (Lab)
Credits	02
Hours	04 hours/week

The students of Zoology (Gen) of Semester-VI will acquire the practical knowledge about the isolation and study of genomic and plasmid DNA from E. coli. They will learn to construct gene mapping and will gain knowledge on the different biotechnologies by hands on practical experiments.

The lab paper (DSE1P) of this course (DSE-1) provides the student with-

CO1: Study of genomic DNA isolation from *E. coli*.

CO2: Study of plasmid DNA isolation (pUC 18/19) from *E. coli*.

CO3: Study of restriction digestion of plasmid DNA.

CO4: Study of construction of circular and linear restriction map from provided data.

CO5: Calculation of transformation efficiency from provided data.

CO6: Study of different techniques like Southern Blotting, Northern Blotting, Western Blotting, DNA Sequencing (Sanger's Method), PCR, and DNA fingerprinting through photographs.

CO7: Prepare a project report on animal cell culture.

Semester	VI
Title of Course	Sericulture (SEC-4)
Paper Code	SEC4T (Theory)
Credits	02
Hours	02 hour/week

The students of Zoology (Gen) of Semester-VI will acquire the knowledge about the biology and rearing of silkworms and develop enhanced idea about the history, present status, prospects, and entrepreneurship in Sericulture by studying this course.

The theory paper (SEC4T) of this course (SEC-4) provides the students with-

CO1: To study the different types of silkworms, and mulberry and non-mulberry Sericulture.

CO2: To understand the definition, history, and present status of Sericulture.

CO3: To study the life cycle of Bombyx mori, structure of silk gland and secretion of silk.

CO4: To understand the selection of mulberry variety and establishment of mulberry garden, rearing house and rearing appliances.

CO5: To study the different disinfectants: Formalin, bleaching powder, RKO.

CO6: To understand the silkworm rearing technology: Early age and late age rearing, the types of mountages, spinning, harvesting, and storage of cocoons.

CO7: To gain knowledge on the different pests and diseases of silkworms, its control and preventive measures.

CO8: To understand the prospectus of Sericulture in India, Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture.