

Bankim Sardar College
A College with Potential for Excellence

Department of Zoology

Honours CBCS, CU

Programme Specific Outcome (PSO) - Course Outcome (CO)

Programme Specific Outcome (PSO):

- PSO 01.* Given a biological phenomenon, formulate questions about that phenomenon.
- PSO 02.* Use the scientific method in conducting experimental research.
- PSO 03.* Perform original observations of biological
- PSO 04.* Present an oral explanation of a biological principle or other biological information.
- PSO 05.* Write an explanation of a biological principle or information from the biological literature.
- PSO 06.* Create and interpret a graph or other visual representation of information.
- PSO 07.* Evaluate arguments supporting different points of view.
- PSO 08.* Explain how biology affects social issues and how social issues affect biology.
- PSO 09.* Discuss ethical dilemmas that are introduced into society through science or introduced into science through the social views of research methods.

Core Courses	Content of CU Syllabus	Course Outcome
Semester 1		
CCH01 ZOOA- CC1-1-TH	Non-Chordates I: Protists to Pseudocoelomates Unit 1: Basics of animal classification Definitions: Classification, Systematics and Taxonomy; Taxonomic Hierarchy, Taxonomic types. Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy; Concept of classification – three kingdom concept of Carl Woese, 1977 and five kingdom concept	Students will be able to <i>CO 01.</i> Identify and discuss features and concepts of the animal classification from unicellular to

<p>ZOOA- CC1-1-P</p>	<p>of Whittaker, 1969</p> <p>Unit 2: Protista and Metazoa Protozoa General characteristics and Classification up to phylum (according to Levine et. al., 1980). Locomotion in <i>Euglena</i>, <i>Paramecium</i> and <i>Amoeba</i>; Conjugation in <i>Paramecium</i>. Life cycle and pathogenicity of <i>Plasmodium vivax</i> and <i>Entamoeba histolytica</i></p> <p>Metazoa Evolution of symmetry and segmentation of Metazoa.</p> <p>Unit 3: Porifera General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Canal system and spicules in sponges.</p> <p>Unit 4: Cnidaria General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6th Ed.), Metagenesis in Obelia; Polymorphism in Cnidaria; Corals and coral reef diversity, Role of symbiotic algae in reef formation. Conservation of coral and coral reefs.</p> <p>Unit 5: Ctenophora General characteristics</p> <p>Unit 6: Platyhelminthes General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6th Ed.). Life cycle and pathogenicity and control measures of <i>Fasciola hepatica</i> and <i>Taenia solium</i></p> <p>Unit 7: Nematoda General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6th Ed.). Life cycle, and pathogenicity and control measures of <i>Ascaris lumbricoides</i> and <i>Wuchereria bancrofti</i> Parasitic adaptations in helminthes</p> <p>Practical: Non-Chordates I lab: Protists to Pseudocoelomates</p> <p>Study of whole mount of <i>Euglena</i>, <i>Amoeba</i> and <i>Paramecium</i>. Identification with reason & Systematic position of <i>Amoeba</i>, <i>Euglena</i>, <i>Entamoeba</i>, <i>Paramecium</i>, <i>Plasmodium</i>, <i>Balantidium</i>, <i>Vorticella</i> (from the prepared slides). Identification with reason & Systematic position of <i>Sycon</i>, <i>Potterion</i> (Neptune's Cup), <i>Obelia</i>, <i>Physalia</i>, <i>Aurelia</i>, <i>Gorgonia</i>, <i>Metridium</i>, <i>Pennatula</i>, <i>Madrepora</i>, <i>Fasciola hepatica</i>, <i>Taenia solium</i> and <i>Ascaris</i></p>	<p>multicellular level.</p> <p>CO 02. Understand general characters of animals based on grades of organization, symmetry, body cavity etc.</p> <p>CO 03. Study the characteristic features of each Phylum up to class with examples.</p> <p>CO 04. Describe unique concepts found in specific animal groups like metagenesis, canal system, polymorphism, pathogenicity, parasitic adaptations etc.</p> <p>CO 05. Knowledge on procedure of whole mount slide preparation, identification according to specific classification system and brief concepts on staining and mounting process of different gut parasites in cockroach.</p>
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lumbricoides.

Staining/mounting of any protozoa/helminth from gut of *Periplaneta sp.*

<p>CCH02</p> <p>ZOOA-</p> <p>CC1-2-TH</p>	<p>Molecular Biology</p> <p>Unit 1: Nucleic acid Salient features of DNA, Chargaff’s Rule, Hypo and Hyperchromic shift. Watson and Crick Model of DNA. RNA types & Function.</p> <p>Unit 2: DNA Replication Mechanism of DNA Replication in Prokaryotes, Prove that replication is Semi-conservative, bidirectional and discontinuous, RNA priming, Replication of telomeres.</p> <p>Unit 3: Transcription Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, Difference between prokaryotic and eukaryotic transcription.</p> <p>Unit 4: Translation Genetic code, Degeneracy of the genetic code and Wobble Hypothesis. Mechanism of protein synthesis in prokaryotes.</p> <p>Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA Capping and Poly A tail formation in mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing and RNA editing</p> <p>Unit 6: Gene Regulation Regulation of Transcription in prokaryotes: lac operon and trp operon; Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, miRNA mediated gene silencing. Epigenetic Regulation: DNA Methylation, Histone Methylation & Acetylation.</p> <p>Unit 7: DNA Repair Mechanisms Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair</p> <p>Unit 8: Molecular Techniques PCR, Western and Southern blot, Northern Blot.</p>	<p>The students will develop a clear concept of</p> <p>CO 01. Explaining the basic structure of nucleic acid and molecular mechanisms of DNA replication in prokaryotes and eukaryotes.</p> <p>CO 02. Understanding concepts of Transcription in prokaryotes and eukaryotes, mRNA processing and modifications and concept of genetic code, mechanism of protein synthesis and post translational modification.</p> <p>CO 03. Describing how gene expression is regulated at the transcriptional and post-transcriptional level.</p> <p>CO 04. Different types of DNA repairing mechanism and biotechnological estimation of DNA, RNA and protein.</p>
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ZOOA- CC1-2-P	Practical: Molecular Biology Lab 1. Demonstration of polytene and lampbrush chromosome from photograph. 2. Isolation and quantification of genomic DNA from goat liver. 3. Agarose gel electrophoresis for DNA. 4. Histological staining of DNA and RNA in prepared slides.	CO 05. Concepts of giant chromosomes and DNA isolation, visualization and quantification techniques.
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Core Courses	Content of CU Syllabus	Course Outcome
Semester 2		
CCH03 ZOOA- CC2-3-TH	Non-Chordates II – Coelomates Unit 1: Introduction Evolution of coelom Unit 2: Annelida General characteristics and Classification up to classes (Ruppert and Barnes, 1994). Excretion in Annelida through nephridia; Metamerism in Annelida. Unit 3: Arthropoda General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Insect Eye(Cockroach only). Respiration in Prawn and Cockroach; Metamorphosis in Lepidopteran Insects; Social life inTermite. Unit 4: Onychophora General characteristics and Evolutionary significance. Unit 5: Mollusca General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Nervoussystem in <i>Pila sp.</i> Torsion in Gastropoda. Feeding and respiration in <i>Pila sp.</i> Unit 6: Echinodermata General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Watervascularsystem in <i>Asterias</i> . Echinoderm larva and affinities with chordates. Unit 7: Hemichordata General characteristics of phylum Hemichordata. Relationship with non-chordates and chordates.	The 2 nd part of Non-chordates will give the students a clear picture of CO 01. Basic concept of Evolution in non-chordates like development of coelom, Study of salient identifying features and special features like metamerism, metamorphosis, eusociality and variation in physiological process in non-chordates like respiration, excretion, vision. CO 02. Concept of connecting link with evolutionary significance. CO 03. Study on classification and salient features of non-chordates from Mollusca to Hemichordata. CO 04. Different physiological adaptations including torsion in Mollusc, water vascular system in Echinoderms and affinities of Hemichordates. The students will develop the skill to

<p>ZOOA- CC2-3-P</p>	<p>Practical Non-Chordates II Lab</p> <p>1. Study of following specimens:</p> <p>a. Annelids- <i>Aphrodite, Nereis, Chaetopterus, Earthworm, Hirudinaria</i></p> <p>b. Arthropods - <i>Limulus, Palaemon, Balanus, Eupagurus, Scolopendra, Peripatus</i>, Silkworm – lifehistory stages, Termite – members of a colony and Honey bee – members of the colony</p> <p>c. Molluscs - <i>Dentalium, Patella, Chiton, Pila, Achatina, Pinctada, Sepia, Octopus, Nautilus</i></p> <p>d. Echinoderms - <i>Asterias, Ophiura, Clypeaster, Echinus, Cucumaria</i> and <i>Antedon</i></p> <p>2. Anatomy study: Nervous system, Reproductive system (Male & female), Mouth parts & Salivary apparatus in <i>Periplaneta sp.</i></p>	<p>CO 05. Study of spot identification of non-chordates specimen and detailed anatomical studies in <i>Periplaneta sp.</i></p>
<p>CCH04 ZOOA- CC2-4-TH</p>	<p>Cell Biology</p> <p>Unit 1: Plasma Membrane Ultra-structure and composition of Plasma membrane: Fluid mosaic model, Transport across membrane - Active and Passive transport, Facilitated transport, Cell junctions: Tight junctions, Gap junctions, Desmosomes.</p> <p>Unit 2: Cytoplasmic organelles I Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes; Protein sorting and mechanisms of vesicular transport.</p> <p>Unit 3: Cytoplasmic organelles II Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis Mitochondrial Respiratory Chain, Chemiosmotic hypothesis; Peroxisomes: Structure and Functions. Centrosome (Kinetochore and centromeric DNA): Structure and Functions.</p> <p>Unit 4: Cytoskeleton Type, structure and functions of cytoskeleton; Accessory proteins of microfilament & microtubule.</p> <p>Unit 5: Nucleus Nuclear envelope, Nuclear pore complex, Nucleolus; Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome),</p> <p>Unit 6: Cell Cycle Cell cycle and its regulation, Cancer (Concept of oncogenes and tumor suppressor genes with special reference to p53,</p>	<p>Students will be able to gain concept on</p> <p>CO 01. Demonstrate an understanding of structure and the functions of different cellular organelles.</p> <p>CO 02. Describing the mechanisms of vesicular and protein transport to various subcellular sites.</p> <p>CO 03. Concepts on Mitochondria, its origin and different biochemical processes; structure and function of Peroxisome, centrosome and cytoskeleton. Brief concepts on different grades of packaging of chromatin fibre with detailed structure and function of nucleus.</p> <p>CO 04. Discuss the mechanisms of cell to cell signaling, including intracellular second-messenger pathways.</p> <p>CO 05. Explain the cell cycle and its regulation. Demonstrate an understanding of molecular</p>

<p>ZOOA- CC2-4-P</p>	<p>Retinoblastoma and Ras. Process of Proto-oncogene activation.</p> <p>Unit 7: Cell Signalling Cell signalling transduction pathways; Types of signalling molecules and receptors (Classification and Example only): RTK & JAK/STAT. Apoptosis.</p> <p>Practical Cell Biology Lab</p> <ol style="list-style-type: none"> 1. Preparation of temporary stained squash of onion/arum root tip to study various stages of mitosis. 2. Study of various stages of meiosis from grasshopper testis. 3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells. 4. Preparation of permanent slide to demonstrate: <ol style="list-style-type: none"> a. DNA by Feulgen reaction. b. Cell viability study by Trypan Blue staining. 	<p>pathways that are altered in cancers, including oncogenes, tumor suppressors, apoptosis, and DNA repair.</p> <p>CO 06. Study on the mechanism of mitosis in Meristematic tissue of onion and Meiosis in grasshopper Demonstrating presence of DNA in permanent slide by Feulgen reaction, Barr body demonstration in buccal epithelium, Cell viability study using Trypan Blue.</p>
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Core Courses	Content of CU Syllabus	Course Outcome
Semester 3		
CCH05 ZOOA- CC3-5-TH	<p>Chordata</p> <p>Unit 1: Introduction to Chordates General characteristics and outline classification of Phylum Chordata (Young, 1981)</p> <p>Unit 2: Protochordata General characteristics and classification of sub-phylum Urochordata and Cephalochordata up to Classes (Young, 1981). Metamorphosis in Ascidia. Chordate Features, structure of pharynx and feeding in <i>Branchiostoma</i></p> <p>Unit 3: Agnatha General characteristics and classification of cyclostomes up to order (Young, 1981)</p> <p>Unit 4: Pisces General characteristics and classification up to living sub classes (Young, 1981); Accessory respiratory organ, Migration in fishes; Parental care in fishes; Swim bladder in fishes.</p> <p>Unit 5: Amphibia General characteristics and classification up to living Orders (Young, 1981); Metamorphosis, Paedomorphosis, Parental care in Amphibia</p> <p>Unit 6: Reptilia General characteristics and classification up to living Orders (Young, 1981); Poison apparatus and Biting mechanism in Snake. Poisonous & Non-Poisonous snake.</p> <p>Unit 7: Aves General characteristics and classification up to living Sub-Classes (Young, 1981); Exoskeleton and migration in Birds; Principles and aerodynamics of flight.</p> <p>Unit 8: Mammals General characters and classification up to living sub classes (Young, 1981); Exoskeleton derivatives of mammals; Adaptive radiation in mammals with reference to locomotory appendages; Echolocation in Micro chiropterans.</p>	<p>Students will be able to gain concept on</p> <p>CO 01. Understanding the levels of organization in chordates.</p> <p>CO 02. Learning general characters of each vertebrate class.</p> <p>CO 03. Describing unique characters of Urochordates, Cephalochordates and fishes.</p> <p>CO 04. Describing unique characters of amphibians, reptiles, aves and mammals upto subclass/order.</p> <p>CO 05. To understand the special features of some chordates like metamorphosis, paedomorphosis, parental care in Amphibia, biting mechanism and poison apparatus in poisonous snake, migration and aerodynamics principle of bird flight, exoskeletal derivative and echolocation in Mammals.</p>

<p>ZOOA- CC3-5-P</p>	<p>Practical Chordata Lab</p> <p>Identification with Reasons</p> <p>a) Protochordata: <i>Balanoglossus</i>, <i>Branchiostoma</i></p> <p>b) Agnatha: <i>Petromyzon</i></p> <p>c) Fishes: <i>Scoliodon</i>, <i>Sphyrna</i>, <i>Pristis</i>, <i>Torpedo</i>, <i>Mystus</i>, <i>Heteropneustes</i>, <i>Labeo rohita</i>, <i>Exocoetus</i>, <i>Hippocampus</i>, <i>Anabas</i>, Flat fish</p> <p>d) Amphibia: <i>Necturus</i>, <i>Bufo</i> (<i>Duttaphrynus</i>) <i>melanostictus</i>, <i>Rana</i> (<i>Hoplobatrachus</i>) <i>tigerinus</i>, <i>Hyla</i>, <i>Tylosotriton</i>, <i>Axolotl</i> larva</p> <p>e) Reptilia: <i>Chelone</i>, <i>Trionyx</i>, <i>Hemidactylus</i>, <i>Varanus</i>, <i>Calotes</i>, <i>Chamaeleon</i>, <i>Draco</i>, <i>Vipera</i>, <i>Naja</i>, <i>Hydrophis</i>,</p> <p>f) Mammalia: Bat (Insectivorous and Frugivorous), <i>Funambulus</i> (Indian Palm squirrel).</p> <p>Dissection of brain and pituitary – ex situ, digestive and Urino-genital system of Tilapia. Pecten from Fowl head. Power point presentation on study of habit, habitat or behaviour of any one animal by student – for internal assessment only.</p>	<p>CO 06. Identification of representative types from each class with appropriate reasons.</p>
<p>CCH06 ZOOA- CC3-6-TH</p>	<p>Animal Physiology: Controlling and Co-ordinating System</p> <p>Unit 1: Tissues Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue</p> <p>Unit 2: Bone and Cartilage Structure and types of bones and cartilages, Ossification</p> <p>Unit 3: Nervous System Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and non-myelinated nerve fibres; Types of synapse, Synaptic transmission and Neuromuscular junction.</p> <p>Unit 4: Muscular system Histology of different types of muscle; Ultra-structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle fibre.</p> <p>Unit 5: Reproductive System Histology of mammalian testis and ovary; physiology of mammalian reproduction – menstrual and oestrous cycle.</p> <p>Unit 6: Endocrine System Histology and function of thyroid, pancreas and adrenal. Function</p>	<p>Students will be able to gain concept on</p> <p>CO 01. Development of concept of different tissues and their organization.</p> <p>CO 02. Learning principles and concepts of basic physiological processes to relate the various levels of organization and interaction amongst them to ensure proper functionality of an individual.</p>

<p>ZOOA- CC3-6-P</p>	<p>of pituitary. Classification of hormones; Mechanism of Hormone action; Signal transduction pathways for Steroidal and Non-steroidal hormones; Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary; Placental hormones.</p> <p>Practical Animal Physiology: Controlling & Coordinating Systems, Lab</p> <ol style="list-style-type: none"> 1. Recording of cardiac and simple muscle twitch with electrical stimulation. 2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells. 3. Study of permanent slides of Mammalian Skin, Spinal cord, Pancreas, Testis, Ovary, Adrenal, Lung, pyloric stomach, cardiac stomach, Thyroid, small intestine and large intestine of mammal (white rat). 4. Microtomy: Preparation of permanent slide of any five mammalian (Goat/white rat) tissues. 	<p><i>CO 03.</i> Learning the practical knowledges to analyse different physiological processes.</p> <p><i>CO 04.</i> Learning of histology of different mammalian tissues.</p> <p><i>CO 05.</i> Development of idea of microtomy by using mammalian tissue.</p>
<p>CCH07 ZOOA- CC3-7-TH</p>	<p>Fundamentals of Biochemistry</p> <p>Unit 1: Carbohydrates Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides; Derivatives of Monosaccharides; Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis.</p> <p>Unit 2: Lipids Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Triacylglycerols, Phospholipids, Sphingolipid, Glycolipids, Steroids, Eicosanoids and terpenoids. Lipid metabolism: β-oxidation of fatty acids - a. Palmitic acid {saturated (C 16:0)}, b. Linoleic acid {unsaturated (C 18:2)}; Fatty acid biosynthesis.</p> <p>Unit 3: Proteins Amino acids: Structure, Classification, General and Electrochemical properties of α-amino acids; Physiological importance of essential and non-essential amino acids, Proteins Bonds stabilizing protein structure; Levels of organization; Protein metabolism: Transamination, Deamination, Urea cycle, Fate of C-skeleton of Glucogenic and Ketogenic amino acids.</p> <p>Unit 4: Nucleic Acids Structure of Purines, Pyrimidines, Nucleosides and Nucleotides; Nucleic Acid Metabolism: Catabolism of adenosine, Guanosine, cytosine and thymine.</p> <p>Unit 5: Enzymes Nomenclature and classification; Cofactors; Specificity of enzyme</p>	<p>Students will be able to gain concept on</p> <p><i>CO 01.</i> Development of biochemical background in various life sustaining processes.</p> <p><i>CO 02.</i> Learning the structure and function of different macro and/or micro molecules.</p>

<p>ZOOA- CC3-7-P</p>	<p>action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Derivation of Michaelis-Menten equation, Lineweaver-Burk plot; Factors affecting rate of enzyme-catalyzed reactions; Enzyme inhibition.</p> <p>Unit 6: Oxidative Phosphorylation Redox systems; Mitochondrial respiratory chain, Inhibitors and uncouplers of Electron Transport System.</p> <p>Practical Fundamentals of Biochemistry Lab</p> <ol style="list-style-type: none"> 1. Qualitative tests for carbohydrates, proteins and lipids. 2. Qualitative estimation of Urea & Uric acid. 3. Paper chromatography of amino acids. 4. Quantitative estimation of water soluble proteins following Lowry Method. 	<p>CO 03. Basic concept on enzyme action, mechanism, kinetics, equation, inhibition and electron transport chain, inhibitors and uncouplers.</p> <p>Students will achieve the knowledge on</p> <p>CO 01. Learning the practical knowledge to analyse different biochemical samples and assess the presence of macro and/or micro molecules there in.</p>
<p>SECA ZOOA- SEC(A)-3- 2-TH</p>	<p>Sericulture</p> <p>Unit 1: Introduction Sericulture: Definition, history and present status; Silk route. Types of silkworms, Distribution and Races. Exotic and indigenous races. Mulberry and non-mulberry Sericulture.</p> <p>Unit 2: Biology of Silkworm Life cycle of <i>Bombyx-mori</i>. Structure of silk gland and secretion of silk.</p> <p>Unit 3: Rearing of Silkworms Selection of mulberry variety and establishment of mulberry garden Rearing house and rearing appliances. Disinfectants: Formalin, bleaching powder, RKO. Silkworm rearing technology: Early age and Late age rearing. Types of mountages. Spinning, harvesting and storage of cocoons.</p> <p>Unit 4: Pests and Diseases Pests of silkworm: Uzi fly, dermestid beetles and vertebrates. Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial. Control and prevention of pests and diseases.</p>	<p>Students will be able to understand basic concept of</p> <p>CO 01. History, development and organization of sericulture industry.</p> <p>CO 02. Understanding biology of silkworm, rearing, silkworm.</p> <p>CO 03. Gaining knowledge of Techniques of Mulberry garden establishment, cultivation, pruning and management.</p> <p>CO 04. Harvesting and storage of silk.</p> <p>CO 05. Pests & disease, future and prospects of silk industry in India with regard to Mulberry and non-Mulberry sericulture.</p>

	<p>Unit 5: Entrepreneurship in Sericulture Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture. Visit to various sericulture centres.</p>	<p><i>CO 06.</i> Visiting sericulture centres to gain an insight of the concepts learned in theory and familiarity with various sericulture practices.</p>
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Core Courses	Content of CU Syllabus	Course Outcome
Semester 4		
<p>CCH08 ZOOA-CC4-8-TH</p> <p>ZOOA-CC4-8-P</p>	<p>Comparative Anatomy of Vertebrates</p> <p>Unit 1: Integumentary System Structure, function and derivatives of integument in amphibian, birds and mammals.</p> <p>Unit 2: Digestive System Comparative anatomy of stomach; dentition in mammals.</p> <p>Unit 3: Respiratory System Respiratory organs in fish, birds and mammals.</p> <p>Unit 4: Circulatory System General plan of circulation, Comparative account of heart and aortic arches.</p> <p>Unit 5: Urinogenital System Succession of kidney in different vertebrate groups; evolution of urino-genital ducts.</p> <p>Unit 6: Nervous system and sense organs Comparative account of brain in vertebrates; cranial nerves; olfactory and auditory receptors in Vertebrates.</p> <p>Unit 7: Skeletal system Overview of axial and appendicular skeleton – limbs, girdles of pigeon; jaw suspension in mammals.</p> <p>Practical Comparative Anatomy of Vertebrates Lab</p> <p>1. Study of placoid, cycloid and ctenoid scales through permanent</p>	<p>The students will have a preliminary idea about</p> <p><i>CO 01.</i> Development of clear concept anatomy of different vertebrate forms.</p> <p><i>CO 02.</i> Correlation between different body plans of various vertebrate taxa and their utilities like integumental derivatives in vertebrates, rumination and dentition in mammals, evolution of aortic arches, succession of kidney, olfactory and auditory receptors..</p> <p><i>CO 03.</i> Evolution of brain, types of olfactory and auditory receptors, basic features of axial and appendicular skeleton.</p> <p><i>CO 04.</i> Correlating the theoretical knowledge with practical curricula</p>

	<p>2. Estimation of haemoglobin using Sahli's haemoglobin meter.</p> <p>3. Identification of blood cells from human blood.</p> <p>4. Preparation of haemin crystals and haemochromogen crystals.</p> <p>5. Identification of blood cells from cockroach haemolymph.</p> <p>6. Demonstration of blood pressure by digital meter.</p>	<p><i>CO 04.</i> Estimation of various haematological and physiological parameters by means of elementary equipments.</p>
<p>CCH10 ZOOA- CC4-10-TH</p>	<p>Immunology</p> <p>Unit 1: Overview of Immune System Introduction – concept of health and disease; Cells and organs of the Immune system.</p> <p>Unit 2: Innate and Adaptive Immunity Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral).</p> <p>Unit 3: Antigens Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes.</p> <p>Unit 4: Immunoglobulins Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA and RIA), Monoclonal antibody production.</p> <p>Unit 5: Major Histocompatibility Complex Structure and functions of MHC molecules. Structure of T cell Receptor and its signalling, T cell development & selection.</p> <p>Unit 6: Cytokines Types, properties and functions of cytokines.</p> <p>Unit 7: Complement System Components and pathways of complement activation.</p> <p>Unit 8: Hypersensitivity Gell and Coombs' classification and brief description of various types of hypersensitivities.</p> <p>Unit 9: Vaccines</p>	<p>Students will be able to gain knowledge on</p> <p><i>CO 01.</i> Identification the cellular and molecular basis of immune responsiveness.</p> <p><i>CO 02.</i> Understand the fundamental concepts of immunity, contributions of the organs and cells in immune responses.</p> <p><i>CO 03.</i> Conceptualize how the innate and adaptive immune responses coordinate to fight invading pathogens.</p> <p><i>CO 04.</i> Realize how the MHC molecules function and conceptualize.</p> <p><i>CO 05.</i> Comprehend the overreaction by our immune system leading to hypersensitive conditions and its consequences.</p> <p><i>CO 06.</i> The students will be able to describe immunological response and how it is triggered and regulated.</p>

	<p>Various types of vaccines. Active & passive immunization (Artificial and natural).</p> <p>Practical Immunology Lab</p> <ol style="list-style-type: none"> 1. Demonstration of lymphoid organs (by picture). 2. Histological study of Bursa fabricius, spleen, thymus and lymph nodes through slides/photographs. 3. Demonstration of ELISA. 	<p><i>CO 07.</i> Learning of different lymphoid organs by histological studies.</p> <p><i>CO 08.</i> Understanding of ELISA.</p>
<p>SEC B</p> <p>ZOOA-SEC(B)-4-2-TH</p>	<p>Medical Diagnostic Technique</p> <p>Unit 1: Diagnostics Methods Used for Analysis of Blood Blood composition, Differential Leucocyte Count (DLC) using Leishman's stain, Platelet counting using haemocytometer, Erythrocyte Sedimentary Rate (ESR), Packed Cell Volume (PCV).</p> <p>Unit 2: Diagnostic Methods Used for Urine Analysis Urine Analysis: Physical characteristics; Abnormal constituents, Urine culture.</p> <p>Unit 3: Non-infectious Diseases Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit.</p> <p>Unit 4: Infectious Diseases Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis, Malarial parasite (Microscope based and ELISA based).</p> <p>Unit 5: Clinical Biochemistry Lipid profiling, Liver function test. PSA test</p> <p>Unit 6: Clinical Microbiology Antibiotic Sensitivity Test</p> <p>Unit 7: Tumours Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).</p> <p>Unit 8: Visit to Pathological Laboratory and Submission of Project</p>	<p>The students will develop knowledge about</p> <p><i>CO 01.</i> Learning and understanding of different methods for analysis of blood, urine sample from human.</p> <p><i>CO 02.</i> Learning of different types of infectious and non-infectious diseases, causes, detection by their symptoms, means of diagnosis and prevention.</p> <p><i>CO 03.</i> Understanding the utilization of clinical biochemistry and clinical microbiology.</p>

	<p>2. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, salinity, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO₂.</p> <p>3. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary/ any place of ecological interest/ ecological uniqueness/ Zoological garden.</p>	<p>with special reference to planktons and estimation of different physical factors (Temperature, pH, DO₂, COD, CO₂).</p> <p><i>CO 07.</i> Detailed concept on ecological uniqueness of place of ecological interest.</p>
<p>CCH12</p> <p>ZOOA-</p> <p>CC5-12-TH</p>	<p>Principle of Genetics</p> <p>Unit 1: Mendelian Genetics and its Extension Principles of inheritance, Incomplete dominance and co-dominance, Epistasis, Multiple alleles, Isoallele (White eye mutations), Pseudoallele (Lozenge Locus) & Cis-trans test for allelism, Lethal alleles, Pleiotropy, Penetrance & Expressivity.</p> <p>Unit 2: Linkage, Crossing Over and Linkage Mapping Linkage and Crossing, Complete & Incomplete Linkage, Measuring Recombination frequency and linkage map construction using three factor crosses, Interference and coincidence. Sex linkage in Drosophila (White eye locus) & Human (Haemophilia).</p> <p>Unit 3: Mutations Types of gene mutations (Classification), Types of chromosomal aberrations (Classification with one suitable example from Drosophila and Human of each), variation in chromosome number; Nondisjunction of X chromosome in Drosophila; Non-disjunction of Human Chromosome 21. Molecular basis of mutations in relation to UV light and chemical mutagens. Mutation detection in Drosophila by attached X method. Biochemical mutation detection in Neurospora.</p> <p>Unit 4: Sex Determination Mechanisms of sex determination in Drosophila and in man; Dosage compensation in Drosophila & Human.</p> <p>Unit 5: Extra-chromosomal Inheritance Kappa particle in Paramoecium, Shell spiralling in snail.</p>	<p>The students will learn about the</p> <p><i>CO 01.</i> Principles of Mendelian inheritance pattern and exception, different allele concepts, cis-trans test.</p> <p><i>CO 02.</i> Linkage and crossing over concepts, estimation of recombination frequency, linkage map construction using three factor cross, sex linkage in Drosophila and human.</p> <p><i>CO 03.</i> Types of gene mutations and chromosomal aberrations, molecular basis of mutation, different mutation detection techniques.</p> <p><i>CO 04.</i> Mechanism of sex determination and dosage compensation, examples of extra chromosomal inheritance, complementation test in bacteriophage, different types of transposable genetic elements and</p>

<p>ZOOA- CC5-12-TH</p>	<p>Unit 6: Genetic Fine Structure Complementation test in Bacteriophage (Benzer's experiment on rII locus).</p> <p>Unit 7: Transposable Genetic Elements IS element in bacteria, Ac-Ds elements in maize and P elements in Drosophila, LINE, SINE, Aluelements in humans.</p> <p>Principles of Genetics Lab</p> <ol style="list-style-type: none"> 1. Chi-square analyses for genetic ratio test. 2. Identification of chromosomal aberration in Drosophila and man from photograph. 3. Pedigree analysis of some inherited traits in animals. 	<p>their functions.</p> <p>CO 05. Concept on genetic ration test, chromosomal aberration detection techniques and pedigree analyses.</p>
<p>DSEA ZOOA- DSE(A)-5- 1-TH</p>	<p>Parasitology</p> <p>Unit 1: Introduction to Parasitology Brief introduction of parasitism, parasite, parasitoid and vectors (mechanical and biological vector); host parasite relationship.</p> <p>Unit 2: Parasitic Protists Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Giardia intestinalis</i>, <i>Trypanosoma gambiense</i>, <i>Leishmania-donovani</i>.</p> <p>Unit 3: Parasitic Platyhelminthes Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Schistosoma haematobium</i>, <i>Taenia-solium</i>.</p> <p>Unit 4: Parasitic Nematodes Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Ascaris-lumbricoides</i>, <i>Ancylostoma duodenale</i>, <i>Wuchereria bancrofti</i>, Nematode plant interaction.</p> <p>Unit 5: Parasitic Arthropods Biology, importance and control of ticks: Soft tick (Ornithodoros), Hard tick (Ixodes), mites (Sarcoptes), Lice (Pediculus), Flea (Xenopsylla) and Bug (Cimex). Parasitoid.</p> <p>Unit 6: Parasite Vertebrates Cookicutter Shark, Hood Mocking bird, Vampire bats their parasitic behaviour and effect on host.</p>	<p>Students will be able to acquire knowledge about</p> <p>CO 01. Parasitoid, Vectors and Host-parasite relationship.</p> <p>CO 02. Understanding biology, life cycles, epidemiology, clinical features, laboratory diagnosis, treatment and prevention of common human parasitic infections (Parasitic protest & platyhelminthes).</p> <p>CO 03. Understanding biology, life cycles, epidemiology, clinical features, laboratory diagnosis, treatment and prevention of common helminth and arthropod parasites of humans as well as explaining behaviour host of some Vertebrate parasites and its effect on host.</p>

<p>ZOOA-DSE(A)-5-1-P</p>	<p>Parasitology Lab</p> <ol style="list-style-type: none"> 1. Study of life stages of <i>Giardia intestinalis</i>, <i>Trypanosoma gambiense</i>, <i>Leishmania donovani</i>, <i>Plasmodium vivax</i>, <i>Plasmodium falciparum</i> through permanent slides/micro photographs. 2. Study of adult and life stages of <i>Schistosoma haematobium</i>, <i>Taenia solium</i> through permanent slides/micro photographs. 3. Study of adult and life stages of <i>Ancylostoma duodenale</i> through permanent slides/micro photographs. 	<p>CO 04. Demonstrate familiarity with some protozoan, platyhelminth, helminth parasites of human, fish, birds and other livestock using permanent slides / photomicrographs / charts.</p>
<p>DSEB</p> <p>ZOOA-DSE(B)-5-1-TH</p>	<p>Endocrinology</p> <p>Unit 1: Introduction to Endocrinology General idea of Endocrine systems, Classification, Characteristic and Transport of Hormones, Neuro-secretions and Neuro-hormones: Examples and Functions.</p> <p>Unit 2: Hypothalamo-Hypophyseal Axis Structure and functions of hypothalamus and Hypothalamic nuclei, Regulation of neuroendocrine glands, Feedback mechanisms, Hypothalamo-Hypophyseal-Gonadal Axis. Structure of pituitary gland, Hormones and their functions, Hypothalamo-hypophyseal portal system.</p> <p>Unit 3: Peripheral Endocrine Glands Structure, Hormones and Functions of Thyroid gland, Parathyroid, Adrenal, Pancreas, Ovary and Testis. Disorders of endocrine glands (Diabetes mellitus type I & Type II; Graves' Disease).</p> <p>Unit 4: Regulation of Hormone Action Mechanism of action of steroidal, non-steroidal hormones with receptors (cAMP, IP3-DAG), Calcium and Glucose homeostasis in mammals. Bioassays of hormones using RIA & ELISA, Estrous cycle in rat and menstrual cycle in human.</p> <p>Unit 5. Non Mammalian Vertebrate Hormone Functions of Prolactin in Fishes, Amphibia & Birds. Function of Melanotropin in Teleost fishes, Amphibians and Reptiles.</p>	<p>Students will be able to acquire knowledge about</p> <p>CO 01. General idea of classification, characteristics, different modes of transport of endocrine hormones and their function.</p> <p>CO 02. Structure and function of Hypothalamus, pituitary, their hormones, function, neuro-endocrine regulation through different hypothalamo-hypophysial axis.</p> <p>CO 03. Structure, Hormones and Functions of several peripheral endocrine glands and associated disorders.</p> <p>CO 04. Mechanism of action of steroid / non-steroid hormones, calcium and glucose homeostasis, bioassays (RIA, ELISA), oestrous and menstrual cycle, function of prolactin and melanotropin in non-mammalian vertebrates.</p>

ZOOA-DSE(B)-5-1-P	<p>Endocrinology Lab</p> <ol style="list-style-type: none"> 1. Dissect and display of Endocrine glands in laboratory bred rat. 2. Study of the permanent slides of all the endocrine glands. 3. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland. 4. H-E staining of Histological slides. 	<p>CO 05. Anatomy of different endocrine glands in rat, histological slide preparation following dissection, fixation, paraffin embedding, tissue block preparation using microtomy and H-E staining protocols.</p>
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Core Courses	Content of CU Syllabus	Course Outcome
Semester 6		
CCH13 ZOOA-CC6-13-TH ZOOA-CC6-13-P	<p>Developmental Biology</p> <p>Unit 1: Early Embryonic Development Gametogenesis: Spermatogenesis, Oogenesis (sea urchin & mammal); Types of eggs, Eggmembranes; Fertilization in sea urchin and mammal; Planes and patterns of cleavage; Types of Blastula [frog and chick]; Fate map in chick embryo, fate mapping using vital dye and radioactivetechnique; Gastrulation in frog and chick; Embryonic induction and organizers in Xenopus(Spemann & Mangold’s experiment).</p> <p>Unit 2: Late Embryonic Development Extra-embryonic membranes in Chick; Implantation of embryo in humans, Placenta (Structure,types and functions of placenta).</p> <p>Unit 3: Post Embryonic Development Development of brain and Eye in Chick. Molecular Induction in Brain and Eye development.</p> <p>Unit 4: Implications of Developmental Biology In vitro fertilization (IVF), Stem cell: Concept of potency, types, markers and applications of stemcell therapy in bone marrow transplantation and cartilage regeneration.</p> <p>Practical Developmental Biology Lab</p> <ol style="list-style-type: none"> 1. Study of whole mounts of developmental stages of chick embryo through permanent slides: 24, 48, and 96hours of incubation. 2. Study of the developmental stages and life cycle of Drosophila. 	<p>Students will be able to gain concept about</p> <p>CO 01. Understanding basic concepts of gametogenesis, fertilization and early embryonic development in different animal groups and appreciating the differences in animal development.</p> <p>CO 02. Explaining process of implantation and placentation, application aspects of <i>in vitro</i> fertilization, stem cell therapy, transplantation and regeneration.</p> <p>CO 03. Explore and gain understanding of embryology through the investigation of development in</p>

	<p>3. Study of different sections of placenta (photomicrograph/slides).</p> <p>4. Identification of Invertebrate larva through slides/ photographs of Phylum Annelida, Arthropoda, Molluscaand Echinodermata.</p>	<p>Chick and Drosophila through slides and charts. Brief idea about some non-chordate larval morphology.</p>
<p>CCH14</p> <p>ZOOA-CC6-14-TH</p>	<p>Evolutionary Biology</p> <p>Unit 1 Origin of Life (Chemical basis), RNA world hypothesis.</p> <p>Unit 2 Historical review of Evolutionary concepts: Lamarkism, Darwinism and Neo Darwinism.</p> <p>Unit 3 Geological time scale, Fossil: types and age determination by Carbon dating, Evolution of horse.</p> <p>Unit 4 Natural Selection: Modes with Examples.</p> <p>Unit 5 Species concept, Isolating mechanisms, modes of speciation; Speciation by chromosomerearrangement in <i>Drosophila</i>. Adaptive radiation/macroevolution (exemplified by Galapagosfinches).</p>	<p>Students will be able to gain knowledge about</p> <p>CO 01. Concept on origin of life, different evolutionary concepts, evolutionary clock and fossil age determination techniques with special reference to horse evolution. Brief idea about natural selection, speciation and adaptive radiation.</p>

<p>ZOOA-CC6-14-P</p>	<p>Unit 6 Origin and Evolution of Man, Unique Hominid characteristics contrasted with primateCharacteristic.</p> <p>Unit 7 Population genetics: Hardy-Weinberg Law; factors disrupting H-W equilibrium (Genetic Drift,Migration and Mutation and Selection in changing allele frequencies (only derivations required). Simple problems related to estimation of allelic and gene frequencies.</p> <p>Unit 8 Extinction, back ground and mass extinctions, detailed example of K-T extinction.</p> <p>Unit 9 Phylogenetic trees, construction and interpretation of Phylogenetic tree using parsimony,convergent and divergent evolution.</p> <p>Practical Evolutionary Biology Lab</p> <ol style="list-style-type: none"> 1. Study of fossils from models/ pictures: <i>Dickinsonia</i>, <i>Paradoxides</i> (Trilobita), <i>Asteroceras</i> (Ammonoid),<i>Pentremites</i> (Blastoid Echinoderm), <i>Ichthyosaur</i>, <i>Archaeopteryx</i>, <i>Cynodont</i>. 2. Study of homology and analogy from suitable specimens. 3. Phylogenetic trees, Construction & interpretation of Phylogenetic tree using parsimony, Constructionof dendrogram following principles of phenetics & cladistics from a data table. 	<p>CO 02. Brief concept on population genetics including Hardy Weinberg equilibrium and factors affecting equilibrium, methods of estimating allele and genotypic frequencies.</p> <p>CO 03. Detailed concepts on extinction, examples, phylogenetic tree construction and interpretation using parsimony and types of evolution.</p> <p>CO 04. Brief idea about different fossil forms in context of evolution, homology & analogy concept, construction of phylogenetic tree and dendrogram using parsimony and principles of phonetics and cladistics respectively.</p>
<p>DSEA ZOOA-DSE(A)-6-2-TH</p>	<p>Animal Biotechnology</p> <p>Unit 1: Introduction Organization of <i>E. coli</i> and <i>Drosophila</i> genome.</p> <p>Unit 2: Molecular Techniques in Gene manipulation Recombinant DNA technology, Restriction endonucleases. Cloning Vectors & their features: Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC,and HAC. Shuttle and Expression Vectors. Construction of Genomic libraries and cDNA libraries. Transformation techniques: Cloning in bacteria and detection</p>	<p>The students will be develop a clear concept of</p> <p>CO 01. Brief idea about organization of <i>E. coli</i> and <i>Drosophila</i> genome. Recombinant DNA technology, restriction endonuclease, different cloning vectors with features.</p> <p>CO 02. Different transformation techniques including Gel electrophoresis, southern, northern and western</p>

<p>ZOOA- DSE(A)-6- 2-P</p>	<p>technique of clone. Agarose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting, Polymerase chain reaction: Allele specific, RAPD & RT PCR, DNA Fingerprinting.</p> <p>Unit 3: Genetically Modified Organisms Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNAmicroinjection. Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knock-out mice.</p> <p>Unit 4: Culture Techniques and Applications Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anaemia, Thalassemia). Dolly & Polly cloning, Genetically modified economically important animal, Gene Therapy.</p> <p>Practical Animal Biotechnology Lab</p> <ol style="list-style-type: none"> 1. Genomic DNA isolation from <i>E. coli</i> and Plasmid DNA isolation (pUC 18/19) from <i>E. coli</i>. 2. To study following techniques through photographs - Southern Blotting, Northern Blotting, Western Blotting, PCR, DNA fingerprinting. 3. Project report on animal cloning & Application & ethical Issues. 	<p>blotting, RAPD, RT-PCR, DNA fingerprinting.</p> <p>CO 03. Production of cloned and transgenic animals and their applications. Different cell culture techniques, molecular diagnosis of some genetic disease, gene therapy, economically important genetically modified animals.</p> <p>CO 04. Genomic and plasmid DNA (pUC 18/19) isolation, qualitative and quantitative analyses of DNA, RNA, protein, DNA amplification, animal cloning and ethical issues.</p>
<p>DSEB ZOOA- DSE(B)-6- 1-TH</p>	<p>Animal Behaviour and Chronobiology</p> <p>Unit 1: Patterns of Behaviour Stereotyped Behaviours (Orientation, Reflex); Individual Behavioural patterns; Instinct vs. Learned Behaviour; FAP, Associative learning, classical and operant conditioning, Habituation, Imprinting.</p> <p>Unit 2: Social and Sexual Behaviour Social organisation in termites; Communication (dance & pheromones in Bees). Social behaviour: Altruism (Hamilton's rule and concept of haplodiploidy), Cooperation and Selfishness. Sexual Behaviour: Sexual dimorphism, Mate choice in peacock, Intra-sexual selection (male rivalry in red deer). Kinship theory: Relatedness & inclusive fitness; parental care in fishes (Nest Building & cost benefit), conflict within families: parent offspring conflict and sibling rivalry.</p>	<p>The students will be develop a clear concept of</p> <p>CO 01. Concepts on orientation, reflex, different types of instinct and learned behaviour.</p> <p>CO 02. Social organization in termites, bee communication, altruism (Hamilton's rule and concept of haplodiploidy), sexual dimorphism & selection, kinship concept, parent-offspring conflict and sibling rivalry.</p>

<p>ZOOA- DSE(B)-6- 1-P</p>	<p>Unit 3: Chronobiology & Biological Rhythm Types and characteristics of biological rhythms: Short- and Long-term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms, Circannual rhythms; Photic and non-photic zeitgebers; Role of melatonin. Biological clock and its adaptive significance. Circannual rhythm in bird migration.</p> <p>Practical Animal Behaviour and Chronobiology Lab</p> <ol style="list-style-type: none"> 1. To study nests and nesting habits of the birds and social insects. 2. To study the behavioural responses of wood lice to dry and humid conditions (demonstration only). 3. To study geotaxis behaviour in earthworm. 4. To study the phototaxis behaviour in insect larvae. 5. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report. 6. Study of circadian functions in humans (daily eating, sleep and temperature patterns). 	<p><i>CO 03.</i> Types and characteristics of biological rhythms, role of hormones, biological clock and adaptive significance (Circannual rhythm in bird migration).</p> <p><i>CO 04.</i> Concepts on nesting behaviour, varied behavioural response to different environmental cues.</p> <p><i>CO 05.</i> Visit to conserved place of zoological interest to study behavioural activities of animals, study of circadian functions in human following definite patterns.</p>
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