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 ofclassification – three kingdom concept of Carl Woese, 1977 and five kingdom concept	Students will be able to *CO 01.* Identify and discuss features and concepts of the animal classification from unicellular to

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

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

CCH02 **ZOOA-** **CC1-2-TH**	**Molecular Biology** **Unit 1: Nucleic acid** Salient features of DNA, Chargaff's Rule, Hypo and Hyperchromic shift. Watson and Crick Model of DNA. RNA types & Function. **Unit 2: DNA Replication** Mechanism of DNA Replication in Prokaryotes, Prove that replication is Semi-conservative,bidirectional and discontinuous, RNA priming, Replication of telomeres. **Unit 3: Transcription** Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, Differencebetween prokaryotic and eukaryotic transcription. **Unit 4: Translation** Genetic code, Degeneracy of the genetic code and Wobble Hypothesis. Mechanism of protein synthesis in prokaryotes. **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 **Unit 6: Gene Regulation** Regulation of Transcription in prokaryotes: lac operon and trp operon;Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, miRNAmediated gene silencing. Epigenetic Regulation: DNA Methylation, Histone Methylation & Acetylation. **Unit 7: DNA Repair Mechanisms** Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair **Unit 8: Molecular Techniques** PCR, Western and Southern blot, Northern Blot.	The students will develop a clear concept of *CO 01.* Explaining the basic structuire of nucleic acid and molecular mechanisms of DNA replication in prokaryotes and eukaryotes. *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. *CO 03.* Describing how gene expression is regulated at the transcriptional and post-transcriptional level. *CO 04.* Different types of DNA repairing mechanism and biotechnological estimation of DNA, RNA and protein.

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.

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 *Pila sp.* Torsion in Gastropoda. Feeding and respiration in *Pila sp.* **Unit 6: Echinodermata** General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Watervascularsystem in *Asterias*. Echinoderm larva and affinities with chordates. **Unit 7: Hemichordata** General characteristics of phylum Hemichordata. Relationship with non-chordates and chordates.	The 2nd 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

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

	Retinoblastoma and Ras. Process of Proto-oncogene activation. **Unit 7: Cell Signalling** Cell signalling transduction pathways; Types of signalling molecules and receptors (Classificationand Example only): RTK & JAK/STAT. Apoptosis. **Practical** **Cell Biology Lab**	pathways that are altered in cancers, including oncogenes, tumor suppressors, apoptosis, and DNA repair.
ZOOA- **CC2-4-P**	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/cheekcells. 4. Preparation of permanent slide to demonstrate: a. DNA by Feulgen reaction. b. Cell viability study by Trypan Blue staining.	*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 Fuelgen reaction, Barr body demonstration in buccal epithelium, Cell viability study using Trypan Blue.

Core Courses	Content of CU Syllabus	Course Outcome
Semester 3		
CCH05 **ZOOA-** **CC3-5-TH**	**Chordata** **Unit 1: Introduction to Chordates** General characteristics and outline classification of Phylum Chordata (Young, 1981) **Unit 2: Protochordata** General characteristics and classification of sub-phylum Urochordata and Cephalochordata up toClasses (Young, 1981). Metamorphosis in Ascidia. Chordate Features, structure of pharynx andfeeding in *Branchiostoma* **Unit 3: Agnatha** General characteristics and classification of cyclostomes up to order (Young, 1981) **Unit 4: Pisces** General characteristics and classification up to living sub classes (Young, 1981); Accessoryrespiratory organ, Migration in fishes; Parental care in fishes; Swim bladder in fishes. **Unit 5: Amphibia** General characteristics and classification up to living Orders (Young, 1981); Metamorphosis,Paedomorphosis, Parental care in Amphibia **Unit 6: Reptilia** General characteristics and classification up to living Orders (Young, 1981); Poisonapparatus and Biting mechanism in Snake. Poisonous & Non-Poisonous snake. **Unit 7: Aves** General characteristics and classification up to living Sub-Classes (Young, 1981); Exoskeletonand migration in Birds; Principles and aerodynamics of flight. **Unit 8: Mammals** General characters and classification up to living sub classes (Young, 1981); Exoskeletonderivatives of mammals; Adaptive radiation in mammals with reference to locomotoryappendages; Echolocation in Micro chiropterans.	Students will be able to gain concept on *CO 01.* Understanding the levels of organization in chordates. *CO 02.* Learning general characters of each vertebrate class. *CO 03.* Describing unique characters of Urochordates, Cephalochordates and fishes. *CO 04.* Describing unique characters of amphibians, reptiles, aves and mammals upto subclass/order. *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.

ZOOA- **CC3-5-P**	**Practical** **Chordata Lab** Identification with Reasons a) Protochordata: *Balanoglossus, Branchiostoma* b) Agnatha: *Petromyzon* c) Fishes: *Scoliodon, Sphyrna, Pristis, Torpedo, Mystus, Heteropneustes, Labeo rohita, Exocoetus,Hippocampus, Anabas*, Flat fish d) Amphibia: *Necturus, Bufo* (*Duttaphrynus*) *melanostictus, Rana* (*Hoplobatrachus*) *tigerinus, Hyla,Tylototriton, Axolotl* larva e) Reptilia: *Chelone, Trionyx, Hemidactylus, Varanus, Calotes, Chamaeleon, Draco, Vipera, Naja,Hydrophis*, f) Mammalia: Bat (Insectivorous and Frugivorous), *Funambulus* (Indian Palm squirrel). 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 internalassessment only.	*CO 06.* Identification of representative types from each class with appropriate reasons.
CCH06 **ZOOA-** **CC3-6-TH**	**Animal Physiology: Controlling and Co-ordinating System** **Unit 1: Tissues** Structure, location, classification and functions of epithelial tissue, connective tissue, musculartissue and nervous tissue **Unit 2: Bone and Cartilage** Structure and types of bones and cartilages, Ossification **Unit 3: Nervous System** Structure of neuron, resting membrane potential, Origin of action potential and its propagationacross the myelinated and non-myelinated nerve fibres; Types of synapse, Synaptic transmissionand Neuromuscular junction. **Unit 4: Muscular system** Histology of different types of muscle; Ultra-structure of skeletal muscle; Molecular andchemical basis of muscle contraction; Characteristics of muscle fibre. **Unit 5: Reproductive System** Histology of mammalian testis and ovary; physiology of mammalian reproduction – menstrualand oestrous cycle. **Unit 6: Endocrine System** Histology and function of thyroid, pancreas and adrenal. Function	Students will be able to gain concept on *CO 01.* Development of concept of different tissues and their organization. *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.

ZOOA- **CC3-6-P**	of pituitary. Classification of hormones; Mechanism of Hormone action; Signal transduction pathways forSteroidal and Non- steroidal hormones; Hypothalamus (neuroendocrine gland) - principal nucleiinvolved in neuroendocrine control of anterior pituitary; Placental hormones. **Practical** **Animal Physiology: Controlling & Coordinating Systems, Lab** 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.	*CO 03.* Learning the practical knowledges to analyse different physiological processes. *CO 04.* Learning of histology of different mammalian tissues. *CO 05.* Development of idea of microtomy by using mammalian tissue.
CCH07 **ZOOA-** **CC3-7-TH**	**Fundamentals of Biochemistry** **Unit 1: Carbohydrates** Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides;Derivatives of Monosaccharides; Carbohydrate metabolism: Glycolysis, Citric acid cycle,Pentose phosphate pathway, Gluconeogenesis. **Unit 2: Lipids** Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Triacylglycerols,Phospholipids, Sphingolipid, Glycolipids, Steroids, Eicosanoids and terpinoids.Lipid metabolism: β-oxidation of fatty acids - a. Palmitic acid {saturated (C 16:0)}, b. Linoleicacid {unsaturated (C 18:2)}; Fatty acid biosynthesis. **Unit 3: Proteins** Amino acids: Structure, Classification, General and Electro chemical properties of α-aminoacids; Physiological importance of essential and non-essential amino acids, Proteins Bondsstabilizing protein structure; Levels of organization; Protein metabolism: Transamination,Deamination, Urea cycle, Fate of C-skeleton of Glucogenic and Ketogenic amino acids. **Unit 4: Nucleic Acids** Structure of Purines, Pyrimidines, Nucleosides and Nucleotides; Nucleic Acid Metabolism:Catabolism of adenosine, Guanosine, cytosine and thymine. **Unit 5: Enzymes** Nomenclature and classification; Cofactors; Specificity of enzyme	Students will be able to gain concept on *CO 01.* Development of biochemical background in various life sustaining processes. *CO 02.* Learning the structure and function of different macro and/or micro molecules.

ZOOA- **CC3-7-P**	action; Isozymes; Mechanismof enzyme action; Enzyme kinetics; Derivation of Michaelis-Menten equation, Lineweaver-Burkplot; Factors affecting rate of enzyme-catalyzed reactions; Enzyme inhibition. **Unit 6: Oxidative Phosphorylation** Redox systems; Mitochondrial respiratory chain, Inhibitors and un-couplers of ElectronTransport System. **Practical** **Fundamentals of Biochemistry Lab** 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 followingLowry Method.	*CO 03.* Basic concept on enzyme action, mechanism, kinetics, equation, inhibition and electron transport chain, inhibitors and uncouplers. Students will achieve the knowledge on *CO 01.* Learning the practical knowledge to analyse different biochemical samples and assess the presence of macro and/or micro molecules there in.
SECA **ZOOA-SEC(A)-3-2-TH**	**Sericulture** **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. **Unit 2: Biology of Silkworm** Life cycle of *Bombyx-mori*. Structure of silk gland and secretion of silk. **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. **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.	Students will be able to understand basic concept of *CO 01.* History, development and organization of sericulture industry. *CO 02.* Understanding biology of silkworm, rearing, silkworm. *CO 03.* Gaining knowledge of Techniques of Mulberry garden establishment, cultivation, pruning and management. *CO 04.* Harvesting and storage of silk. *CO 05.* Pests & disease, future and prospects of silk industry in India with regard to Mulberry and non-Mulberry sericulture.

	Unit 5: Entrepreneurship in Sericulture Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential inmulberry and non-mulberry sericulture. Visit to various sericulture centres.	*CO 06.* Visiting sericulture centres to gain an insight of the concepts learned in theory and familiarity with various sericulture practices.

Core Courses	Content of CU Syllabus	Course Outcome
Semester 4		
CCH08 **ZOOA-** **CC4-8-TH**	**Comparative Anatomy of Vertebrates** **Unit 1: Integumentary System** Structure, function and derivatives of integument in amphibian, birds and mammals. **Unit 2: Digestive System** Comparative anatomy of stomach; dentition in mammals. **Unit 3: Respiratory System** Respiratory organs in fish, birds and mammals. **Unit 4: Circulatory System** General plan of circulation, Comparative account of heart and aortic arches. **Unit 5: Urinogenital System** Succession of kidney in different vertebrate groups; evolution of urino-genital ducts. **Unit 6: Nervous system and sense organs** Comparative account of brain in vertebrates; cranial nerves; olfactory and auditory receptors inVertebrates. **Unit 7: Skeletal system** Overview of axial and appendicular skeleton – limbs, girdles of pigeon; jaw suspension inmammals.	The students will have a preliminary idea about *CO 01.* Development of clear concept anatomy of different vertebrate forms. *CO 02.* 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.. *CO 03.* Evolution of brain, types of olfactory and auditory receptors, basic features of axial and appendicular skeleton.
ZOOA- **CC4-8-P**	**Practical** **Comparative Anatomy of Vertebrates Lab** 1. Study of placoid, cycloid and ctenoid scales through permanent	*CO 04.* Correlating the theoretical knowledge with practical curricula

	slides/photographs. 2. Study of disarticulated skeleton of toad, Pigeon, Guineapig (limb bones, vertebrae, limb and girdle). 3. Comparative study of heart and brain, with the help of model/picture. 4. Identification of skulls: Pigeon, one herbivore (Guineapig) and one carnivore (Dog) animal.	to develop a holisticidea on Vertebrate Zoology by considering their skeletal systems.
CCH09 **ZOOA-** **CC4-9-TH**	**Animal Physiology: Life Sustaining Systems** **Unit 1: Physiology of Digestion** Structural organisation and function of gastro-intestinal tract; Mechanical and chemical digestionof food, absorption of Carbohydrates, Lipids and Proteins in Human. **Unit 2: Physiology of Respiration** Mechanism of Respiration, Respiratory volumes and capacities, transport of Oxygen and Carbondioxide in blood, Dissociation curves and the factors influencing it, respiratory pigments; Carbon monoxide poisoning. **Unit 3: Physiology of Circulation** Structure and functions of haemoglobin; Blood clotting system; Haematopoiesis; Basic steps andits regulation; Blood groups; ABO and Rh factor. **Unit 4: Physiology of Heart** Coronary Circulation, Structure and working of conducting myocardial fibres, Origin andconduction of cardiac impulses; Cardiac Cycle and cardiac output. **Unit 5: Thermoregulation & Osmoregulation** Thermal regulation in camel and polar bear, Osmoregulation in aquatic vertebrates. **Unit 6: Renal Physiology** Structure of Kidney and its functional unit, Mechanism of urine formation, Regulation of acid-basebalance.	Students will be able to gain concept on *CO 01.* 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. *CO 02.* Understanding brief physiological processes like chemical digestion and absorption of food, mechanism of respiration, respiratory pigments, CO poisoning, haematopoesis, blood clotting, blood grouping, Rh factor, working principle of myocardial fibres, conduction of cardiac impulse, cycle and output. *CO 03.* Understanding extreme thermal adaptation, thermoregulatory mechanism in camel and polar bear, osmoregulatory properties, counter current mechanism of urin formation and different types of acid-base buffer.
ZOOA- **CC4-9-P**	**Practical** **Animal Physiology: Life Sustaining Systems Lab** 1. Determination of ABO Blood group.	

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

	Various types of vaccines. Active & passive immunization (Artificial and natural). **Practical** **Immunology Lab** 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.	*CO 07.* Learning of different lymphoid organs by histological studies. *CO 08.* Understanding of ELISA.
SEC B **ZOOA-SEC(B)-4-2-TH**	**Medical Diagnostic Technique** **Unit 1: Diagnostics Methods Used for Analysis of Blood** Blood composition, Differential Leucocyte Count (DLC) using Leishman's stain, Platelet countusing haemocytometer, Erythrocyte Sedimentary Rate (ESR), Packed Cell Volume (PCV). **Unit 2: Diagnostic Methods Used for Urine Analysis** Urine Analysis: Physical characteristics; Abnormal constituents, Urine culture. **Unit 3: Non-infectious Diseases** Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and TypeII), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit. **Unit 4: Infectious Diseases** Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis, Malarialparasite (Microscope based and ELISA based). **Unit 5: Clinical Biochemistry** Lipid profiling, Liver function test. PSA test **Unit 6: Clinical Microbiology** Antibiotic Sensitivity Test **Unit 7: Tumours** Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture,PET, MRI and CT Scan (using photographs). **Unit 8: Visit to Pathological Laboratory and Submission of Project**	The students will develop knowledge about *CO 01.* Learning and understanding of different methods for analysis of blood, urine sample from human. *CO 02.* Learning of different types of infectious and non-infectious diseases, causes, detection by their symptoms, means of diagnosis and prevention. *CO 03.* Understanding the utilization of clinical biochemistry and clinical microbiology.

Core Courses	Content of CU Syllabus	Course Outcome
Semester 5		
CCH11 **ZOOA-** **CC5-11-TH**	**Ecology** **Unit 1: Introduction to Ecology** Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physicalfactors, The Biosphere. **Unit 2: Population** Unitary and Modular populations Unique and group attributes of population: Demographic factors,life tables, fecundity tables, survivorship curves, dispersal and dispersion. Geometric, exponentialand logistic growth, equation and patterns, r and K strategies Population regulation – densitydependentand independent factors, Population Interactions, Gause's Principle with laboratory andfield examples, Lotka-Volterra equation for competition. **Unit 3: Community** Community characteristics: species diversity, abundance, dominance, richness, Verticalstratification, Ecotone and edge effect; Ecological succession with one example. **Unit 4: Ecosystem** Types of ecosystem with an example in detail, Food chain: Detritus and grazing food chains,Linear and Y-shaped food chains, Food web, Energy flow, Ecological pyramids and Ecologicalefficiencies; Nitrogen cycle. **Unit 5: Applied Ecology** Types & level of biodiversity Mega-diversity countries, Biodiversity Hot spot, Flagship species,Keystone species, Wildlife Conservation (in situ and ex situ conservation), concept of protected areas. Red data book, Indian wild life act & Schedule. Concept of corridor, advantages andproblem of corridor. Threats to survival and conservation strategies for Tiger, Olive-ridley, White Rumped Vulture.	Students will learn the concept about *CO 01.* Describe the different levels of organization used in ecology. *CO 02.* Unique and group attributes of population, r and k strategies, population regulation, Gause's principle, Lotka-voltera equation for competition. *CO 03.* Community characteristics and indices, concepts on vertical stratification, ecotone & edge effect, ecological succession. *CO 04.* Types of ecosystem, different types of food chain, food web, concept of energy flow, ecological pyramid and nitrogen cycle *CO 05.* Explain the large scale patterns of biodiversity, describe how biodiversity is measured and predict the consequences of continued species loss.
ZOOA- **CC5-11-P**	**Practical** **Ecology Lab** 1. Determination of population density in a natural/hypothetical community by quadrate method andcalculation of Shannon-Weiner diversity index for the same community.	Students will develop the skill to get idea about *CO 06.* Population density and diversity measurement with use of different indices, study of aquatic ecosystem

	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 OxygenDemand and free CO_2. 3. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary/ any place of ecologicalinterest/ ecological uniqueness/ Zoological garden.	with special reference to planktons and estimation of different physical factors (Temperature, pH, DO2, COD, CO2). *CO 07.* Detailed concept on ecological uniqueness of place of ecological interest.
CCH12 **ZOOA-** **CC5-12-TH**	**Principle of Genetics** **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. **Unit 2: Linkage, Crossing Over and Linkage Mapping** Linkage and Crossing, Complete & Incomplete Linkage, Measuring Recombination frequency andlinkage map construction using three factor crosses, Interference and coincidence. Sex linkage in Drosophila (White eye locus) & Human (Haemophilia). **Unit 3: Mutations** Types of gene mutations (Classification), Types of chromosomal aberrations (Classification with onesuitable example from Drosophila and Human of each), variation in chromosome number; Nondisjunctionof X chromosome in Drosophila; Non-disjunction of Human Chromosome 21. Molecular basis of mutations in relation to UV light and chemical mutagens. Mutation detection inDrosophila by attached X method. Biochemical mutation detection in Neurospora. **Unit 4: Sex Determination** Mechanisms of sex determination in Drosophila and in man; Dosage compensation in Drosophila &Human. **Unit 5: Extra-chromosomal Inheritance** Kappa particle in Paramoecium, Shell spiralling in snail.	The students will learn about the *CO 01.* Principles of Mendelian inheritance pattern and exception, different allele concepts, cis-trans test. *CO 02.* Linkage and crossing over concepts, estimation of recombination frequency, linkage map construction using three factor cross, sex linkage in Drosophila and human. *CO 03.* Types of gene mutations and chromosomal aberrations, molecular basis of mutation, different mutation detection techniques. *CO 04.* Mechanism of sex determination and dosage compensation, examples of extra chromosomal inheritance, complementation test in bacteriophage, different types of transposable genetic elements and

ZOOA- **CC5-12-TH**	**Unit 6: Genetic Fine Structure** Complementation test in Bacteriophage (Benzer's experiment on rII locus). **Unit 7: Transposable Genetic Elements** IS element in bacteria, Ac-Ds elements in maize and P elements in Drosophila, LINE, SINE, Aluelements in humans. **Principles of Genetics Lab** 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.	their functions. *CO 05.* Concept on genetic ration test, chromosomal aberration detection techniques and pedigree analyses.
DSEA **ZOOA-DSE(A)-5-1-TH**	**Parasitology** **Unit 1: Introduction to Parasitology** Brief introduction of parasitism, parasite, parasitoid and vectors (mechanical and biological vector); host parasite relationship. **Unit 2: Parasitic Protists** Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment *of Giardia intestinalis, Trypanosoma gambiense, Leishmania-donovani*. **Unit 3: Parasitic Platyhelminthes** Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis,Prophylaxis and Treatment of *Schistosoma haematobium*, *Taenia-solium.* **Unit 4: Parasitic Nematodes** Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis,Prophylaxis and Treatment of *Ascaris-lumbricoides, Ancylostoma duodenale, Wuchereria bancrofti*,Nematode plant interaction. **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. **Unit 6: Parasite Vertebrates** Cookicutter Shark, Hood Mocking bird, Vampire bats their parasitic behaviour and effect on host.	Students will be able to acquire knowledge about *CO 01.* Parasitoid, Vectors and Host-parasite relationship. *CO 02.* Understanding biology, life cycles, epidemiology, clinical features, laboratory diagnosis, treatment and prevention of common human parasitic infections (Parasitic protest & platyhelminthes). *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.

ZOOA-DSE(A)-5-1-P	Parasitology Lab 1. Study of life stages of *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani*, *Plasmodium vivax*, *Plasmodium falciparum* through permanent slides/micro photographs. 2. Study of adult and life stages of *Schistosoma haematobium*, *Taenia solium* through permanentslides/micro photographs. 3. Study of adult and life stages of *Ancylostoma duodenale* through permanent slides/micro photographs.	*CO 04.* Demonstrate familiarity with some protozoan, platyhelminth, helminth parasites of human, fish, birds and other livestock using permanent slides / photomicrographs / charts.
DSEB **ZOOA-DSE(B)-5-1-TH**	**Endocrinology** **Unit 1: Introduction to Endocrinology** General idea of Endocrine systems, Classification, Characteristic and Transport of Hormones, Neuro-secretions and Neuro-hormones: Examples and Functions. **Unit 2: Hypothalamo-Hypophyseal Axis** Structure and functions of hypothalamus and Hypothalamic nuclei, Regulation ofneuroendocrine glands, Feedback mechanisms, Hypothalamo-Hypophyseal-Gonadal Axis.Structure of pituitary gland, Hormones and their functions, Hypothalamo-hypophyseal portalsystem. **Unit 3: Peripheral Endocrine Glands** Structure, Hormones and Functions of Thyroid gland, Parathyroid, Adrenal, Pancreas, Ovaryand Testis. Disorders of endocrine glands (Diabetes mellitus type I& Type II; Graves'Disease). **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. **Unit 5. Non Mammalian Vertebrate Hormone** Functions of Prolactin in Fishes, Amphibia & Birds. Function of Melanotropin in Teleost fishes, Amphibians and Reptiles.	Students will be able to acquire knowledge about *CO 01.* General idea of classification, characteristics, different modes of transport of endocrine hormones and their function. *CO 02.* Structure and function of Hypathalamus, pituitary, their hormones, function, neuro-endocrine regulation through different hypothalamo-hypophysial axis. *CO 03.* Structure, Hormones and Functions of several peripheral endocrine glands and associated disorders. *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.

ZOOA-DSE(B)-5-1-P	Endocrinology Lab 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.	*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.

Core Courses	Content of CU Syllabus	Course Outcome
Semester 6		
CCH13 **ZOOA-CC6-13-TH**	**Developmental Biology** 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 ofBlastula [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). Unit 2: Late Embryonic Development Extra-embryonic membranes in Chick; Implantation of embryo in humans, Placenta (Structure,types and functions of placenta). Unit 3: Post Embryonic Development Development of brain and Eye in Chick. Molecular Induction in Brain and Eye development. 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.	Students will be able to gain concept about *CO 01.* Understanding basic concepts of gametogenesis, fertilization and early embryonic development in different animal groups and appreciating the differences in animal development. *CO 02.* Explaining process of implantation and placentation, application aspects of *in vitro* fertilization, stem cell therapy, transplantation and regeneration.
ZOOA-CC6-13-P	**Practical** **Developmental Biology Lab** 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.	*CO 03.* Explore and gain understanding of embryology through the investigation of development in

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

ZOOA-CC6-14-P	**Unit 6** Origin and Evolution of Man, Unique Hominid characteristics contrasted with primateCharacteristic. **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. **Unit 8** Extinction, back ground and mass extinctions, detailed example of K-T extinction. **Unit 9** Phylogenetic trees, construction and interpretation of Phylogenetic tree using parsimony,convergent and divergent evolution. **Practical** **Evolutionary Biology Lab** 1. Study of fossils from models/ pictures: *Dickinsonia*, *Paradoxides* (Trilobita), *Asteroceras* (Ammonoid),*Pentremites* (Blastoid Echinoderm), *Ichthyosaur*, *Archaeopteryx*, *Cynodont*. 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.	*CO 02.* Brief concept on population genetics including Hardy Weinberg equilibrium and factors affecting equilibrium, methods of estimating allele and genotypic frequencies. *CO 03.* Detailed concepts on extinction, examples, phylogenetic tree construction and interpretation using parsimony and types of evolution. *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.
DSEA **ZOOA-DSE(A)-6-2-TH**	**Animal Biotechnology** **Unit 1: Introduction** Organization of *E. coli* and *Drosophila* genome. **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	The students will be develop a clear concept of *CO 01.* Brief idea about organization of E. coli and Drosophila genome. Recombinant DNA technology, restriction endonuclease, different cloning vectors with features. *CO 02.* Different transformation techniques including Gel electrophoresis, southern, northern and western

	technique of clone. Agarose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting,Polymerase chain reaction: Allele specific, RAPD & RT PCR, DNA Fingerprinting. **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. **Unit 4: Culture Techniques and Applications** Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis ofgenetic diseases (Cystic fibrosis, Sickle cell anaemia, Thalassemia). Dolly &Polly cloning, Genetically modified economically important animal, Gene Therapy.	blotting, RAPD, RT-PCR, DNA fingerprinting. *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.
ZOOA-DSE(A)-6-2-P	**Practical** **Animal Biotechnology Lab** 1. Genomic DNA isolation from *E. coli* and Plasmid DNA isolation (pUC 18/19) from *E. coli*. 2. To study following techniques through photographs - Southern Blotting, Northern Blotting, WesternBlotting, PCR, DNA fingerprinting. 3. Project report on animal cloning & Application & ethical Issues.	*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.
DSEB ZOOA-DSE(B)-6-1-TH	**Animal Behaviour and Chronobiology** **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. **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 andSelfishness. Sexual Behaviour: Sexual dimorphism, Mate choice in peacock, Intra-sexual selection (malerivalry in red deer). Kinship theory: Relatedness & inclusive fitness; parental care in fishes (Nest Building & costbenefit), conflict within families: parent offspring conflict and sibling rivalry.	The students will be develop a clear concept of *CO 01.* Concepts on orientation, reflex, different types of instinct and learned behaviour. *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.

ZOOA-DSE(B)-6-1-P	**Unit 3: Chronobiology & Biological Rhythm** Types and characteristics of biological rhythms: Short- and Long-term rhythms; Circadianrhythms; Tidal rhythms and Lunar rhythms, Circannual rhythms; Photic and non-photiczeitgebers; Role of melatonin. Biological clock and its adaptive significance. Circannual rhythmin bird migration. **Practical** **Animal Behaviour and Chronobiology Lab** 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(demonstrationonly). 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 ofanimals and prepare a short report. 6. Study of circadian functions in humans (daily eating, sleep and temperature patterns).	*CO 03.* Types and characteristics of biological rhythms, role of hormones, biological clock and adaptive significance (Circannual rhythm in bird migration). *CO 04.* Concepts on nesting behaviour, varied behavioural response to different environmental cues. *CO 05.* Visit to conserved place of zoological interest to study behavioural activities of animals, study of circadian functions in human following definite patterns.