

Annexure-I

Batch : 2015-onwards

**HIMACHAL PRADESH UNIVERSITY
SHIMLA-171005**

**CHOICE BASED CREDIT SYSTEM
(CBCS)-B.Sc. Zoology (Major)**

Syllabus and Examination for B.Sc. Zoology (Major)

Under CBCS

Semester System

June 2016 (IIIrd semester- onwards)

HIMACHAL PRADESH UNIVERSITY, SHIMLA-171005

CHOISE BASED CREDIT SYSTEM (CBCS) IN ZOOLOGY

CBCS Programme for B.Sc. with ZOOLOGY (Major)

2016

Semester I

BSCZOO0101	INVERTEBRATES-I	Marks 50	Credits 3	40 hrs
	Protozoa:			10hrs
	General characters, unique features and outline . Type study: <i>Plasmodium</i> and <i>Paramecium</i> . Economic importance of protozoans.			
	Porifera:			8hrs
	General characters, unique features, affinities with protozoans and coelenterates and outline classification up to order. Type study: <i>Sycon</i> (emphasis on canal system, skeleton) and their economic importance.			
	Coelentrata:			10hrs
	General characters, unique features, advancements and outline. Type study: <i>Obelia</i> (emphasis: Polymorphism and alternation of generation), polymorphism in Siphonophora, corals and coral reefs and their economic importance.			
	Ctenophora:			2hrs
	General characters, unique features and outline. Relationship with Cnidaria.			
	Platyhelminthes:			10hrs
	General characters, unique features and outline. Morphology, Life cycle and transmission of infection in <i>Fasciola hepatica</i> and <i>Taenia solium</i> . Parasitism and parasitic adaptations. Economic importance and evolution of parasitism.			

BSCZOO0101(P) INVERTEBRATES I PRACTICALS Marks 50 Credits 1

Classification of following animals: Protozoa, Porifera, Coelenterata, Ctenophora, Platyhelminthes,

Classification up to order with ecological notes and economic importance of the following animals:

- Protozoa: Examination of the following permanent prepared slides:
 - *Amoeba*, *Paramecium* conjugation, *Entamoeba*, forminifera ooze, radiolarian ooze, trypanosome, *Opalina*, *Balantidium*, *Nyctotherus*, *Plasmodium*, *Vorticella*, *Giardia*.
 - Porifera: *Sycon* (T.S. and L.S.), gemmules, spicules, sponging fibres. Specimens: *Leocosolinia*, *Sycon*, *Spongilla*, *Euplectlea*, *Grantia*. Temporary mounting of spicules and gemmules of *Sycon*.
 - Coelentrata: Study of slides of *Obelia* colony, ephyra larva. Specimens of *Physalia*, *Porpita*, *Favia*, *Tubipora*, *Madripora*, jelly fish. Staining and mounting of *Sertularia* and *Obelia*.

- Ctenophora: specimen -jelly fish.
 - Platyhelminthes: Study of slides of *Fasciola* T.S., miracidium, sporocyst, redia and cercaria larva, mature and gravid proglottids of *Taenia*.
- Specimens: *Fasciola*, *Taenia*, scolex of *Taenia*.

Suggested readings:

1. Barnes, R.D. Invertebrate Zoology. (1982) VI Edition. Holt Saunders International Edition.
Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. & J.I., Spicer (2002) The Invertebrates: A New Synthesis. III Edition. Blackwell Science.
2. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
3. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
4. ushbaum, R. (1964) Animals without Backbones. University of Chicago Press.

BSCZOO0102 INVERTEBRATES-II Marks 50 Credits 3 40 Hrs

Nematoda:

6 hrs

General characters, unique features, advancements and outline.

Morphology, Reproduction and life cycle of *Ascaris*. Parasitism. Elementary idea of Plant nematodes their economic importance and control.

Annelida:

6 hrs

General characters, unique features, advancements and outline.

Type study: Earthworm-Morphology, digestive, excretory, circulatory, reproductive, nervous system. Metamerism, vormiculture, filter feeding in polychetes, economic importance of annelids.

Arthropoda:

8 hrs

General characters, unique features, advancements and outlin.

Morphology, respiratory and excretory system in cockroach. Vision in insects (cockroach). Mouth parts of insects, metamorphosis in insects, economic importance of insects.

Mollusca:

8 hrs

General characters, unique features and outline.

Type study: *Pila*. Foot in decapoda and octopoda. Economic importance

Echinodermata:

8 hrs

General characters, unique features, degenerate features and outline.

Type study: star fish (emphasis on water vascular system and three larval forms- diplura, bipinaria and brachiolaria), economic importance and phylogenetic position of echinoderms.

BSCZOO0102 (P) INVERTEBRATES II PRACTICALS Marks 50 Credits 1

Classification of Following animals, Nemathelminthes, Annelida, Arthropoda, Mollusca, Echinodermata

Classification up to order with ecological notes and economic importance of the following animals.

- Nemathelminthes: slides-*Ascaris* T.S. of male and female, *Ancylostoma*.
Specimens: *Ascaris*, *Ancylostoma*.
- Annelida: slides of earthworm-T.S. through pharynx, gizzard and typhlosole. to study digestive and nervous system. Specimens: earthworm, *Nereis*, *Aphrodite*, *Chaetopterus*, *Tubifex*, *Hirudineria*. Mounting of ovary and septal nephredia of earthworm.
- Arthropoda: Slides/specimens of *Limulus*, spider, cockroach, mosquito, crustacean larva, scoleopendra, *Palamnaeus*, mantis, termite, forficula, dragon fly, moth, *Apis*, wasp, *Peripatus*.
- Mollusc: specimens-*Chiton*, *Dentalium*, *Cypraea*, *Aplysia*, *Limax*, *Unio*, *Pectin*, *Sepia*, *Octopus*, *Nautilus*. Slides-Glochidium larva, L.S. of ospharadium. Radula.
- Echnioderms: Slides-T.S. of arm of star fish, bipinaria larva. Specimen-*Asterias*, *Echinus*, *Cuccumaria*.

Suggested readings: (As given for course BSCZOO0101 and BSCZOO0101(P))

SEMESTER II

BSCZOO0203	Biology of Chordates-I	Marks 50	Credits 3	40 Hrs
Chordates:				4hrs
Origin of chordates, characteristics and classification.				
Protochordates:				10hrs
Hemichordates, Urochordates and Cephalochordates: General characters only, classification, affinities and economic importance. Ciliary mode of feeding in <i>Balanoglossus</i> . Retrogressive metamorphosis and economic importance.				
Vertebrata Pices- Cyclostomata.				8hrs
<i>Petromyzon</i> : General characters, classification upto order and economic importance. Phylogenetic position of <i>Petromyzon</i> and Ammocoete larva.				
Chondrichthyes:				8hrs
<i>Scolidon</i> : General characters, affinities and economic importance. Scales and fins. Nervous system of scolidon.				
Osteichthyes (bony fishes)				8hrs
General characters, advancements, accessory respiratory organs, osmoregulation in fishes, fish migration, common food fishes and economic importance.				
BSCZOO0203(P) BIOLOGY OF CHORDATES I PRACTICALS			Marks 50	Credits 1

Classification of Chondrichthyes

Classification up to order with ecological notes and economic importance of the following animals.

- Lower Chordates: Specimens- *Branchiostoma*, *Balanoglossus*, *Herdmania*. Slides: sections of *Branchiostoma* through pharynx, intestine, caudal region.
Amphioxus whole mount sections through pharyngeal, intestinal and caudal region.
- Pices: specimen- *Petromyzon*, *Pristis*, *Zygaena*, *Trygon*, *Torpedo*, *Myleobates*, *Echenis*, *Ophiocephalus*, *Calarias*, *Labeo*, *Hippocampus*, *Mystis*, *Catla*, *Chimera*, *Synganthus*, cat fish, puffer fish, flat fish, flying fish.
 - Temporary mount-placoid scales, ctenoid scales, cycloid scales.
 - Setting of live fresh water aquarium in lab.
 - Visit to fish culture farm or aquarium/zoo.

Suggested readings:

1. Kardong, K.V. (2005) Vertebrates Comparative Anatomy, Function and evolution. IV Edition. McGraw-Hill Higher Education.
2. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
3. Young, J.Z. (2004). The life of vertebrates. III Edition. Oxford university press.
4. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers, Inc.

BSCZOO0204 Biology of Chordates-II Marks 50 Credits 3 40Hrs

Amphibia:

10hrs

General characters, advancement over fishes and. Circulatory and respiratory system of frog. Adaptations to land life. Hibernation, aestivation and parental care. Origin and evolution of terrestrial ectotherms. Economic importance.

Reptilia:

10hrs

General characters. Reason for success on land. Exoskeleton in reptiles, Mesozoic reptiles, poisonous and non poisonous snakes of India. Poison apparatus and biting mechanism in snakes.

Aves:

10hrs

General characters, and advancements over reptiles and amphibians. Exoskeleton, circulatory and respiratory system of Pigeon. Birds as glorified reptiles, flight muscles and flight mechanism. Flight adaptations. Perching mechanism. Flightless birds. Bird migration.

Mammals:

10hrs

General characters and. Origin and evolution of mammals. Superiority and success of mammals. Sense organs (eye and ear) of mammal (rabbit). Differences between prototheria, metatheria and eutheria. Economic importance.

BSCZOO0204(P) BIOLOGY OF CHORDATES II PRACTICALS Marks 50 Credits 1

Classification of following animals: Reptila, Aves, Mammals

Classification up to order with ecological notes and economic importance of the following animals:

- Amphibians: specimens- salamander, *Triton*, *Necturus*, toad, *Bufo*, *Hyla*, *Rachophorus*, *Uraeotyphus*, frog, *Amphiuma*, axotol larva. Study of disarticulated skeleton of frog. Study of arterial, venous and urinogenital system of frog (chart/model).
- Reptelia: specimens-*Cheleone*, *Testudo*, crocodile, *Draco*, *Chameleon*, *Salotes*, *Uromastix*, *Varanus*, cobra, krait, sea snake, viper, python, rattle snake.
- Aves: study of birds of H.P. Study of state bird-jujurana (model/chart/photomicrograph). Specimens-kite, vulture, duck, koel, owl, wood pecker, ostrich, house sparrow, parrot, pigeon, crow.
- Mammals: specimens-*Platypus*, bat, hedgehog, shrew, dolphin, ant eater, squirrel, *Macaque*..
- Zoological excursion and its report or
 - Project report on any topic from theory paper (eg. Study of birds/animals of local area)

Suggested Readings: (As given in BSCZOO0203 and BSCZOO0203 (P))

SEMESTER III

BSCZOO0305 DEVELOPMENTAL BIOLOGY Marks 50 Credits 3 40hrs

Introduction:

2hrs

History, significance of embryology. Elementary idea of methods in study of embryonic development.

Gametogenesis

5hrs

Histology and physiology of male and female reproductive system (man). Gametogenesis-Spermatogenesis and oogenesis, types of eggs, egg membranes, polarity and symmetry of eggs. Discharge and transportation of gametes.

Fertilization

3hrs

Changes in gametes. Time and types of fertilization, mechanism and significance of fertilization.

Parthenogenesis:

2hrs

Natural and artificial parthenogenesis. Significance of parthenogenesis.

Cleavage

4hrs

Characteristics of cleavage-planes, patterns and rate of cleavage. Influence of yolk on cleavage. Changes during cleavage. Morulation, Blastulation. Significance of cleavage. Fate maps.

Gastrulation

3hrs

Characteristic features, major events during gastrulation and gastral movements. Significance of gastrulation.

Growth and Differentiation

10hrs

Measurement of growth, growth controlling, promoting and arresting factors. Differentiation of germ layers-formation of neural tube (development of CNS and eyes), skin, notochord, somites, coelom, and digestive tube (upto rudiments only). Extra embryonic membranes in birds and humans only. Implantation of embryo. Placentation-structure, type and physiology of placenta.

Post Embryonic Development**3hrs**

Metamorphosis-changes and hormonal regulation of metamorphosis in insects. Regeneration, modes of regeneration.

Embryology and Human Welfare**3hrs**

Birth control, infertility-IVF, teratogenic agents and their effects on embryonic development, ageing.

Development of chick embryology (upto gastrulation).**5hrs****BSCZOO0305(P) DEVELOPMENTAL BIOLOGY PRACTICALS Marks 50 Credits 1**

- Chick-study of developmental stages-primitive streak 8hrs, 21hrs, 24hrs, 36hrs, 48hrs, 72hrs, 96hrs.
- Frog-study of whole embryos of the stages-blastula, neurula.
- Examination of slide of testis/ovary of a mammal.
- Sections of placenta.
- Visit to hatchery and submission of field report.

Suggested reading

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland,

BSCZOO0306 ANIMAL PHYSIOLOGY Marks 50 Credits 3 40 Hrs**Nutrition, Digestion and Absorption.****6hrs**

Components of food. Nutritional requirement and balanced diet. Function mechanism and regulation of digestive glands. Mechanism of absorption, role of gastrointestinal hormones.

Circulatory system**6hrs**

Blood composition, function and haemopoiesis. Structure of haemoglobin. Blood clotting mechanism. Heart structure. Origin and conduction of heart beat. Cardiac cycle, cardiac output and Frank-Starling law of heart. ECG-elementary idea.

Respiratory System.**6hrs**

Transport of respiratory gases. Mechanism and control of breathing. Regulation of acid base balance. Oxygen dissociation curves. Bohr effect and chloride shift.

Excretory System.**5hrs**

Mechanism and regulation of urine formation. Regulation of acid base balance. Dialysis.

Muscles**5hrs**

Structure and types of muscles. Molecular and structural basis of muscle contraction.

Nervous system**6hr**

Origin and propagation of nerve impulse. Types of reflexes, reflex arc and reflex action. Synaptic junctions and neurotransmitters.

Endocrine system.**6hrs**

Histology and functions of endocrine glands-pituitary, thyroid, adrenals, testis, ovary. Nature, regulation and mode of action of hormones. Feedback relationship with other endocrines.

BSCZOO0306(P) ANIMAL PHYSIOLOGY PRACTICALS Marks 50 Credits 1

- Estimation of haemoglobin using Sahli's haemoglobinometer.
- Enumeration of DLC and RBC and WBC using haemocytometer.
- Preparation of haemin crystals.
- Blood clotting time.
- Recording of blood pressure using sphygmomanometer.

Preparation of stained slides of striated and non-striated muscles.

- Study of T.S. sections of the following slides (mammal)
- T.S of mammalian skin, cartilage, bone, pancreas, testis, ovary, pituitary, adrenals, thyroid, liver, artery, vein, stomach, intestine, spleen, kidney, lung, spinal cord.
- Project- Undertake computer aided diet analysis and nutrition counseling for different age groups or
 - Identify nutrient rich sources of foods, their seasonal availability and price; study of nutrition labelling on selected foods.

Suggested reading:

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons, Inc.
3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional Correlations. XII Edition. Lippincott W. & Wilkins.
4. Arey, L.B. (1974). Human Histology. IV Edition. W.B. Saunder

SEMESTER IV

BSCZOO0407 CYTOGENETICS Marks 50 Credits 3 40Hrs

Genetic material and Gene

12hrs

Molecular basis of genetic information, genetic materials-DNA, RNA their structure, types and functions, mechanism of replication, transcription and translation. Gene (modern concept), gene and enzymes, Genetic code and its characteristics, Gene expression (central dogma), Protein synthesis, Gene regulation (prokaryote and eukaryote). Mendels laws of inheritance. Gene interactions-modification of Mendelian ratios.

Cell cycle

3hrs

Stages of Mitosis and meiosis. Regulation of cell cycle.

Linkage Crossing Over and Recombination

6hrs

Crossing over, cytological and molecular basis of crossing over. Types of crossing over, factors influencing crossing over, importance of crossing over and recombination. Linkage-chromosome maps.

Mutations

8hrs

Mutations, characteristics of mutations, types of mutations, mutagens-types, mechanism of gene mutation, chromosomal aberrations, Numerical aberrations (Autoploidy, euploidy and polyploidy), importance of mutations.

Sex Determination

5hrs

Chromosomal mechanisms, Environmental factors affecting sex determination, Barr bodies, Dosage compensation.

Sex Linked Inheritance

6hrs

Haemophilia and colour blindness in man, eye colour in *Drosophila*. Sex linked and sex influenced inheritance.

BSCZOO0407(P) CYTOGENETICS PRACTICALS Marks 50 Credits 1

- Study of various stages of mitosis and meiosis from permanent stained slides.

Preparation of temporary mount of stained onion root tip by squash method to study stages of mitosis.

- Stained preparation of chromosomes of onion flower buds to study stage of meiosis.
- Study of permanent stained slides of giant chromosomes and Barr body.

Suggested reading:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. 2006 Principles of Genetics. 8th edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. 2009 Principles of Genetics. 5th edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. 2009 Concepts of Genetics. 9th Edition. Benjamin Cummings.
4. Russell, P. J. 2009 Genetics- A Molecular Approach. 3rd edition. Benjamin Cummings.
5. Glick, B.R., Pasternak, J.J. 2003 Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

BSCZOO0409 CELL BIOLOGY Marks 50 Credits 3 40 Hrs

Overview of cells. 2hrs

Prokaryotic and eukaryotic cells-ultrastructure. Virioids and mycoplasmas. Cell theory and cell principles, properties and protoplasm.

Tools and Techniques 4hrs

(Basic concepts-Principle and Applications only): Light microscope, phase contrast and electron (SEM, TEM) microscope, Centrifugation, density gradient centrifugation, chromatography, microtomy.

Cell Adhesions and cell junctions, cell-cell interaction. 2hrs

Selectins, Immunoglobulins, Cadherins, Adherens. Junctions and desmosomes. Tight junctions, Gap junctions and Plasmodesmata.

Cellular structure and functions of 16hrs

Biomembranes: Structure and function. Transport across membranes. Bacterial and animal cell wall. Cell-cell interactions.

Cellular organelles (ultrastructure, composition and function): Endoplasmic reticulum, golgi complex, ribosomes, lysosomes, mitochondria, plastids, microtubules and filaments, microbodies and vacuoles, nucleus.

Cell Differentiation 4hrs

Immunology 2hrs

Cells of immune system.

Cell Death: 4hrs

Apoptosis, mechanism of cell death. Necrosis. Stem cells-sources, properties and therapeutic uses.

Cancer 4hrs

Development and properties of cancer cells, causes and types of cancers, P53 and oncogenes, tumor suppressor genes, cancer treatment.

BSCZOO0409(P) CELL BIOLOGY PRACTICALS Marks 50 Credits 1

- Theoretical knowledge and working of light microscope.
- Basic concept of stains and staining techniques.
 - Effect of tonicity of solutions on plasma membrane-hypotonic, hypertonic and isotonic solution.
- Study of stages of mitosis and meiosis from permanent slides.
- Identification and study of cancer cells -from slides or photomicrographs.

Study of immune cells and lymphoid organs of human body through chart/photomicrograph/permanent slide.

Suggested reading:

1. De Robertis, E.D.P. and De Robertis, E.M.F. 2006 Cell and Molecular Biology. 8th edition. LippincottWilliams and Wilkins, Philadelphia.
2. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press &Sunderland, Washington, D.C.; Sinauer Associates, MA.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

BSCZOO0615	PARASITOLOGY	Marks 50	Credits	40 Hrs
Introduction to parasitology.Parasitism-definition and types.Types of animal associations-(commensalism, predation, mutualism, phoresis, symbiosis).Types of hosts. Vectors-(natural and unnatural), host parasite relationship.Effect of parasites on host.Host specificity. 10 hrs				
General characters and salient features of phylum Protozoa, platyhelminthes, nematihelminthes and acanthocephala. 10 hrs				
Morphological features, life cycle, transmission, pathogenicity, epidemiology and control measures of the following: Plasmodium, Trypanosoma, Fasciola, Paragonimus, Schistosoma, Taenia, Echinococcus, Ascaris, oxyuris, wuchereria, Dracunculus, trichenella and trichuris. 10 hrs				
Modes of transmission of parasites and methods of dissemination of infective stages of parasites. 5 hrs				
Immunity to parasitic infections (natural and acquired). 5hrs				

BSCZOO0615 (P)	PARASITOLOGY PRACTICALS	Marks 50	Credits	1
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- Study of some important specimens belonging to protozoa, platyhelminthes, nematohelminthes (including plant nematodes)
- Important arthropod vectors of human diseases and animal diseases-identification features and life history.
- Study of larval/developmental stages of parasites-slides/specimens.
- Study of interrelationship parasitism, symbiosis,commensalism (2-3 examples from each).
- Project report.

Suggested readings:

1. Arora, D.R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributers
2. Parasitology - By K.D. Chaterjee, Medical Pulisher Calcutta,1987.
3. Physiology of parasites - By L.S. Chapell, John, Willey & SionsN.Y. (1980).
4. Parasitology - By Hobler, E.R. and Noble, G.A. (1982) 2nd Ed. Lea & Febieger

U.S.A.

SEMESTER V

BSCZOO0510	BIOCHEMISTRY	Marks 50	Credits 3	40 hrs
Carbohydrates.				9hrs

Structure, properties and functions of mono, di and polysaccharides.
Glycogenesis, glycogenolysis, glyconeogenesis. Glucolysis, hexose monophosphate shunt. TCA cycle. Role of dicarboxylic acid shuttle. ETC. fermentation, oxidative phosphorylation.

Lipids.**8hrs**

Structure, properties and function of fatty acids, triglycerides and steroids.
Biosynthesis and beta oxidation of fatty acids. Ketogenesis (ketone-ketosis bodies). Types and properties of lipoproteins.

Proteins.**8hrs**

Structure and general properties of amino acids. Four levels of structures in proteins. Transamination, deamination and urea cycle. Interrelationship of carbohydrate, lipid and protein metabolism.

Enzymes.**10hrs**

Definition, nature, functions and specificity of enzymes. Enzyme kinetics. Inhibition. Theories of enzyme action. Concepts of-Allosteric enzymes, apoenzyme, holoenzyme and coenzyme. Nature and function of co-enzymes w.r.t. Co-enzyme-A, co-enzyme-Q, NAD and NADP, FMN, FAD, cytochromes. Lysozymes.

High energy compounds.**5hrs**

High energy compounds. Types of high energy compounds. Phosphagens. Structure and formation of ATP. Biological oxidation and energy release mechanism.

BSCZOO0510(P) BIOCHEMISTRY PRACTICALS**Marks 50 Credits 1**

- Qualitative analysis (colour test) for detection of carbohydrates, lipids and protein.
- Study of action of salivary amylase at optimum conditions and effect of pH and temperature on enzymatic activity.
- Isolation of milk proteins.
- Effect of inhibitors on salivary amylase.

Suggested reading:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IV Edition. W.H Freeman and Co.
3. Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. (2009). Harper's Illustrated Biochemistry. XXVIII Edition. Lange Medical Books/McGraw-Hill

BSCZOO0511**BIOTECHNOLOGY****Marks 50****Credits 3****40 Hrs****Tools and Techniques in Biotechnology.****8hrs**

(Principle and applications only)

Electrophoresis (SDS PAGE), Northern and Western Blotting, Polymerase chain reaction (PCR), ELISA, IFA. Cloning vectors (plasmids, cosmids and bacteriophages).

Animal cell and tissue culture.**5hrs**

Cell culture media-types and composition/properties, growth media, preparation and sterilization of media. Primary cell culture, cell lines, pluripotent stem cells. Cryopreservation of culture media.

Applications of Biotechnology**15hrs**

Medicine : molecular diagnosis of genetic diseases (cystic fibrosis, huntingtons disease, sickle cell anaemia). RFLP, RAPD and DNA fingerprinting. Radioimmunoassays. Vaccines-significance and

types, DNA vaccines, transgenic animals as source of biopharmaceuticals. Gene therapy. Hybridoma technology and monoclonal antibodies.

Agriculture : Transgenic plants-Agrobacterium mediated transformation. Micropropagation, somatic embryogenesis. Modifications by somoclonal variations. Transgenic plants (insecticide, herbicides, pest and virus resistant plants).

7hrs

Industry : Metabolite production-antibiotics, organic acids, vitamins, food industry-single cell proteins. Leather industry. Solid Waste management, sewage management. Bioremediation and biore restoration.

Basic Concepts of:

5hrs.

Bioinformatics, intellectual property rights, patent and biosafety issues, genetically modified organisms, stem cell technology and its applications.

BSCZOO0511(P) BIOTECHNOLOGY PRACTICALS Marks 50 Credits 1

- Prepare tris HCl 0.5M and 1.5M buffer solution to be use in gel electrophoresis.
- Components and working of mini vertical gel electrophoresis apparatus.
- Separation of blood proteins by SDS PAGE and staining.
- Blood group testing to show antigen antibody interaction
- Visit to research lab/institute for demonstration of PCR, ELISA, IFA.
- Project report/assignment on any topic from theory paper.

Suggested readings:

1. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.
2. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
3. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA- genes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.
4. Watson, J.D., Gilman, M., Witkowski, J. and Zoller, M., (1983) Recombinant DNA. II Edition. Freeman and Co., N.Y., USA.

BSCZOO617 ENTOMOLOGY 50 Marks Credits 3 40 hrs

Introduction

Scope and importance of insects. Origin and evolution. Classification.

5hrs.

5hrs

Anatomy

Segmentations and divisions of the body: Head-segments and attachments (antennae, eyes). Mouth parts-various modifications and feeding mechanism. Thorax-thoracic segmentation and appendages (wings). Abdomen-morphology and appendages (legs).

Physiology

15hrs

Integumentary system-anatomy, moulting and sclerotization and role of hormones. Digestive System-anatomy and histology of gut. Modifications of gut. Physiology of digestion. Circulatory system-course of circulation, haemolymph and functions

Respiratory System-anatomy of trachea, tracheoles, spiracles and air sacs. Respiratory pigments.

Excretory System-anatomy of malpighian tubules, physiology of excretion. Reproductive System-male and female reproductive system.

Nervous System-brain, ganglia and nerves. Mechanoreceptors, chemoreceptors and photoreceptors.

Endocrine System-neurosecretory cells and endocrine glands (corpora cardiac, corpora allata, prothoracic glands) hormones and their functions. Pheromones and types.

Social Organisation

5hrs

Social organisation w.r.t. termites, ants, honey bees.

Applied Entomology

10hrs

Insect pests of rice, wheat, cotton, sugarcane. Insects as vectors of diseases of humans and animals. Insect pest management. Apiculture and sericulture.

BSCZOO0617(P) ENTOMOLOGY PRACTICALS Marks 50 Credits 1

- Collection and preservation of insects (dry and wet) (non endangered/endemic/rare)
 - Collection and preservation of insect pests (house hold pest, food grain pest, animal pests)
 - Preparation of permanent slides (w.m.) of small insects and insect pests (non endangered/endemic/rare).
 - Study of insect (cockroach/house fly/honey bee) head and its appendages, thorax and its appendages, abdomen and its appendages.
- Identification and economic importance of at least two pests of the following
- Pests of cereals, pests of vegetable crops, pests of pulses, animal pests.
- Field visit for demonstration of pest damage.

Suggested reading:

1. Awasthy V.B. 1998. Introduction to General and Applied Entomology. ELBS, London
2. Carde R.T. and W.J. Bell. 1995. Chemical Ecology of Insects (2nd edn). Chapman and Hall, NY.
3. Chapman R.F. 1982. *The Insects Structure and Functions*. ELBS, London.

SEMESTER VI

BSCZOO0613 ECOLOGY MARKS 50 Credits 3 40

Introduction to Ecology and Ecosystem.

12hrs

Biotic, abiotic factors. Concept of species, population, community. Interactions among organisms. Environmental factors. Components and functioning of ecosystem. Energy flow and nutrient cycles. Ecological pyramids. Laws of limiting factors. Brief account of ecological succession. Ecological niche and ecological adaptations.

Natural resources and Wild life conservation.

8hrs

Objectives of conservation. Conservation of minerals, forests, soil, land water and fisheries. Pollution of natural resources. Climate change and consequences. Wild life as a resource, values of wild life. Important wild animals of H.P. In situ, exsitu conservation. Causes of depletion of wild life.

Biodiversity.

6hrs

Concept and importance of biodiversity. Components and gradient of biodiversity. Biodiversity indicators-surrogate species. Biodiversity indices. Hot spots and threats to biodiversity (natural and human). Biodiversity and rarity, biodiversity and endemism. Ecological mechanisms contributing to biodiversity. National and international efforts to conserve biodiversity. Biozoogeographic zones of India, western ghats and their significance. Factors promoting biodiversity.

Concepts Of:

4hrs

EIA-Environment Impact Assessment, Sustainable development, Green Technologies, Environment ethics, Restoration ecology, Ecological foot prints, carbon foot print, carbon credits, greenhouse effect.

BSCZOO0613(P) ECOLOGY PRACTICALS Marks 50 Credits 1

- Study of all the biotic and abiotic components of any simple ecosystem-pond, crop field, garden or terrestrial or human modified ecosystem.
- Study of rare/endemic /threatened species of birds or animal of Himachal Pradesh (models, pictures charts).
- Visit to national park, sanctuary to study management of wild life.
- Submit a detailed project report based on any topic mentioned in theory paper e.g.
 - EIA report on i) hydro power project in HP ii) making of national highways iii) nuclear power stations iv) any other v) biodiversity of your area.
- Harness information through internet regarding biodiversity.

Suggested readings:

1. Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
2. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
3. Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
4. Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Press

BSCZOO0614 APPLIED ZOOLOGY MARKS 50 Credits 3 40 hrs

Human Diseases

15hrs

Epidemiology, transmission, prevention and control of common human diseases: TB, dengue, cholera, typhoid, small pox and AIDS. Brief account of life history, mode of infection and pathogenicity of following pathogens: *entamoebahistolitica*, *trypanosoma*, *Echinococcus*, *Wuchereria*, *Dracunculus* and *oxyuris*. Non communicable diseases diabetes, arthritis, gout, hypertension, cardiovascular diseases. Vectors : Examples, structures associated with disease transmission and names of diseases transmitted by fleas, ticks and mosquitoes; management of these vectors. Brief introduction to human defense mechanism- antigens, immunoglobulins- structure, types and functions. Allergies. Auto immune diseases.

Community health and welfare.

6hrs

Mental health causes and remedy. Addictions-tobacco, alcohol, drugs, stimulants. Effect of addictions on adolescent health. National immunization programme.

Implantation, pregnancy and infertility. Assisted reproductive techniques (IVF, IVT). Family planning.

Animal Husbandry

9hrs

Livestock-concept, breeds of cattle in India. Exotic breeds, common diseases in animals, preservation and artificial insemination in cattle. Cattlebreeding. Role of biotechnology in animal husbandry. Embryo transfer technique, cryopreservation. Knockout animals.

Applied Entomology

10hrs

Bionomics and control of crop pest of rice, wheat, sugarcane, cotton. Pesticides: types, advantages and hazards of chemical pesticides. Biological methods of pest control, benefits. IPM, Apiculture w.r.t. apiculture in H.P. Lac culture, sericulture-w.r.t. H.P. Pisciculture-edible food fish of India and HP. Poultry farming. Zebra fish as a model for biotechnology.

BSCZOO0614(P) APPLIED ZOOLOGY PRACTICALS Marks 50 credits 1

- Study of permanent slides and specimens of protozoan, helminthic parasites associated with human diseases.
- Economic importance of insect pests of rice, wheat, sugarcane and cotton-identification of their adults and preparation of their life cycles.
- Study of beneficial insects their life cycles and their products
- Visit to veterinary centre/ poultry farm/ apiary/ fish farm and prepare visit report.
- Project report on any topic of the theory paper.

Suggested readings:

1. Park, K. (2007) Preventive and social medicine. XVI Edition. B.B Publisher.
2. Arora, D.R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributers.
3. Chaudhury, S.K. (1996) Practice of fertility Control, A Comprehensive Textbook. B.I.Churchill Livingstone Pvt Ltd, India.
4. Hafez, E. S. E. (1962). Reproduction in Farm Animals. Lea & Fabiger Publisher.

CORE ELECTIVE

BSCZOO0408 EVOLUTION BIOLOGY Marks 50 Credits 3 40 Hrs

Origin of Life: 10hrs

Theories of origin of life. Organic Evolution: Evidences of Organic evolution (taxonomic, morphological and anatomical, embryological, palaeontological, biogeographical and biochemical evidences) fossils and geological time scale.

Theories of Evolution 10hrs

Lamarckism, Neo-Lamarckism, theory of continuity of germplasm, recapitulation theory, Darwinism, Neo-Darwinism, mutation theory, modern synthetic theory. Micro, macro and molecular evolution.

Speciation and Isolation 4hrs

Species concept (biological, evolutionary and ecological). Speciation, types of speciation, mechanism of speciation. Isolation, types of isolations. Effects of isolation.

Variations: 3hrs

Variations, types of variations, Importance of variations.

Adaptations: 3hrs

Adaptations, types of adaptations and importance of adaptations.

Population Genetics 3hrs

Gene pool, Hardy-Weinberg Equilibrium, its significance and applications. Genetic drift.

Human Evolution: 3hrs

Evolutionary history of man. Stages in evolution of man.

Zoogeography: 4hrs

Geographical distribution, zoogeographic realms and principle fauna. Factors determining geographic distribution.

BSCZOO0408(P) EVOLUTIONARY BIOLOGY PRACTICALS Marks 50 Credits 1

- Study of human evolution through chart/photomicrograph.
- Study of various animals in different zoogeographic realms through chart/photomicrograph.
- Study of adaptations in animals from pices, amphibians, reptiles, birds and mammals.
- Visit to a fossil park and submission of visit report.

Suggested reading:

1. Ridley, M. (2004) Evolution. III Edition. Blackwell Publishing
2. Barton, N. H., Briggs, D.E.G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). Evolution. Cold SpringHarbour Laboratory Press.
3. Hall, B.K. and Hallgrimsson, B. (2008) Evolution. IV Edition. Jones and Bartlett Publishers
4. Pevsner, J. (2009) Bioinformatics and functional genomics. II Edition. Wiley-Blackwell

BSCZOO 0512 MOLECULAR BIOLOGY MARKS 50 CREDITS 3 40 Hrs

Brief account of common organisms used in molecular biology 2hrs

Viruses; Bacteria; *Musmusculus* (Mice); *Drosophila melanogaster* (Fruit fly); *Caenorhabditis elegans* (Roundworm); *Daniorerio* (Zebra fish); *Saccharomyces cerevisiae* (Yeast); *Neurospora* and *Arabidopsis thaliana*.

Genome structure and nucleosome. 12hrs

DNA, RNA structure, types and functions. Nucleosome. Structure of eukaryotic chromosome, nucleosome model, Chromosome condensation-euchromatin and heterochromatin. Giant chromosomes, organisation of chromosomes, banding patterns of chromosomes, transcription and translation, genetic code.

Genetic Engineering 15hrs

Introduction and terminology, Recombinant DNA technology, tools of recombinant technology -cloning and expression vectors, shuttle vectors, enzymes, molecular markers and probes-SNP, VNTR, RAPD, FISH., cloning and nuclear transfer technology, CONCEPTS OF: transgenics, bionomics and genomics, proteonomics, gene library, gene splicing. DNA sequencing, DNA fingerprinting, genetically modified organisms. Knock out and knock in animals.

Human Genetics**11hrs**

Human chromosomes- karyogram and karyotyping. Chromosomal abnormalities-syndroms. Human sex determination. Sex chromosome linked genetic disorders. Gene probes. Concepts of eugenics, eutenic and euphenics, human genome project, chromosome walking. Common human hereditary traits.

BSCZOO0512(P) MOLECULAR BIOLOGY PRACTICALS Marks 50 Credits 1

- Study of the following through permanent stained slides:
 - Barr bodies, giant chromosomes, stained preparation of chromosomes by squash method (onion root tip/flower bud)
- Study of common human hereditary traits.
- Study of human karyogram through photo micrograph

Suggested readings:

1. Karp, G. 2010 Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons.Inc.
 2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006 Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
 3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition.Pearson Benjamin Cummings Publishing, San Francisco.
- Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., 2008
Molecular Biology of the Gene (6th edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

BSCZOO0615 PARASITOLOGY Marks 50 Credits 40 Hrs

Introduction to parasitology.Parasitism-definition and types.Types of animal associations-(commensalism, predation, mutualism, phoresis, symbiosis).Types of hosts. Vectors-(natural and unnatural), host parasite relationship.Effect of parasites on host.Host specificity. **10 Hrs**

General characters and salient features of phylum Protozoa, platyhelminthes, nematohelminthes and acanthocephala. **10 hrs**

Morphological features, life cycle, transmission, pathogenicity, epidemiology and control measures of the following:

Plasmodium, Trypanosoma, Fasciola, Paragonimus, Schistosoma, Taenia, Echinococcus, Ascaris, oxyuris, wuchereria, Dracunculus, trichenella and trichuris. **10 hrs**

Modes of transmission of parasites and methods of dissemination of infective stages of parasites. **5 hrs**

Immunity to parasitic infections (natural and acquired). **5hrs**

BSCZOO0615 (P) PARASITOLOGY PRACTICALS Marks 50 Credits 1

- Study of some important specimens belonging to protozoa, platyhelminthes, nematohelminthes (including plant nematodes)
- Important arthropod vectors of human diseases and animal diseases-identification features and life history.
- Study of larval/developmental stages of parasites-slides/specimens.
 - Study of interrelationship parasitism, symbiosis,commensalism (2-3 examples from each).
- Project report.

Suggested readings:

1. Arora, D.R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributers
2. Parasitology - By K.D. Chaterjee, Medical Pulisher Calcutta,1987.
3. Physiology of parasites - By L.S. Chapell, John, Willey & SionsN.Y. (1980).
4. Parasitology - By Hobler, E.R. and Noble, G.A. (1982) 2nd Ed. Lea & Febieger U.S. A.

BSCZOO0616 RADIATION BIOLOGY**Marks 50****Credits 3****40 Hrs****Interaction of radiation with matter**

a) Interactions of electromagnetic radiations with matter, photoelectric effect, Compton scatter, pair production, dependence on photon energy, dependence on Z (atomic number) of absorbing material, distribution of energy deposition (scale), half value layer b) Interactions of particles with matter, electrons, energy dependence, alpha particles, neutrons,
 c) Linear energy transfer (LET)/Relative biologic effectiveness (RBE)
 d) Definition of dose; gray (Gy)
 e) Principles of dosimetry Ionization chambers, Thermoluminescent dosimetry (TLD)
 f) Radiation chemistry of water
 g) Formation and reaction of free radicals with oxygen, scavengers: Direct/Indirect effects of radiation on macromolecules, Concept of chemical restitution/competition
 Sources and types of ionizing radiation, non ionizing radiations- Particulate radiation, free radicals, Radiation dose and units, Principles of radiation dosimetry, Direct and indirect effects.

10hrs

Molecular and cellular radiobiology :Radiation lesions in DNA, Major types of DNA repair, Consequences of unrepaired DNA damage , chromosome damage, Radiobiological definition of cell death, cell cycle effects, Relative biological effectiveness (RBE), Radiation sensitizers, Radiation protectors.

10hrs

Sources of radiation to human population: Natural, Cosmic rays, Man made sources.

2hrs

Radiation quantities: Exposure, Absorbed dose, Equivalent dose, Effective dose, Activity.

3hrs

Radiation effects: Health consequences : Health consequences after total body irradiation from radiation accidents, Long term radiation risks from low radiation doses, Radiation effects in the developing embryo and foetus, occupational exposure of a pregnant worker and heritable radiation effects.

5hrs

Body: effect of radiation on cell and whole organism, genetic effect of radiation, treatment of radiation accident victims. Radiation induced cataracts. Tissue heating. Effect of Radiations on cancer cells.

5hrs**Radiation protection:**

Principles and Objectives of radiation protection (Time, distance , shielding) Occupational exposure, As low as reasonably achievable (ALARA), Protection of embryo / foetus, Dose estimation, LD50, Brief idea of Radiation protection instruments.

5hrs**BSCZOO0616(P) RADIATION BIOLOGY PRACTICALS****Marks 50****Credits 1**

- Study of chromosomal mutations/abberations (ring formation, bridge formations) due to radiation exposure through permanent slides/photo micrograph.
- Study of harmful effects of radiation on body through photomicrographs.
- Visit to cancer hospital/research institute to study about radio diagnostics/instruments.
- Project report on benefits and harmful effects of radiation to society.

Suggested reading: Hall, EJ. Radiation biology for radiologist.

BSCZOO617 ENTOMOLOGY 50 Marks Credits 3 40 hrs**Introduction**

Scope and importance of insects. Origin and evolution. Classification. **5hrs. 5**

Anatomy**5hrs**

Segmentations and divisions of the body: Head-segments and attachments (antennae, eyes). Mouth parts-various modifications and feeding mechanism. Thorax-thoracic segmentation and appendages (wings). Abdomen-morphology and appendages (legs).

Physiology**15hrs**

Integumentary system-anatomy, moulting and sclerotization and role of hormones. Digestive System-anatomy and histology of gut. Modifications of gut. Physiology of digestion. Circulatory system-course of circulation, haemolymph and functions

Respiratory System-anatomy of trachea, tracheoles, spiracles and air sacs. Respiratory pigments.

Excretory System-anatomy of malpighian tubules, physiology of excretion. Reproductive System-male and female reproductive system.

Nervous System-brain, ganglia and nerves. Mechanoreceptors, chemoreceptors and photoreceptors.

Endocrine System-neurosecretory cells and endocrine glands (corpora cardiac, corpora allata, prothoracic glands) hormones and their functions. Pheromones and types.

Social Organisation**5hrs**

Social organisation w.r.t. termites, ants, honey bees.

Applied Entomology**10hrs**

Insect pests of rice, wheat, cotton, sugarcane. Insects as vectors of diseases of humans and animals. Insect pest management. Apiculture and sericulture.

BSCZOO0617(P) ENTOMOLOGY PRACTICALS Marks 50 Credits 1

- Collection and preservation of insects (dry and wet) (non endangered/endemic/rare)
 - Collection and preservation of insect pests (house hold pest, food grain pest, animal pests)
 - Preparation of permanent slides (w.m.) of small insects and insect pests (non endangered/endemic/rare).
 - Study of insect (cockroach/house fly/honey bee) head and its appendages, thorax and its appendages, abdomen and its appendages.
- Identification and economic importance of at least two pests of the following
- Pests of cereals, pests of vegetable crops, pests of pulses, animal pests.
- Field visit for demonstration of pest damage.

Suggested reading:

1. Awasthy V.B. 1998. Introduction to General and Applied Entomology. ELBS, London
2. Carde R.T. and W.J. Bell. 1995. Chemical Ecology of Insects (2nd edn). Chapman and Hall, NY.
3. Chapman R.F. 1982. *The Insects Structure and Functions*. ELBS, London.

BSCZOO0618 WILD LIFE AND CONSERVATION BIOLOGY Credits 3 40 Hrs**Wild life****5hrs**

Concept and importance of wild life, wild life as a resource. Concept of habitat, niche, biodiversity and bioindicators.

Wild Life of India and Himachal Pradesh**5hrs**

Wild life of India-its distribution in relation to ecological sub divisions. Threatened endangered mammals of India. Wild life of Himachal and threatened and endemic animals (birds and mammals only) of Himachal. Reasons for depletion of wildlife. Wild life conservation and limitations.

Wild Life habitat**5hrs**

Protected area concept-national parks, sanctuaries, biosphere reserves, cores and buffers, nodes and corridors. Wild life sanctuaries, national parks of HP. Community reserve and conservation reserve. Wetlands concept, wetlands of HP. Characteristics of Fragile habitats-grassland, wetland, coastland and tropical rain forest. Case study-Great Himalayan national park.

Wild life management**10hrs**

Management of rare and endangered species, control of weed species. Control and management of over abundant wildlife populations. Use of barriers, demographic and genetic management of small populations. Ecological monitoring of animal species and restoration programmes. Management, problems and prospects of captive breeding. Community participation in wild life management. Man animal conflict. Importance of wild life health management. Case study of western trangopan and snow leopard. Wild life census-techniques, objectives and direct and indirect methods. GIS-instrumentation,, applications, merits and limitations. Telemetry-instrumentation, applications, merits and limitations.

Wild life conservation**5hrs**

Biogeographic classification of India. Conservation strategies past and present. Conservation challenges from climate change, habitat loss and fragmentation. Special conservation projects-project tiger, project elephant. Ecological sensitive area-concept. National and international efforts to conserve wild life.

Wild life behaviour**5hrs**

Migration, communications and signaling. Territoriality, home range and courtship display. Scent markings and competition for resources.

Wild life trade and legislation**5hrs**

Assessment, documentation and prevention of trade, trans boundary problems. Wild life laws and ethics. National and state (HP) biodiversity action plan. Wild life protection act 1972. National wild life action plan 2002. State wild life board-functions.

BSCZOO0618(P) WILD LIFE AND CONSERVATION BIOLOGY PRACTICALS Marks 50 Credits 1

- Study of at least three endangered/threatened wild animals of India from reptiles,birds and mammals through charts/photomicrograph/model/specimen.
- Study of state animal and state bird of HP -chart, picture, model.
- GIS and application of remote sensing in management of wild life.
- Study of modern tools and techniques in wild life analysis.
 - Field Study: visit to any one of the national parks of state (GHNP Kullu/ Pin Valley NP) or zoo to study the management and estimation of wild animals and submit project/field report.

Suggested reading:

1. Dasmann R F. 1981.Wildlife Biology,2nd Ed John Wiley Sons.
2. Bhatnagar MC, Bansal G. 2010, Ecology and Wildlife Biology Krishna Prakashan media Pvt. Ltd. Meerut, India.

BSCZOO0619 HUMAN BIOLOGY Marks 50 Credits 3 40 Hrs

Chemistry of Life

5hrs

Biomolecules, their properties and function, carbohydrates, fats, proteins-functions. Balanced diet, diet for different age groups, obesity and starvation. Energy metabolism

Cell and tissues

5hrs

Cell, parts of eukaryotic cell, ultrastructure and function of cell and its organelles. Tissues-types and function.

Organs and organ system (anatomy, histology and physiology)

15hrs

Skeletal system: Bones: types, composition, functions. Axial and appendicular skeleton. Joints, disorder of skeletal system.

Muscles: types, properties and function. Skeletal muscle-ultrastructure, contraction. Disorder of muscular system.

Circulatory system: Heart-structure, function, cardiac muscles-properties, two circuits of blood flow, blood vessels-structure and functions. cardiovascular diseases. ECG. Blood-composition, properties, haemoglobin, blood cells, functions, homeostasis, blood disorders

Respiratory system: Lungs, respiratory path, Process of gas exchange, control over breathing, disorders of respiratory system. Oxygen therapy and toxicity.

Reproductive system: Male and female reproductive system, fertilization, infertility.

Excretory system: Kidney-structure, function, nephron, urine formation, acid base balance, dialysis.

Neuroendocrine system: Brain and spinal, action potential and nerve conduction, reflexes and reflex arc, endocrine glands and their secretions. Mechanism of action of hormones.

Environment Physiology

5hrs

Physiology of hot and cold environment, high altitude, aviation physiology, space and deep sea diving and hyperbaric conditions.

Human genetics

5hrs

Gene and chromosome, sex chromosome, human genetic analysis, inheritance of genes on autosomes and X chromosome, chromosomal mutations, common genetic diseases.

Human Evolution

5hrs

Evolutionary stages in human evolution. Microevolution-how new species arise.

BSCZOO0619(P) HUMAN BIOLOGY PRACTICALS Marks 50 Credits 1

- Study of human bones through disarticulated human skeleton.
 - Study of human histological slides: skin, stomach, intestine, artery, vein, liver, spleen, pancreas, thyroid, thymus, adrenals, testis, ovary, spinal cord, striated muscle.
- Measurement of blood pressure.
- Estimation of haemoglobin.
- Project work on topic related to theory paper.

Suggested readings:

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hecourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons, Inc.

BSCZOO0620 ANIMAL BEHAVIOUR Marks 50 Credits 3 40 Hrs

Principle and mechanism of animal behaviour

6hrs

Scope of ethology, Classification of behavioural patterns, analysis of behaviour (ethogram), innate behaviour. Four propositions of Tinbergen. Perception of environment-chemical, olfactory, auditory, visual. Control of behaviour-neural and hormonal.

Communication-

6 hrs

Electrical, auditory, chemical, visual, evolution of languages (primates), orientation and cues. Dance language of honey bees, pheromonal communication.

Social behavior

6hrs

Aggregation, schooling in fishes, flocking in birds, group selection, kin selection and altruism. Social organisation in insects and primates. Aggression-aggressive behaviour, game theory models. Territoriality and group foraging.

Reproductive Behaviour

6hrs

Reproductive strategies, Mating system, courtship, sperm competition, parental care.

Biological Rhythms

6hrs

Circadian and circannual rhythms, lunar periodicity, tidal rhythms, genetic basis of biological rhythms, orientation and navigation, migration of fishes and birds.

Learning and Memory

6hrs

Insight learning, association learning, reasoning, cognitive skills.

Cooperation and conflict

4hrs

Male male competition and sexual selection, parent offspring conflict. Range of cooperative behaviours.

BSCZOO0620(P) ANIMAL BEHAVIOUR PRACTICALS Marks 50 Credits 1

- Study of fish in response to three temperatures (Normal and + 50C) of water in a microenvironment and preparation of an ethogram.
- Study of the grooming behaviour in insects/bird.
- Visit to zoo/bird park to study their activity/behaviour.
- Project report on any topic form theory.

Suggested readings:

1. Alcock, J. Animal behaviour : An evolutionary approach, Sinauer Assoc., Sunderland, Mass. USA.
2. Bradbury, J.W., and S.L. Verhrencamp. Principles of Animal Communication, Sinauer Assoc., Sunderland, Mass. USA.
3. Clutton-Brock, T.H. The evolution of Parental care, Princeton Univ. Press, Princeton, NJ, USA.
4. Eibl-Eibesfeldt, I. Ethology. The biology of behaviour, Holt, Rinechart & Winston, New York.
5. Gould, J.L. The mechanisms and evolution of behaviour.

BSCZOO0621 FISH BIOLOGY Marks 50 Credits 3 40 Hrs**Introduction:****6hrs**

Introduction to world of fishery-production, demand and utilization. Origin and evolution of fish, Fresh water fishes of India-River system, reservoir, pond, tank fisheries; captive and culture fisheries, cold water fisheries. Fishing crafts and gears. Outline classification of fish upto order, biogeographic distribution of fish.

Body Form and locomotion**6hrs**

Body shape, swimming modes, fins-type,structure, modifications and functions. Colouration-chromatophore pigments, colouration and biological significance. Bioluminescence and its significance. Electric organs-structure and uses.

Respiratory system**6hrs**

Gillstructure and physiology of gill respiration, accessory respiratory organs and mechanism of breathing, swim bladder structure and function, webberian ossicles.

Ecology of fishes**6hrs**

Adaptations to special conditions of life - deep sea, cave, hill-stream fishes. Aestivation and hibernation. Migrations and orientation. Homing and territorial recognition. Schooling.

Fish pathology**8hrs**

Fish diseases and their causes-viral, bacterial, fungal, prophylactic and therapeutic measures.

Biochemical composition and preservation**8hrs**

Biochemical composition of fish, nutritional value of fish, Poisoning toxicity and allergies from fish as food, fish spoilage and Fish preservation. Fish byproducts.

BSCZOO0621(P) FISH BIOLOGY PRACTICALS Marks 50 Credits 1

Identification of important fishes (specimens/models/charts) *Labeo*, *Ophiocephalus*, *Heteropneustes*, *Mystus*, *Salmo*, *Wallago*, *Cyprinus*, *Barbus*.

- Preparation of permanent slides of different types of scales.
 - Dissection of *Scolidon* to study the external and internal anatomy, digestive system of fish.
- Any other experiment set by the teacher/ Department.
- Field trips and study tours to fish farms, fisheries institute, or national laboratory etc.

- **Suggested readings:**

1. Jhingran, V.G. 1978, Fish and Fisheries of India, Hindustan Publishing House (India), New Delhi, India.
2. Talwar, P.K., Jhingran, A.G. 1991, Inland Fishes of India, Vols I & II., Oxford & IBH, New Delhi, India.
3. Karl, F. L., Win, C. 1969, Freshwater Fishery Biology, Brown Company Publication, Iowa.
4. Moyel, P.B; J.J. Jr., Cech. 1988, Fishes: An introduction to ichthyology, Prentice Hall, Englewood, Cliffs, N.J.

Nelson, J.S., 1976, Fish of the World, John Wiley and Sons, New York.

OPEN ELECTIVE COURSES

BSCZOO0622 ENVIRONMENT MANAGEMENT Marks 50 Credits 3 40 Hrs

Introduction: 2 hrs

Man as a biological species in the ecosystem; population increase; carrying capacity, exploitation of resources due to activities like agriculture, horticulture, urbanization and industrialization.

Public awareness of Environment issues: Role of 3 hrs

Government, NGO's, International Environmental organizations, treaties and conventions. movements.

Natural resources: 5 hrs

Land, Water, Air, Bioresearches and biodiversity.

Effect of human activities: 5 hrs

Depletion of resources; Generation of waste; types (agricultural, municipal, industrial); Management of wastes and disposal (emphasis on concepts of reduce, reuse and recycle); Pollution of air, water, soil, noise, and due to radioactive substances; Causes and methods of prevention and control; Eutrophication; Bioremediation; Depletion of forests; Threats to biodiversity, Extinction of species.

Sustainable Development: 5 hrs

Definition; Brundlandt Report; Threats to sustainable development, green technologies, eco-cities, Ecological footprint, National Environmental Policy.

Energy: 5 hrs

Conventional Fuel - wood, fossil fuels; Non-conventional or alternate sources - sun, wind, bioenergy, geothermal, ocean, hydrogen, nuclear.

Conservation of resources 5 hrs

Soil - Contour farming, a forestation and reforestation; Water - Rainwater harvesting, aquifers, groundwater recharge, watershed management; Biodiversity - In-situ conservation (Sanctuaries, National Parks, Biosphere Reserves, World Heritage Sites), Project Tiger and other conservation efforts. Social forestry and Joint forestry Management; Ex-situ conservation (botanical gardens, gene banks, cryopreservation); Role of organizations like NBPGR, BSI, ZSI, WWF, IUCN and conventions like Convention on Biological diversity; Ramsar Convention, National Action Plan on Conservation of Biodiversity; Environmental laws and acts.

Global environment change 8 hrs

Greenhouse effect and global warming; climate change; Shrinking of glaciers and polar ice caps and consequent effects on river and sea levels; Ozone layer depletion; vegetation and biota; International efforts to control these effects (Vienna Convention, Montreal Protocol, UNFCCC, Kyoto Protocol, Copenhagen Summit, etc.); IPCC; Biosafety of GMOs and LMOs.

Environmental impact assessment 2 hrs

Concept, aim and steps.

BSCZOO0622(P) ENVIRONMENT MANAGEMENT PRACTICALS
Marks 50 Credits 1

- Student would be required to submit a detailed project report based on the practical work on any topic mentioned in the theory paper. Evaluation of the project will be based on the detailed report and presentation.

Suggested readings:

1. Joseph, B., Environmental studies, Tata Mc Graw Hill.
2. Mohapatra Textbook of Environmental Biotechnology IK publication.
3. Thakur, I. S., Environmental Biotechnology, I K Publication.
4. Michael Allabay, Basics of environmental science, Routledge Press.

Defining Biodiversity

6Hrs

Components of biodiversity. Biodiversity crisis and biodiversity loss. Factors promoting biodiversity. Importance of biodiversity in daily life. Biodiversity and climate change.

Types of Ecosystems

5Hrs

India as mega biodiversity Nation. Hot spots and biodiversity in India. Biodiversity and Ecosystem functioning. Plant and Animal systematic. Species concept in biodiversity studies.

Modern Tools in the study of Biodiversity

10Hrs

Endemism, endemic plants and animals; Assessment of mapping of biodiversity; GIS/Remote sensing; Biotechnology and Conservation, IUCN; Germplasm banks, National Parks, Botanical Gardens; Wildlife Sanctuaries, Bioresources.

Crop Diversity

4Hrs

Wild relatives of cultivated plant; Domesticated diversity; Spice diversity; Forest diversity and wild life.

Biodiversity conservation:

15Hrs

Threats to biological diversity, loss of biodiversity & its courses, listing of threatened biodiversity including vulnerable, rare, threatened, endangered & extinct plant & animal species. Concept of conservation, conservation values & ethics, inventorisation of biological resources, Action plan of conservation, conservation of rare & endangered species, conservation through network of protected areas, Role of NGO's in conservation activities & conservation & sustainable development.

BSCZOO0623(P) BIODIVERSITY PRACTICALS Marks 50 Credits 1

- Study of museum specimens of chordates phylum (two representative from each class) biodiversity.
 - Study of endangered species (birds, mammals of India). (Models, pictures, charts.).
 - Harnessing information through Internet regarding Biodiversity (hot spots of India, western ghats).
 - Visit to national Park or biosphere reserve and prepare report w.r.t. biodiversity and management of resources.
- OR
- Project report on any topic from theory.

Suggested readings:

1. Wilson, E.O. Biodiversity National Academy Press 1988.
2. K.V. Krishnamurthy: An advanced textbook on biodiversity, principles and practice.

Minor Elective Courses in Zoology

Semester I BSCZOO0101 BSCZOO0101(P)	Invertebrates I Invertebrates I Practicals	Marks 70 (40+30) Marks 30
Semester II BSCZOO0203 BSCZOO0203 (P)	Biology of Chordates I Biology of Chordates I Practicals	Marks 70 (40+30) Marks 50
Semester III BSCZOO0102 BSCZOO0102 (P)	Invertebrates II Invertebrates II Practicals	Marks 70 (40+30) Marks 50
Semester IV BSCZOO0204 BSCZOO0204 (P)	Biology of Chordates II Biology of Chordates II Practicals	Marks 70 (40 +30) Marks 50
Semester V BSCZOO0305 BSCZOO0305 (P)	Developmental Biology Developmental Biology Practicals	Marks 70 (40+30) Marks 50

Annexure-I

Batch : 2015-onwards

HIMACHAL PRADESH UNIVERSITY SHIMLA-171005

**CHOICE BASED CREDIT SYSTEM
(CBCS)-B.Sc. Zoology (Major)**

Syllabus and Examination for B.Sc. Zoology (Major)

Under CBCS

Semester System

June 2016 (IIIrd semester- onwards)

CHOISE BASED CREDIT SYSTEM (CBCS) IN ZOOLOGY**CBCS Programme for B. Sc. with ZOOLOGY (Major)****June 2016**

	Code	Core Course (Hard Core)	Teaching Hrs.	Credits
SEMESTER I	BSCZOO0101	Invertebrates I	40	3+1=4
	BSCZOO0102	Invertebrates II	40	3+1=4
SEMESTER II	BSCZOO0203	Biology of Chordates I	40	3+1=4
	BSCZOO0204	Biology of Chordates II	40	3+1=4
SEMESTER III	BSCZOO0305	Development Biology	40	3+1=4
	BSCZOO0306	Animal Physiology	40	3+1=4
SEMESTER IV	BSCZOO0407	Cytogenetics	40	3+1=4
	BSCZOO0409	Cell Biology	40	3+1=4
SEMESTER V	BSCZOO0510	Biochemistry	40	3+1=4
	BSCZOO0511	Biotechnology	40	3+1=4
SEMESTER VI	BSCZOO0613	Ecology	40	3+1=4
	BSCZOO0614	Applied Zoology	40	3+1=4
	Core Elective			
	BSCZOO0408	Evolutionary Biology	40	3+1=4
	BSCZOO0512	Molecular Biology	40	3+1=4
	BSCZOO0615	Parasitology (Can be opted in IV semester)	40	3+1=4
	BSCZOO0616	Radiation Biology	40	3+1=4
	BSCZOO0617	Entomology(Can be opted in V semester)	40	3+1=4
	BSCZOO0618	Wild Life and Conservation Biology	40	3+1=4
	BSCZOO0619	Human Biology	40	3+1=4
	BSCZOO0620	Animal Behaviour	40	3+1=4
	BSCZOO0621	Fish Biology	40	3+1=4
	BSCZOO0622	Environment Management	40	3+1=4
	BSCZOO0623	Biodiversity	40	3+1=4

Scheme of Examinations for every major /minor and additional course:

End semester examination	50 marks	Time 3 hrs
Mid-term test after 48 teaching days	15 marks	
Mid-term test after 90 teaching days	15 marks	
Assignments/seminar (with power point presentation) Minimum 30 min. duration	15 marks	Time 30 mins
Class Room Attendance	05 marks	
Practicals of every major/minor/additional course	50 marks	Time 3 hrs

Annexure-I

Batch : 2015-onwards

HIMACHAL PRADESH UNIVERSITY SHIMLA-171005

**CHOICE BASED CREDIT SYSTEM
(CBCS)-B.Sc. Zoology (Major)**

Syllabus and Examination for B.Sc. Zoology (Major)

Under CBCS

Semester System

June 2016 (IIIrd semester- onwards)

**Approved in BOS meeting in the
Subject of Zoology held on 21-04-2016**

**Annexure- I of
BOS Meeting**

**DEPARTMENT OF BIOSCIENCES
HIMACHAL PRADESH UNIVERSITY**

SYLLABI AND COURSES IN THE SUBJECT OF ZOOLOGY FOR B.Sc.
WITH MAJOR IN ZOOLOGY AND MINOR ELECTIVE IN ZOOLOGY

June 2016 onwards

(A) Structure Outline of Major in Zoology (Minimum Credits to be Earned=56)

Semester	Course Code	Course Type	Course Name	Credit(s)/ week	Cumulated Credits Category-wise
I (Odd)		Compulsory Course I	To be Selected from the list of Compulsory Courses	3	Compulsory – 6 Core – 8 Elective – 8 GI & H – 1 Total – 23
		Compulsory Course II (Skill Based)	To be Selected from the list of Compulsory Courses (Skill Based)	3	
	BSCZOO0101	Major Core Course I	Invertebrates I	3	
	BSCZOO0102	Major Core Course II	Invertebrates II	3	
		Minor Elective Course I (a)	To be Selected from the list for Minor Elective Subject other than zoology	3	
		Minor Elective Course I (b)	To be Selected from the list for Minor Elective Subject other than zoology	1	
	BSCZOO0101(P)	Major Core Lab Course I	Invertebrates I	1	
	BSCZOO0102(P)	Major Core Lab Course II	Invertebrates II	1	
		Minor Elective Lab Course I (a)	To be Selected from the list for Minor Elective Subject other than zoology	1	
		Minor Elective Lab Course I (b)	To be Selected from the list for Minor Elective Subject other than zoology	1	
		GI and H Course I	To be Selected from the list GI and Hobby Courses	1	

II (Even)		Compulsory Course III	To be Selected from the list of Compulsory Courses	3	Compulsory – 6 (12) Core – 8 (16)
Semester	Course Code	Course Type	Course Name	Credit(s)/ week	Cumulated Credits Category-wise
		Compulsory Course IV(Skill Based)	To be Selected from the list of Compulsory Courses (Skill Based)	3	Elective – 8 (16) GI & H – 1 (2) Total 23 (46)
	BSCZOO0203	Major Core Course III	Biology of Chordates I	3	
	BSCZOO0204	Major Core Course IV	Biology of Chordates II	3	
		Minor Elective Course II (a)	To be Selected from the list for Minor Elective Subject other than zoology	3	
		Minor Elective Course II (b)	To be Selected from the list for Minor Elective Subject other than zoology	3	
	BSCZOO0203(P)	Major Core Lab Course III	Biology of Chordates I	1	
	BSCZOO0204(P)	Major Core Lab Course IV	Biology of Chordates II	1	
		Minor Elective Lab Course II (a)	To be Selected from the list for Minor Elective Subject other than zoology	1	
		Minor Elective Lab Course II ()	To be Selected from the list for Minor Elective Subject other than zoology	1	
		GI and H Course II	To be Selected from the list GI and Hobby Courses	1	
		Compulsory Course V	To be Selected from the list of Compulsory Courses	3	Compulsory – 6 (18) (Complete) Core – 8 (24) Elective – 8 (24) GI & H – 1 (3) (Complete) Total 23 (69)
		Compulsory Course VI	To be Selected from the list of Compulsory Courses (Skill Based)	3	
	BSCZOO0305	Major Core Course V	Developmental Biology	3	
	BSCZOO0306	Major Core Course VI	Animal Physiology	3	
		Minor Elective Course III (a)	To be Selected from the list for Minor Elective Subject other than zoology	3	
		Minor Elective Course III(b)	To be Selected from the list for Minor Elective Subject other than zoology	3	
III (Odd)	Course Code	Course Type	Course Name	Credit(s)/ week	Cumulated Credits

					Category-wise
	BSCZOO0305(P)	Major Core Lab Course V	Developmental Biology	1	
	BSCZOO0306(P)	Major Core Lab Course VI	Animal Physiology	1	
		Minor Elective Lab Course III(a)	To be Selected from the list for Minor Elective Subject other than zoology	1	
		Minor Elective Lab Course III(b)	To be Selected from the list for Minor Elective Subject other than zoologyt	1	
		GI and H Course III	To be Selected from the list GI and Hobby Courses	1	
	BSCZOO0407	Major Core Course VII	Cytogenetics	3	
	BSCZOO0409	Major Core Course IX	Cell Biology	3	
		Minor Elective Course IV (a)	To be Selected from the list for Minor Elective Subject other than Physics	4	
		Minor Elective Course IV (b)	To be Selected from the list for Minor Elective Subject other than Physics	4	
	BSCZOO0407(P)	Major Core Lab Course VII	Cytogenetics	1	
	BSCZOO0409(P)	Major Core Lab Course IX	Cell Biology	1	
		Minor Elective Lab Course IV (a)	To be Selected from the list for Minor Elective Subject other than zoology	1	
		Minor Elective Lab Course IV(b)	To be Selected from ‘ -[the list for Minor Elective Subject other than zoology	1	
IV (Even)		Core / Elective			Core – 12 (36) Elective – 8 (32) Core / Elective (additional) - 4 Total 24 (93)
V (Odd)	BSCZOO0510	Major Core Course X	Biochemistry	3	Core – 12 (48) Elective – 8
	BSCZOO0511	Major Core Course XI	Biotechnology	3	

Semester	Course Code	Course Type	Course Name	Credit(s)/week	Cumulated Credits Category-wise
		Minor Elective Course V(a)	To be Selected from the list for Minor Elective Subject other than Physics	3	
		Minor Elective Course V(b)	To be Selected from the list for Minor Elective Subject other than Physics	3	
	BSCZOO0510(P)	Major Core Lab Course X	Biochemistry	1	
		Minor Elective Lab Course V (a)	To be Selected from the list for Minor Elective Subject other than zoology	1	
		Minor Elective Lab Course V (b)	To be Selected from the list for Minor Elective Subject other than zoology	1	
		Core / Elective Course (Additional)*	Any one of the Additional or open elective courses	4	
VI (Even)	BSCZOO0613	Major Core Course XIII	Ecology	3	Core – 8 (56) Core / Elective (additional) – 20* Total 28 (145)
	BSCZOO0614	Major Core Course XIV	Applied Zoology	3	
	BSCZOO0613(P)	Major Core lab Course XIII	Ecology	1	
	BSCZOO0614(P)	Major Core lab Course XIV	Applied Zoology	1	
	BSC(Or Other than Science) (Zoo or other than zoology) 06**	Core / Elective Course (Additional)*	Any one of the Additional or open elective courses	4	
	BSC(Or Other than Science) ZOO(or other than zoology) 06**	Core / Elective Course (Additional)*	Any one of the Additional or open elective courses	4	
	BSC(Or Other than Science) ZOO(or other than zoology) 06**	Core / Elective Course (Additional)*	Any one of the Additional or open elective courses	4	
	BSC(Or Other than Science) ZOO(or other than zoology) 06**	Core / Elective Course (Additional)*	Any one of the Additional or open elective courses	4	
Semester	Course Code	Course Type	Course Name	Credit(s)/week	Cumulated Credits Category-wise
	BSC(Or Other than Science) ZOO(or other than zoology) 06**	Core / Elective Course (Additional)*	Any one of the Additional or open elective courses	4	

Note: Students in VI th semester can opt any of the following courses.

***Additional Elective Courses offered by ZOOLOGY Department (can be chosen for earning credits over and above 56 Major subject credits, 40 Minor elective credits, 9 (Min.) Compulsory course credits and 1 (Min.) 3G I&H Course credits i.e. total 106 credits; for getting B.Sc. Degree a learner has to earn a minimum of 120 credits.)**

Semester	Course Code	Course Type	Course Name	Credit(s)/ week	Cumulated Credits Category wise
VI	BSCZOO0408	Core / Elective Course (Additional)*	Evolutionary Biology	3	
VI	BSCZOO0408(P)		Evolutionary Biology	1	
VI	BSCZOO0512	Core / Elective Course (Additional)*	Molecular Biology	3	
VI	BSCZOO0512(P)		Molecular Biology	1	
VI	BSCZOO0615 (also open in IV semester)	Core / Elective Course (Additional)*	Parasitology	4	
VI	BSCZOO0616	Core / Elective Course (Additional)*	Radiation Biology	4	
VI	BSCZOO0617 (also open in V Semester)	Core / Elective Course (Additional)*	Entomology	4	
VI	BSCZOO0618	Core / Elective Course (Additional)*	Wild Life and conservation Biology	4	
VI	BSCZOO0619	Core / Elective Course (Additional)*	Human Biology	4	
VI	BSCZOO0620	Core / Elective Course (Additional)*	Animal Behaviour	4	
VI	BSCZOO0621	Core / Elective Course (Additional)*	Fish Biology	4	

***Open Elective Courses offered by ZOOLOGY Department**

Semester	Course Code	Course Type	Course Name	Credit(s)/ week	Cumulated Credits Categorywise
VI	BSZOO0622	Open /Core Elective Course (Additional)*	Environment Management	4	
VI	BSCZOO0623	Core / Elective Course (Additional)*	Biodiversity	4	

(B) Structure Outline of Minor Elective in ZOOLOGY for other than Major Zoology Students (Minimum Credits to be Earned=20). Other than Zoology Major learner can do Double major by earning 34 more credits over and above 20 credits of Minor.

Semester	Course Code	Course Name	Course Name	Credit(s)/week	Cumulated Credits Category-wise
I (Odd)		Compulsory Course I		3	Compulsory – 6 Core – 8 Minor Elective 1(a) – 4(4) Minor Elective 1(b)=4 Total Minor Electives – 8 (8) GI & H – 1 Total – 23
		Compulsory Course II (Skill Based)		3	
		Major Core Course I		3	
		Major Core Course II		3	
	BSCZOO0101	Minor Elective Course I (a)	Invertebrates I	3	
		Minor Elective Course I (b)		1	
		Major Core Lab Course I		1	
		Major Core Lab Course II		1	
	BSCZOO0101(P)	Minor Elective Lab Course I (a)	Invertebrates I	1	
		Minor Elective Lab Course I (b)		1	
	GI and H Course I		1		
II (Even)		Compulsory Course III		3	Compulsory – 6 (12) Core – 8 (16) Minor Elective 1I(a) – 4 (8) Minor Elective 1I(b) – 4 (8) Total Minor Electives – 8 (16) GI & H – 1 (2) Total 23 (46)
		Compulsory Course IV(Skill Based)		3	
		Major Core Course III		3	
		Major Core Course IV Optics		3	
	BSCZOO0203	Minor Elective Course II (a)	Biology of Chordates I	3	
		Minor Elective Course II (b)		3	
		Major Core Lab Course III		1	
		Major Core Lab Course IV		1	
	BSCZOO0203(P)	Minor Elective Lab Course II (a)	Biology of Chordates I	1	
	Minor Elective Lab Course II (b)		1		
	GI and H Course II		1		
III (Odd)		Compulsory Course V		3	Compulsory – 6 (18)
Semester	Course Code	Course Name	Course Name	Credit(s)/week	Cumulated Credits Category-wise

		Compulsory Course VI		3	(Complete) Core – 8 (24)	
		Major Core Course V		3	Minor	
		Major Core Course VI	-----	3	Elective III(a) – 4 (12)	
	BSCZOO0102	Minor Elective Course III (a)	Invertebrates II	3	Minor Elective III(b) – 4 (12) Elective – 8 (24)	
		Minor Elective Course III(b)	-----	3	GI & H – 1 (3)	
		Major Core Lab Course V	-----	1	(Complete)	
		Major Core Lab Course VI	-----	1	Total 23 (69)	
	BSCZOO0102 (P)	Minor Elective Lab Course III(a)	Invertebrates II	1		
		Minor Elective Lab Course III(b)	-----	1		
		GI and H Course III	-----	1		
IV (Even)		Major Core Course VII	-----	4	Core – 12 (36) Minor Elective IV(a) – 4 (16) Minor Elective IV(b) – 4 (16) Total Minor Electives – 8 (32) Core / Elective (additional) - 4 Total 24 (93)	
		Major Core Course VIII Nuclear Physics	-----	4		
		Major Core Course IX Particle Physics	-----	4		
		BSCZOO0204	Minor Elective Course IV (a)	Biology of Chordates II		4
		Minor Elective Course IV (b)	-----	4		
		Major Core Lab Course VII	-----	1		
		Major Core Lab Course VIII	-----	1		
		BSCZOO0204(P)	Minor Elective Lab Course IV (a)	Biology of Chordates II		1
		Minor Elective Lab Course IV(b)	-----	1		
	Core / Elective Course (Additional)*	-----	4			
V (Odd)		Major Core Course X	-----	3	Core – 12 (48) Minor Elective V(a) – 4 (20) Minor Elective V(b) – 4 (20) Total Minor Electives – 8	
		Major Core Course XI	-----	3		
		Major Core Course XII	-----	3		
		BSCZOO0305	Minor Elective Course V(a)	Developmental Biology		3
		Minor Elective Course V(b)	-----	3		

Semester	Course Code	Course Name	Course Name	Credit(s)/week	Cumulated Credits Category-wise
		Major Core Lab Course X	-----	1	(40) (Complete) Core / Elective (additional) - 4 Total 24 (117)
		Major Core Lab Course XI	-----	1	
		Major Core Lab Course XII *	-----	1	
	BSCZOO0305(P)	Minor Elective Course V	Developmental Biology	1	
		Minor Elective Lab Course V (b)	-----	1	
		Core / Elective Course (Additional)*	-----	4	
VI (Even)		Major Core Course XIII	-----	4	Core – 8 (56) Core / Elective (additional) – 20* Total 28 (145)
		Major Core Course XIV	-----	4	
		Core / Elective Course (Additional)*	-----	4	
		Core / Elective Course (Additional)*	-----	4	
		Core / Elective Course (Additional)*	-----	4	
		Core / Elective Course (Additional)*	-----	4	
		Core / Elective Course (Additional)*	-----	4	