



Goa University
P.O. Goa University, Taleigao Plateau, Goa 403 206
Syllabus of M.Sc. (Zoology) Programme

From the Academic year: 2014 -15 (Approved by AC April 2014)

A brief description of the course:

Purpose:

- To understand the importance of taxonomy and the biodiversity of fauna (non chordate and chordate) and their conservation.
- To study comparative structure and function of the different organ systems and their physiological importance in relation to habit and habitat of the organism.
- To understand the biochemical integrity of various life processes.
- To have advanced knowledge on animal genetics, molecular biology and developmental biology and their applications
- To prepare the students for pursuing advance studies in various fields of animal sciences by research.

Prerequisites:

The Candidate must pass the Bachelor's degree examination in Zoology at T.Y.B.Sc. level or its equivalent.

Credits:

A student has to take minimum 60 credit course form the department out of which 40 credits are core courses and 20 credits are optional courses. Besides, to get Post -graduate degree student has also to take another 20 credits optional courses either from the department and or other department / Institution.

Dissertation:

Dissertation is to be treated as equivalent to 12 credits and compulsory for all students and it is in lieu of 12 credit optional courses. Student has to undertake dissertation work during 3rd and 4th Semester and the same will be evaluated at the end of 4th semester.

Filed Work:

It is compulsory for all students and they have to do the field work during 1st to 4th Semester and the same will be evaluated at the end of 4th semester. It is equivalent to 2 credit optional courses.

Number of Semester: Four.

In first and second semesters a student has to take courses equivalent to 20 credits. However, in third and fourth semesters, Besides Field work and Dissertation work, a student has to take courses equivalent to 15 credits besides.

Framework of Credit based syllabus (w.e.f. Academic year 2014-2015)

SEMESTER I

Paper Code	Title of the Paper	L-T-P / week	Credits	Page No.
ZOC 101	Animal Taxonomy and Systematics	4-1-0	4	4
ZOC 102	Comparative Anatomy of Non - Chordates and Chordates	4-1-0	4	5
ZOC 103	Animal Biochemistry	4-1-0	4	6
ZOC 104	Cell and Molecular Biology	4-1-0	4	7
ZOC 105	Laboratory course I (based on paper ZOC 101, 102, 103and 104)	0-0-12	4	8

SEMESTER II

Paper Code	Title of the Paper	L-T-P / week	Credits	Page No
ZOC 201	Animal Genetics	4-1-0	4	9
ZOC 202	Comparative Animal Physiology	4-1-0	4	10
ZOC 203	Developmental Biology	4-1-0	4	11
ZOC 204	Agricultural Entomology	4-1-0	4	12
ZOC 205	Laboratory course II (based on paper ZOC 201, 202, 203and 204)	0-0-12	4	13

SEMESTER III

Paper Code	Title of the Paper	L-T-P / week	Credits	Page No
ZOO 301	Environmental Physiology	3-0-1	4	14
ZOO 302	Animal Tissue Culture	3-0-1	4	15
ZOO 303	Fishery Biology	3-0-1	4	16
ZOO 304	Parasitology	3-0-1	4	17
ZOO 305	Biodiversity	3-0-0	3	18
ZOO 306	Avian Biology	3-0-0	3	19
ZOO 307	Wild life Biology	2-0-0	2	20
ZOO 308	Immunology *	2-0-0	2	21
ZOO 309	Animal Behaviour *	2-0-0	2	21
ZOO 310	Radiation Biology*	2-0-0	2	22

SEMESTER IV

Paper Code	Title of the Paper	L-T-P / week	Credits	Page No
ZOO 401	Toxicology	3-0-1	4	23
ZOO 402	Human Genetics	3-0-1	4	24
ZOO 403	Marine Zoology	3-0-1	4	25
ZOO 404	Biology of Reproduction	3-0-1	4	26
ZOO 405	Biochemical Techniques	2-0-0	2	27
ZOO 406	Application of Animal Biotechnology	2-0-0	2	28
ZOO 407	Molecular Endocrinology	2-0-0	2	29
ZOO 408	Nutritional Biochemistry*	2-0-0	2	30
ZOO 409	Evolutionary Biology*	2-0-0	2	30
ZOO 410	Medical Entomology*	2-0-0	2	31
ZOO 411	Field work	2-0-0	2	32
ZOO 412	Dissertation	12-0-0	12	32

*Inter disciplinary course (students from other departments can also opt for the said course)

ZOC-101: Animal Taxonomy and Systematics

Contract Hours: 60 Hrs

Credits: 4

ALL MODULES CARRY EQUAL WEIGHTAGE

Module 1:

Introduction to taxonomy, stages of taxonomy, importance of taxonomy, Rise of taxonomy, Principles and rules of Taxonomy, Zoological nomenclature, ICZN regulations, new trends in taxonomy Zoological classification, problems of taxonomists concept of speciation, Taxonomic collections, identification and description, Taxonomical hierarchy (Linnean hierarchy), Concepts of Taxon, holotype, paratype, topotype etc.

Module 2:

Affinities, Phylogeny and systematic position of Protozoa, Porifera, Cnidaria, Helminthes, Annelida, Arthropoda, Mollusca and Echinodermata

Module 3:

General Organization, affinities and systematic position of minor phyla Lophophorates, Phoronida, Ectoprocta, Brachiopoda, Pogonophora,, Chaetognatha, Acanthocephala, Entoprocta and Sipunculida

Module 4:

Molecular basis of animal taxonomy: Genetic polymorphism, electrophoretic variations, amino acid sequencing for variety of proteins, DNA-DNA and DNA- RNA hybridization.

Reference Books:

Barnes RD, *Invertebrate Zoology*, Halt Saunders Intl. Edition
Hymen LH, *The invertebrates (all volumes)*, McGraw Hill, Philadelphia, USA
Huston AM, *Biological Diversity*, Cambridge University Press, Cambridge
Kapoor VC, *Theory and Practice of Animal Taxonomy*, Oxford and IBH Publ., Delhi
McNeely JA, *Economics and Biological Diversity*, IUCN, Gland, Switzerland
Prasad SN, *Life of Invertebrates*, Vikas Publ. New Delhi
Sinha AK, Adhikari S and Ganguly BB, *Biology of Animals(vol. I & II)*, Central Book Agency, Kolkata
Young JZ, *Life of Vertebrates*, Clarendon Press, Oxford.

ZOC-102 : Comparative Anatomy of Non-Chordates and Chordates

Contract Hours: 60 Hrs

Credits: 4

Module 1:

Skeletal system: Skeletal system of Arthropods and Echinoderms. Tetrapod limbs and their modification.

Muscular system: Locomotory organs in Annelids and Molluscs; Types of Vertebrate musculature. Appendicular musculature of Tetrapodes. Flight muscles of Insects and Birds.

Module 2:

Vascular system: Canalicular system in Porifera, Vascular system in Annelida, Arthropoda and Echinodermata; Evolution of Portal system in Vertebrates, Lymphatic system in Land Vertebrates

Respiratory system: Respiratory organs of Annelids and Molluscs. Pharyngeal basket in Lower Chordates.

Module 3:

Nervous system: Nervous system in Arthropods and Molluscs; Sensory organs in Cnidarians and Helminthes; Central and autonomous nervous system in Tetrapodes; Somatic and visceral receptors of the Vertebrates

Module 4:

Urino-genital system: Excretory organs in Helminthes, Annelids and Molluscs; Reproductive organs in Echinoderms and Arthropods. Testes, vasa deferentia, ovary and oviduct of Vertebrates.

Reference Books:

Barrington EJ, *Invertebrate Structure and Function*, Thomas Nelson and Sons, USA.

Kardong K, *Vertebrates: Comparative Anatomy, Function and Evolution*, McGraw-Hill Companies, USA.

Kent CG and Carr R, *Comparative Anatomy of Vertebrates*, McGraw-Hill Companies, USA.

Liem KF and Franklin W, *Functional Anatomy of the Vertebrates: an Evolutionary Perspective*, Harcourt College Publishers, California.

Wolff RG, *Functional Chordate Anatomy*, Amazon Publication, UK.

ZOC 103 : Animal Biochemistry

Contract Hours: 60 Hrs

Credits: 4

Module1:

Concept of metabolism; Concept of free energy; Coupled reaction; Electron transport system; TCA cycle; Oxidative phosphorylation; Catalytic and Regulatory strategies of enzymes.

Module 2:

Glycolysis and Gluconeogenesis ; Pentose phosphate pathway; Glycogenolysis and Glycogenesis;
Biosynthesis of fatty acid, Oxidation of fatty acid ; Biosynthesis of Phospholipid, Tri- acylglycerol and Cholesterol.

Module 3:

Protein turn-over and amino acid catabolism; Nitrogen excretion pathways; Oxidation of amino acids; Biosynthesis of amino acids in animal.
Biosynthesis of Pyrimidine and Purine.

Module 4:

Prostaglandins and leukotriene; Biochemical Signals Transduction pathways: G protein, IP₃, Tyrosine kinase, Protein kinase; Role of Ca⁺⁺ and Calmodulin in metabolism.

Reference Books:

Albert Lehninger, *Principles of Biochemistry*, CBS Publisher, New Delhi.

Berg J, Tymoczko J and Stryer L, *Biochemistry*, W H Freeman and Company, New York.

Devlin TM, *Text book of Biochemistry with Clinical Correlations*, Willey, Oxford.

Murray RK, Granner D, Mayes P and Rodwell VW. *Harper's Illustrated Biochemistry*, McGraw-Hill Companies, USA.

Nelson DL and Cox MM, *Lehninger's Principles of Biochemistry*, Freeman WH and Co, USA.

ZOC 104: Cell and Molecular Biology

Contract Hours: 60 Hrs

Credits: 4

Module 1:

Viruses: Structure and classification of animal viruses - reverse transcription; Bacterial viruses: structure, lysogenic and lytic life cycle, transformation experiment;

Regulation of gene expression: Operon concept, *lac* and *trp* operons; regulation at the transcriptional, post-transcriptional, translational and post-translational changes in eukaryotes; activators, enhancers and silencers; Restriction maps and molecular marker maps.

Module 2:

Plasma membrane: Current concepts of Structure and Function; Cell adhesion Molecules; Extra Cellular Matrix (ECM); Cytoskeletal structure and functions; Structure and biogenesis of ribosomes and lysosomes.

Module 3:

Fluorescence, electron (SEM, TEM & STEM) and confocal microscopy: principle, methods and applications; Flow cytometry; Southern, Northern and Western blotting techniques; DNA fingerprinting; Fluorescent in situ hybridization (FISH) and Chromosome painting, DNA sequencing, Autoradiography, PCR, RTPCR, Nested PCR, RAPD, PCR based RAPD.

Module 4:

Mitochondrial genetic system Cell cycle and cell division: Phases of cell cycle, Cyclins and Cyclin dependant kinases, Cellular aspects of cancer, Apoptosis, cellular dynamics.

Reference Books:

Alberts B, Johnson A, Lewis J, *et al.*, *Molecular Biology of the Cell*, Taylor & Francis Group, New York, USA.

Bakjwr WM, Reece JB and Poenie MF, *The World of Cell*, The Benjamin Publ. Co., UK.

Bray BAD, Lewis J, Raff M, Roberts K and Watson JD, *Molecular Biology of the Cell*, Garland Publishing Co. Ltd. New York.

De Robertis EDP and De Robertis EMF, *Cell and Molecular Biology* Saunders College, Philadelphia

Dowben RM, *Cell Biology*, Harper and Row Publ. London.

Hartl DL and Jones EW, *Genetics: Analysis of Genes and Genomes*, Jones & Bartlett Publishers, Boston.

Lodish H, Berk A, Lawrence S, *et al.*, *Molecular Cell Biology*, Freeman WH & Co. New York.

Watson JD, Beyker, Bell JD, *et al.*, *Molecular Biology of the Gene*, Pearson Education, Delhi

ZOC 105 : Laboratory Course 1

(Based on ZOC 101, 102, 103 and 104)

Contract Hours: 60 x3 hrs

Credits: 4

Module 1:

Study of taxonomic characters, identification and classification (up to Orders) of members of Protozoa, Porifera, Coelenterate, Helminths, Annelids, Arthropods, Molluscs and Echinodermates, Fishes, Amphibians, Reptiles, Birds, Mammals and minor phyla
Study of techniques of collection, preservation and mounting of insects.

Module 2:

Osteological preparation of chick and rat with emphasis on limb bones and girdles;
Appendicular and flight muscles of bird;
Afferent and efferent branchial system of fishes; Hepatic portal system of rat.
Nervous system of Crab, Pila/Loligo, Cranial nerves (V- VIIth and IX- Xth) of teleosts;
Nerves and blood vessels in the neck region of rat;
Reproductive system of cockroach and fish;
Mounting (Temporary) of Mouth parts of Mosquito, Salivary glands of cockroach, Statocyst of Prawn/Loligo, Ctenidium and Osphradium of Pila, Radula of Pila, Trachea and Spiracles of insect.

Module 3:

Isolation and quantification of bio-molecules (carbohydrate, fat, and protein) from given tissues;
Biochemical extraction of phosphatidylcholine, collagen and their purification;
Kinetic and characteristic of Enzyme :P^H optima, temperature optima, determination of K_m and V_{max} and enzyme inhibition;
Electrophoresis of serum protein (PAGE);
Thin Layer Chromatography of lipid.

Module 4:

Mitotic metaphase chromosomes of Swiss albino mice / rat
Study of various stages of meiosis (grasshopper testis)
Extraction/Isolation of genomic DNA from mammalian blood (man/mice/rat)
Restriction digestion of lambda DNA with EcoRI and Hind III restriction enzymes
Agarose Gel Electrophoretic analysis of DNA
Southern blotting
Isolation of cell organelles (Plasma Membrane, mitochondria and microsomes) by differential centrifugation / sub cellular fractionation and monitoring of purity.
Fluorescence In Situ Hybridization (FISH).

ZOC 201: Animal Genetics

Contract Hours: 60 Hrs

Credits: 4

Module 1:

Drosophila Genetics: Biology and life cycle of Drosophila; Drosophila as “Cinderella of genetics”; Chromosome constitution; Polytene chromosomes; puffs as regions of gene transcription; Lozenge in Drosophila.

Epigenetics and Epigenomes : Definition, brief history; Epigenetic patterns; Genomic imprinting; Histone Code; DNA Methylation (DM); Mutations and Epimutations; Cellular transformation; chromosome imprinting; Epigenetic defects and ageing.

Module 2:

Cancer Genetics: Introduction; Origin of Oncogenes; Identification of an Oncogene; Viral Oncogene; Transfection Assay for Oncogene; Activation of Proto- oncogenes; retroviruses contain Oncogenes; Proto- oncogenes; A model of Carcinogenesis; Evidences supporting Pall’s model; Tumor suppressor genes or Anti-oncogenes; Inherited Cancer genes (Familial Cancers); Cellular function of Oncoproteins.

Module 3:

Genomics and Proteomics: Introduction; assigning function to a Gene; tool to study Functional Genomics; Construction of cDNA libraries; methods of cDNA synthesis, cDNA cloning, Isolation, synthesis and sequencing of Genes; Potential Applications of Functional Genomics; Genome research; Proteomics Research; Significance of proteomics research; methods of proteome analysis. Gene transfer methods and transgenic organisms

Module 4:

Bioinformatics: Definition and brief history of bioinformatics; bioinformatics tool for genetic studies; bioinformatics institutes; Protein and Nucleic Acid database; Systems Approach in Biology; Problems addressed by bioinformatics; Sequence analysis; Genetic Algorithm; Expressed sequence tags; Phylogenetic analysis; Gene prediction; Proteomics; Industrial market for bioinformatics

Reference Books:

Alberts B, Johnson A, Lewis J, *et al.*, *Molecular Biology of the Cell*, Taylor & Francis Group, New York, USA.

David AC and Jenuwein T, *Epigenetics*, Cold Spring Harbor Laboratory Press, New York, USA.

Griffiths AJF, Gelbart WM, Lewontin RC and Miller JH, *Modern Genetic Analysis: Integrating Genes & Genomes*, WH Freeman & Co. New York.

Hartl DL and Jones EW, *Genetics: Analysis of Genes and Genomes*, Jones & Bartlett Publishers, Boston.

Lewin B, *Genes IX*, Oxford University Press, Oxford, New York.

Lodish H, Berk A, Lawrence S, *et al.*, *Molecular Cell Biology*, Freeman WH & Co. New York.

Primrose SB and Twyman RM, *Principle of Genome Analysis and Genomics*, Blackwell Publishing Co. Malden, USA.

Watson JD, Beyker, Bell JD, *et al.*, *Molecular Biology of the Gene*, Pearson Education, Delhi.

ZOC 202: Comparative Animal Physiology

Contract Hours: 60 Hrs

Credits: 4

Module 1:

Comparative physiology of digestion: Principle of digestion, Digestive juices – composition, phases of secretion, regulations and functions; Absorption of digestive nutrients; egestion of undigested food, role of gut micro flora in digestion. Movements of GI tract – control and functions and reflexes.

Respiratory pigments in different phylogenetic groups; Pulmonary circulation; Transport and exchanges of gases in aquatic and terrestrial organism; Ventilation – perfusion ratio; Acid-base balance; Regulation of pH; Neural and chemical regulation of respiration.

Module 2:

Physical principle of circulation; Pumping activity of heart; Action potential – Pace maker and Myocardiac; Electrical-mechanical relationship; Cardiac cycle – Volume, Pressure, Electrical Changes; Systems of circulation; Peripheral circulation; Regulation of heart beat, cardiac output and blood pressure,

Physiology of nitrogenous excretion; Role of gills in excretion; Role of kidney in excretion; Osmoregulation, Volume regulation; Role of Skin in excretion.

Module 3:

Adaptive physiology of muscle for various activities; neuronal control of muscle contraction, Physiology of electric organ.

Nervous tissue : neuron and glia; Regulation of sensory and motor pathways; neurotransmitters and their physiological functions; physiology of learning and memory; posture.

Module 4:

Sensing the environment: Photoreception, Thermo reception, Chemoreception, Mechanoreception; Endogenous and Exogenous biological rhythms; Bioluminescence and Chemoluminescence, Pheromones and other similar chemicals as means of communication among the animals.

Reference Books:

Kenney WL, Wilmore J and Costill D, *Physiology of Sport and Exercise*, Amazon, UK.

Moyces C and Schulte P, *Principles of Animal Physiology*, Pearson International Edition, USA.

Prosser CL, *Comparative Animal Physiology (vol 1 and 2)*, Willey Publication, Oxford.

Randall D, Burggren W and French K, *Eckert Animal Physiology*, WH Freeman and Co, New York.

Withers P, *Comparative Animal Physiology*, Saunders College Publications, Philadelphia.

ZOC 203: Developmental Biology

Contract Hours: 60 Hrs

Credits: 4

Module 1:

Recognition of sperm and egg during fertilization; Prevention of Polyspermy; Activation of egg metabolism; Regulation of Cleavage; Mechanism of cell cellular differentiation; Paracrine factors and signal transduction cascade.

Module 2:

Developmental dynamics of cell speciation; Establishment of fate map in Sea Urchin embryo and nematodes. Localisation of insect germ cell determinants in cytoplasm; Genetics of axes specification in insect.

Module 3:

Morphogenetic determination of tunicate embryo; Axes formation in fish embryos; Determination of amphibian axes; Axes formation in Avian embryos; Axes formation in mammalian embryo.

Module 4:

Induction and Competence, Regional Specificity of Induction(at the molecular level); Pattern formation in Vertebrate Limbs, Formation of Limb Bud; Generation of the Proximal – Distal, Anterior – Posterior, Dorso - Ventral axis of the Limb; Molecular mechanism of Limb Regeneration.

Reference books:

Carlson BM, *Pattern's Foundation of embryology*, Mc Graw Hill Inc.USA.

Gilbert SF, *Developmental Biology*, Sinauer Associates Inc., Sunderland, USA.

Moody SA, *Principles of Developmental Genetics*, Academic Press. New York.

Waddington CH, *Principles of Development and Differentiation*, The MacMillan Co. New York.

ZOC 204: Agricultural entomology

Contract Hours: 60 Hrs

Credits: 4

Module 1:

Role of insects in agriculture, insect population and crop losses, organs of support and movement in insects, segmentation and body regions, segmental appendages, musculature, ingestion and digestion of food, control and coordination, reproduction, development and growth in insects, insect-responses to the environment.

Module2:

Insect pests of cereals, sub tropical and tropical fruits, vegetables, fiber crops, oil seeds, plantation crops, spices, house hold pests, insects of veterinary importance.

Module 3:

Pests of stored products and their control: Introduction, types of produce and pests, types of damage, storage structures insect pest types, pest spectra for stored products, stored products pest control.

Module 4:

Principles of pest control, selection methods for pest control, cultural, mechanical, legislative, chemical control, pesticide residues and their monitoring, bio-ecological practices, Biological control, Microbial pesticides, Integrated pest management, Pesticide application equipments.

Reference Books:

Atwal A S, *Agricultural pests of South East Asia*, Kalyani Publishers, New Delhi.

Apple JL and Smith RF, *Integrated Pest Management*. Plenum Press, New York.

Evans JW, *Insect Pests and Their Control*. Sameer Book Centre, Delhi.

Hill DS, *Agricultural Insect Pests of the Tropics and Their Control*. Cambridge University Press, Cambridge.

Kumar A and Nigam M, *Economic and Applied Entomology*, Emkay Publications, New Delhi.

Mani MS, *General Entomology*, Oxford and IBH Publishing Co., New Delhi.

Nair MRGK, *Insects and Mites of Crops in India*. ICAR, New Delhi.

ZOC 205 : Laboratory course II
(Based on ZOC 201, 202, 203 and 204)

Contract Hours: 180hrs

Credits: 4

Module 1: Demonstration of Green and Red Fluorescence proteins for monitoring gene expression.

- Observation of DNA fragmentation in apoptotic cells
- Culture and maintenance of *Drosophila*
- Study of Life cycle of *Drosophila*
- Mutant Phenotypes of *Drosophila*
- Paper chromatographic separation of proteins (*Drosophila* eye pigments)
- Study of transcriptional activity in polytene chromosomes
- Induction of phenocopies in *Drosophila*
- Mounting of the eggs and sex combs of *Drosophila*

Module 2: Assessing physical and chemical modifier of heart rate in rat/mice.

- To study the effect of load on muscle contraction on man.
- Effect of ions and channel blocker on the transportation of ions across the membrane.
- Transport of glucose and amino acids across the intestine of rat.
- Study of human lung volume during exercise.
- To examine the relative activity of enzyme in different region of gut of fish.
- Electro physiology of membrane excitable cells of bivalve.

Module 3: Identification of developmental stages of chick embryo/ amphibian embryo

- Chick embryo culture, in vitro.
- Changes in biochemical profiles of developing chick embryo.
- Effect of thyroxin in developing chick embryo.
- Organogenesis, preparation of slides and studies of 96 hrs. chick embryo.
- Effect of retinoic acid and essential amino acids in the development of chick embryo.
- Effect of colchicines in the somite proliferation in chick embryo.

Module 4:

- Collection, preservation and identification of agriculturally important insects
- Study of insect body parts (antennae, wings, appendages etc.,)
- Study of insect pests of Paddy
- Study of insect pests of cereals
- Study of insect pests of sugarcane/ coconut
- Detection of insect pest infestation in agriculture
- Appliances of insect pest control
- Study of pests of household
- Study of insect pests of storage
- Study of pests of Live stock

ZOO 301: Environmental Physiology

Contract Hours: 45 + 45 hrs

Credits: 3(Theory) + 1 (Practical)

Module 1:

Nature and levels of adaptation; Mechanism of adaptation; Cellular metabolism, regulation and homeostasis; physiological regulation of gene expression. Biochemical and physiological effects of temperature; regulation of heat gain and heat loss, Role of nervous system and endocrine system in thermal biology; homeoviscous adaptation.

Module 2:

Regulation and movements of water and solute; Osmoregulatory organs and their excretory products; cost and energy of regulation of water and ions; Atmosphere, Solubility of gases in water and air; Respiration in water and air; Hypoxia and anoxia; problems of diving, high altitude adaptation.

Module 3:

Strategies and mechanism in physiological adaptation with reference to marine, estuarine, freshwater, terrestrial, cold, dessert & parasitic life.

Module 4 (Practical):

Effect of low temperature in the rates of nitrogenous excretion and respiration of aquatic animals; Determination of Q₁₀; Pattern of thermal acclimation; Effect of temperature on the kinetics of Acetylcholine esterase; Effect of salinity in the transportation of Na⁺/K⁺ ions; Role of transporter proteins in salinity adaptation.

Reference Books:

Hochachka PW and Somero GN, *Biochemical Adaptation*, Oxford University Press, Oxford.

Nielsen S, *Animal Physiology: Adaptation and Environment*, Cambridge University Press, Cambridge.

Wilimer P, Stone G and Johnston IA, *Environmental Physiology. of Animals*, Wiley Blackwell Publishing Co, USA.

ZOO 302: Animal Tissue Culture

Contract Hours: 45 + 45 hrs

Credits: 3(Theory) + 1 (Practical)

MODULE1:

Introduction, Advantages and disadvantages of tissue culture, Definitions. Equipments and materials for animal cell culture technology. Various systems of tissue culture, their distinguishing features, advantages and limitations. Culture medium: natural media, synthetic media, sera. Introduction to balanced salt solutions and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, role of carbon di oxide, serum and supplements.

MODULE 2:

Primary Culture: Behavior of cells, properties, utility. Explant culture; suspension culture. Established cell line cultures: Definition of cell lines, maintenance and management; cell adaptation. Measurement of viability and cyto-toxicity. Cell cloning, cell synchronization and cell manipulation. Various methods of separation of cell types, advantages and limitations; flow cytometry.

MODULE 3:

Scaling up of animal cell culture. Cell transformation. Stem cell cultures, embryonic stem cells and their applications. Somatic cell genetics. Apoptosis: Measurement of cell death, role of cytochrome Commercial applications of cell culture: Tissue culture as a screening system; cyto-toxicity and diagnostic tests.

Module 4: (Practical):

Epithelial cell culture of mantle and gills of bivalve.
Culture of hepatopancreatic cells of crab.
Neuronal culture using chick embryo.
Fibroblast cell culture using chick embryo.
Organ culture from chick embryo- kidney, muscle.
Culture of bone marrow cells of rat/mice.
Stem cell culture from bone marrow of rat/mouse.

Reference Books:

Boulton A, Glenbaker, Wolfgang W, *Practical Cell Culture Techniques*. Human Press. Iowa. New Jersey.
Conn PM, *Cell Culture*. Academic Press. Sandeigo. USA
Freshney RI. *Culture of Animal Cells*, Wiley Liss New York.
Freshney RI, Pragnell IB and Freshney MG, *Culture of Epithelial Cells*, Wiley Liss, New York
Shahar A, De Vellis J, Vernadakis A and Haber BA(1990), *Dissection and Tissue Culture Manual of Nervous system*. Allan Liss. New York.

ZOO 303: Fishery Biology

Contract Hours: 45 + 45 hrs

Credits: 3(Theory) + 1 (Practical)

Module 1:

INLAND CAPTURE FISHERIES: Fishing gear- Hook and line, Long line; Cast net, Scoop net, Gill net, Trawl net, Rampan net, Purse seine Fishing craft: Catamaran, Dingy, Dugout canoe, Outrigger canoe, Mechanized boat. Sole fish fishery: Mackerel fishery and Sardine fishery ; Shell fish fishery: Mussels, Oysters and Clams ;North Indian plains with those of Southern peninsula; Dams, Impoundment and their impact on the riverine fishery.

Module 2:

CULTURE FISHERIES: Freshwater Fish Culture: Aquatic weeds and their control; Aquatic pests in the fish farm and their control; Site selection for a fish farm; Types of ponds in a self sustainable fish farm; Bunds, inlets, outlets and monks; Management of fish farm ponds: manuring, liming, stocking, supplementary feeding and harvesting; Composite culture systems of India, China, Israel and Europe. Culture systems- Monoculture, Monosex culture, Cage culture, Pen culture, Integrated culture.

Module 3:

MARINE FISHERIES: Shrimp aquaculture: types of culture practices, critical requirements, site selection and pond preparation, selection of species, hatchery production and management, nutrition, live feed culture and formulated feed preparation, water quality management in hatchery. Preservation and fish processing, transporting and marketing of fishes, by-product of fish industry, Export of fishery products. Impact of aquatic pollution on fishes

Module 4 (Practical):

Morphometry including fin formulae of fin fishes.

Identification of commercially important fin and shell fishes from the west coast region.

Identification of fin fishes belonging to 10 different families up to species level by using identification keys.

Working out of the growth curve of fish by length-weight ratio by using suitable fish.

Working out the GSI in a suitable fin fish species.

Analysis of gut content and feeding habits of fishes.

References Books:

Bal D , *Marine Fisheries of India*, Tata McGraw Hill Publ., India.

DuttaMunshi, J, *Fundamentals of Freshwater Biology*, Narendra Publishing House, Delhi.

DuttaMunshi J and Srivastava MP, *Natural History of Fishes and Systematics of Freshwater Fishes of India*, Narendra Publishing House, Delhi.

Jayram K, *The Freshwater Fishes of India, Pakistan, Bangladesh, Burma and Sri Lanka, A Hand*

book. Zoological Survey of India, Kolkata.
Jingran VG, *Fish and fisheries of India*, Hindustan Publishing Corporation, New Delhi.
Kurian, C and Sebastain VO, *Prawn and Prawn Fisheries of India*, Hindustan Publishing Corp.
Delhi.
Merett NR and Haedrich RL. *Deep Sea Demersal Fish and Fisheries*, Chapman and Hall, New York.

ZOO 304: Parasitology

Contract Hours: 45 + 45 hrs

Credits: 3(Theory) + 1 (Practical)

Module 1:

Introduction to Parasitology: Host Parasitic interactions in health and diseases, Signs and symptoms of parasitic diseases, Intestinal & Urogenital Protozoa (Parasitic Protozoa: General characters & classification of Flagellates (*Giardia intestinalis*, *Trichomonas vaginalis*) Ciliates (*Balantidium coli*, *Isospora belli*, *Cryptosporidium parvum*), Hemosomatic Protozoa (Free living Amoeba phase, Trypanosomes' monomorphic / Polymorphic, *Leishmania*, *Plasmodium*, *Toxoplasma gondii*).

Module 2:

Trematodes: General Characters, systematics and pathogenicity of Liverfluke (*Fasciola hepatica*), Intestinal Fluke (*Fasciolopsis buski*), Lung flukes (*Paragonimus westermani*), Blood flukes (Schistosomes), Cestodes (General characters and classifications. Intestinal Tape worms (*Taenia solium*, *Dipylidium caninum*), Extra- Intestinal Larval Cestodes (*Diphyllobothrium spp.* *Echinococcus spp.*).

Module 3:

Nematodes: General Characters & Classifications, Intestinal Nematodes (*Ascaris lumbricoids*, *Trichinella spiralis*, Hook worms), Blood and tissue nematodes (*Wuchereria bancrofti*, *Dracunculus medinensis*), Parasites of insect origin (Flies & bugs, Fleas and lice) Arachnids (ticks and mites), Crustaceans (Cyclops).

Module 4 (Practical):

Study of life cycle stages of Urogenital protozoa, Ameoba spp.
Study of life cycle of Balantidium / Trypanosoma
Study of life cycle of Leishmania / Malarial parasite
Study of liver fluke/ intestinal fluke / lung fluke
Study of Blood fluke/ tape worm/ Diphyllbothrium / Echinococcus

Study of Intestinal nematodes (eg: Ascaris / Trichinella / Hook worm)
Study of blood tissue nematodes (Eg: Filariasis / Medina worm)
Study of parasites of insect origin (Flea / bug / lice)
Study of arachnid parasites (Ticks / mites)
Study of crustacean parasites (Cyclops)

Reference Books:

Alan H Linton, *Microbes, Man and Animals*. John Wiley & Sons, New York.
Burton J. Bogitsh, *Human Parasitology*, Academic press. New York.
Leslie Collier, Albert Balows and Max Sussman , *Topley and Wilson's Microbiology and microbial infections: Vol 5: Parasitology*, Arnolds publ. New York,
Rathnaswamy GK, *A Hand book of Medical Entomology and Elementary Parasitology*, S.Vishwanath Pvt.Ltd., India
Shukla AN and Tyagi R, *Protozoan Diseases*, Anmolo publication, New Delhi.

ZOO-305: Biodiversity

Contract Hours: 45 Hrs

Credits: 3

Module 1:

Concepts and components of biodiversity, genetic, species and ecosystem diversity;
Biodiversity as an important resource, human population growth and its implications on biodiversity, biodiversity indices, value of biodiversity.

Module 2:

Conservation of biodiversity, in-situ and ex-situ conservation. Wildlife reserves in India, Earth summit and follow up action, Convention on biodiversity.

Module 3:

Biodiversity hotspots in the world, national and global red data lists, categories of species and their management, biodiversity prospecting, IPR of biodiversity and its products, patent protection and biopiracy.

Bioprospecting and conservation, importance of biodiversity. biodiversity informatics, databases in biological materials. International efforts and issues of sustainability

Reference Books:

Belsare DK (2007), *Introduction to Biodiversity*, A. P. H. Publishing Corp. New Delhi
Groombridge B (2002), *Global Biodiversity: Status of Earth's Living Resources*. Chapman and Hall Publ. London
Huston AM (1994), *Biological Diversity*, Cambridge University Press, Cambridge
Wilson, E O (1998), *Biodiversity*, National Academy Press, New York

ZOO-306: Avian Biology

Contract Hours: 45 Hrs

Credits: 3

Module 1:

Bird identification, Systematics and Census: Avian systematics, Principal orders and families of Class Aves with salient features; Morphology and morphometry; Methods of identification; Bird diversity, Bird identification on field; Field guides. Bird Census: Counting techniques; Sampling techniques, Sampling bias, Estimation of breeding population, mapping..

Module 2:

Bird fossils- Archosaurs, Archeopteryx and Archiornis; Adaptation for flight in birds, types of flight, identification of birds based on flight patterns, flight metabolism, avian energy balance and thermoregulation. Habitat/niche based adaptations in birds: woodland, grassland, wetland, desert, polar region. Birds as monitors of environmental change. Environmental impact assessment and conservation

Module 3:

Avian Ecology, Field Biology and Avian conservation: Habitats: Niche preferences; Niche adaptations, foraging behaviour: Feeding territory, resource partitioning. Colonial behaviour: Cooperation, Competition and conflicts. Bird migration and Navigation: Types of migration, Migratory routes, Bird banding. Breeding Biology: Nesting territories, Communal nesting, Bird songs, courtship, mating systems; Type of nests ; Nest building; Nest defense, Clutch size; Brood parasitism, Incubation and parental care. Extinct and endangered species, causes of extinction and endangered status. Habitat management and other strategies for conservation of endangered species. Conservation of wetland birds.

Reference Books:

Ali S, *The Book of Indian Birds*. Bombay Natural History Society and Oxford University Press, India.

Bibby CJ, Burgess ND, Hill A *et al.*, *Bird Census Techniques*. Academic Press, UK.

Faborg J and Chaplin SB, *Ornithology: an Ecological Approach*. Prentice Hall Inc. New Jersey.

Goodfellow P, *Birds as Builders*. Arco Publishing Co., New York.

Giles RH, *Wildlife management Techniques*, Wildlife Society, Washington.

ZOO 307 : Wildlife Biology

Contract Hours: 30 Hrs

Credits: 2

Module1:

Habitat diversity of Indian wildlife and faunal zonation; Endemic species
Important Indian fauna and their distribution: Asiatic Lion, Indian Tiger, Indian one horned Rhinoceros, Indian Elephant, Golden Langur, Lion-tailed Macaque, Red Panda, Brow Antler Deer, Indian Wild Buffalo, Crocodile, Great Indian Bustard, Dolphin

Module 2:

Capturing and marking techniques – entrapping, darting, tagging and banding
Conservation and management: In-situ conservation and Ex-situ conservation; Regional, National and global Conservation efforts and legal aspects: National and international conventions – CITES, TRAFFIC; Forest laws and wildlife laws in wildlife conservation; Rio Protocol, Rio 20+ , Project Tiger, Project Elephant, Gir Lion Project, Crocodile Breeding Projects, Project Hangul(1972).

Reference Books:

- Dasmann RF, *Wildlife Biology*, Wiley Publication, New York.
Krishnan M, *India's Wildlife*, Bombay Natural History Society, India.
Nair SM, *Endangered animals of India*, National Book Trust, India.
Noen AN, *Wildlife Ecology: An Analytical Approach*, WM Freeman and Co, New York.
Shah JH , *Introduction to Wildlife Management*, McGraw Hill, New York.
Usher MB, *Wildlife Conservation and Evaluation* Chapman and Hall, London.

ZOO 308: Immunology
(Interdisciplinary course)

Contract Hours: 30 Hrs

Credits: 2

Module 1:

Immunity and immunology, History of immunology, Immunity inflammation, phagocytosis, Kinds of immunity, natural resistance, acquired immunity, grades and measurement of immunity, mechanism of natural immunity. Antibodies: specificity, one antibody many manifestations, specificity, Structure and function of globulin, formation of antibodies

Module 2:

Antigen: antigenicity, competition, specificity, natural proteins, bovine antigen and heptanes. Antigen-antibody interaction, combination, neutralization, fixation, precipitation, complementary activity, agglutination

Reference Books:

Abbas AK, Litchman AHH and Pillai S, *Cellular and Molecular Immunology*, W. B. Saunders Co., Philadelphia.

Berrette JT, *Textbook of Immunology*, C. V. Mosby & Co., USA.

Boyd C, *Fundamentals of Immunology*, Inter Science Publ. NY.

Carpenter PL, *Immunology and Serology*, W. B. Saunders Corp. Philadelphia.

Latha PM, *Text Book of Immunology*, Tata McGraw Hill Publ. New Delhi.

ZOO 309: Animal Behaviour
(Interdisciplinary course)

Contract Hours: 30 Hrs

Credits: 2

Module 1:

Evolution of behavior: natural selection and behavior, Behavior genetics: single gene and behavior, polygenic inheritance behavior, Heritability of behavior, colony and behavior, adaptational behavior, social behavior: sexual selection, altruism, social organization.

Module 2:

Mechanism of behavior: Natural control of behaviors, sensory process and perception, Homeostasis and behavior, behavior in changing environment. Animal learning and decision making, mentality of animals: language and mental representation, Intelligence, tool using, animal awareness and Emotion

Reference Books:

Bonner JT, *Evolution of Culture in Animals*, Princeton Univ Press. New Jersey
Ehrman L and Parsons PA, *The Genetics of Behavior*, Sinauer Associates, Massachusetts.
Halliday T, *Sexual Strategies*, Oxford University Press, Oxford.
Lythgoe, JN, *The Ecology of Vision*, Clarendon press, Oxford
McFarland D, *Animal Behavior*, ELBS Longman Publ. London

ZOO 310: Radiation Biology
(Interdisciplinary course)

Contract Hours: 30 Hrs

Credits: 2

Module 1:

Introduction: Definition, scope and significance of radiation biology; General classification of radiation. Ionizing radiation: Linear energy transfer; radiation dose and units; principles of radiation dosimetry; direct and indirect effects. Molecular radiobiology: Radiation lesions in DNA; major types of DNA repair; damage recognition and signaling; consequence of unrepaired DNA damage (chromosome damage). Cellular radiobiology: Radiobiological definitions of cell death; survival curves and models; cell cycle effects; relative biological effectiveness (RBE); cellular repair exemplified in survival curves; cellular hyper-radiosensitivity (HRS) and induced repair (IRR); Other molecular targets – bystander (epigenetic) effects; radiation sensitizers and protectors

Module 2:

Radiobiological basis of radiation protection: Health consequences after total body irradiation from radiation accidents; long term radiation risks from low radiation doses; radiation-induced cancer in the atomic bomb survivors; epidemiological studies in other radiation exposed populations; mechanisms of radiation induced cancer; radiation effects in the developing embryo and fetus; radiation induced heritable diseases

Reference Books:

Anonymous, *Radiation Biology: A handbook for teachers and students*; International Atomic Energy Agency (IAEA), Training Course Series 42, Vienna.
Albert P Li and Heflich RH, *Genetic toxicology*, CRC Press, USA.
Steel GG, *Basic Clinical Radiobiology*, Amazon, UK.

ZOO 401: Toxicology

Contract Hours: 45 + 45 hrs

Credits: 3(Theory) + 1 (Practical)

Module 1:

Introduction to toxicology, Branches of toxicology, Dosage and time response relationships. Biotic and abiotic aspects effecting toxicity. Means of exposures (acute, chronic, Impact of toxicants on organism (Direct / indirect, long term etc.) Toxic risk assessment.

Module 2:

Biotoxins: Phyto, Zoo and microbial toxins, metabolism of toxic substances by plants / animals/ microbes. Effect of toxicants at various levels such as sub cellular, cellular, individual, population, ecosystem, biosphere etc. Biomagnification of toxicants, Interaction of toxins with other substances such as vitamins, minerals. Food additives as toxicants.

Module 3:

Genotoxicity: Introduction to genotoxicity, Neurotoxicity Vs Genotoxicity / hepatotoxicity, Mechanisms, test techniques like bacterial reverse mutation assay, *in vitro* toxicology testing, *In vivo* toxicology testing, comet assay, Genotoxic Chemotherapy, Risk and different treatment like alkylating agents, intercalating agents, enzyme inhibitors.

Module 4 (Practical):

Determination of LC50 of a pesticide in Bivalves.

Acute and chronic toxicity of a pesticide on the acetyl-cholinesterase activity in bivalves

Acute and chronic toxicity of heavy metals on the ion transport through gill of fish.

Genotoxic effect of cyclophosphamide on the mitotic chromosomes of Swiss albino mice.

Single cell gel electrophoresis studies of blood cells of Swiss albino mice treated with cyclophosphamide

Reference:

Butler JC, *Principle of Toxicology*, John Wiley & Sons, NY

Duffers JH, *Environmental Toxicology*, Edwards Arnold Publ. London

De Anil Kumar, *Environmental Chemistry*, Wiley Eastern Ltd., New Delhi
Hays JW and RR Laws, *Handbook of Pesticide Toxicology (vol. I)*, Academic Press, NY
Li A and Heflich RH, *Genetic Toxicology*, CRC Press, USA.

ZOO 402: Human Genetics

Contract Hours: 45 + 45 hrs

Credits: 3(Theory) + 1 (Practical)

Module 1:

Introduction: Basic principles of genetics, growth of human genetics, human genetic make-up, genes as submicroscopic factors controlling human traits, packing of DNA/chromatin into chromosomes, nucleosomes and histones.
Human chromosome structure, chromosomal heteromorphism (X & Y chromosomes), Sex determination in man, Sex chromatin, Lyon hypothesis
Human karyotype, developments since 1956, banding techniques, chromosome identification and nomenclature (ISCN)

Module 2:

An overview of Principles of inheritance in man (autosomal / sex linked / dominant / recessive); human pedigree analysis
Human genetic disorders, chromosomal (structural and numerical; autosomal or X linked) and biochemical (inborn errors of metabolism) with examples
Eugenics and genetic counseling

Module 3:

Prenatal diagnosis of genetic disorders, cytogenetic, biochemical and ultrasonography techniques, amniocentesis, chorionic villus sampling, cordocentesis
Biochemical markers for prenatal diagnosis, triple test for Down's syndrome
Dermatoglyphics and its application in the diagnosis of human genetic disorders
Principles of FISH, RFLP & DNA finger printing and their uses in human genetics

Module 4 (Practicals) :

Sterilization techniques for leukocyte culture
Inoculation and Culture of human leucocytes
Preparation of metaphase plates and their staining and analysis
G- banding of metaphase plates and their analysis
Human karyotyping
Barr Body analysis using fluorescent probes.
Micrometric analysis of chromosomes.
Camera-lucida drawing of chromosomes.
Dermatoglyphics
Working out of Genetic problems

Reference Books:

Cummings ML, *Human Genetics*, CENGAGE Learning, Stamford

Kothari ML, Mehta LA and Roychoudhury SS, *Essentials of Human Genetics*, Oxford University Press, India.

Hoelzel AR, *Molecular Genetic Analysis of Populations*, Oxford University Press, India.

Gersen SL and Keagle MB, *The Principles of Clinical Cytogenetics*, Humana Press, Totowa, New Jersey

Turnpenny P and Ellard S, *Emery's Elements of Medical Genetics*, Elsevier, UK

ZOO 403: Marine Zoology

Contract Hours: 45 + 45 hrs

Credits: 3(Theory) + 1 (Practical)

Module 1:

Types of Marine habitats & their characteristics, Chemical Environmental factors: O₂, CO₂, CO₃, H₂S, pH, anions/salts, organic matters, Natural association of organisms, Nutritional relationship, Sea Floor, sediments on the sea floor, Ecological subdivisions of marine environment

Module 2:

Marine Zones-Littoral, Pelagic & Benthic, Floral, and Faunal distribution and limiting factors, Benthic Zone - flora and fauna, Pelagic Zone - flora and fauna

Module 3:

Marine resources, Marine pollution, Origin of estuaries, Classification of estuaries, Bio-fouling & Bio-deterioration-Fouling organisms, Boring organisms: rock borers, coral reef borers Wood borers, lamellibranchs: Structural adaptations, Antifouling agents.

Module 4 (Practicals):

Study of physical parameters of sea water/ estuarine water

Analysis of chemical factors- O₂, CO₂, carbonates, nitrates, sulphates, phosphates, salinity

Assay of marine diversity- floral and faunal studies in the field.

Study of ecological adaptations of intertidal organisms

Collection of marine planktons and their identification.

Study of bio fouling in marine habitat through field experiments

Study of primary production

Reference Books:

- Carol Lalli, and Timothy Parsons (2002), *Biological Oceanography*, Butterworth-Heinemann Publ.,UK
- Karleskint G, Turner R, and Small J (2002), *Introduction to Marine Biology*, Brooks Cole Publ.,USA
- Nair NB and DM Thampy (1990), *A Text Book of Marine Ecology*, Macmillan Company India Ltd., India.
- Southward, Young & Fuiman (2000), *Advances in Marine Biology*, Elsevier, UK.
- Sumich JL and Marissey JF (2002), *Introduction to Biology of Marine Life*, Jones & Bartlett Publ., USA

ZOO 404: Biology of Reproduction

Contract Hours: 45 + 45 hrs

Credits: 3(Theory) + 1 (Practical)

Module 1:

Male Reproduction: Histo-architecture of testis, Spermatogonia, Stem cells; Biology of spermatozoa ,Seminiferous epithelial cycle, Lablond and Clermont Concept of wave and cycle; Spermatogenesis, Hormonal control of spermatogenesis, hormonal regulations of accessory male reproductive organs- epididymis , Vas deferens ,prostate glands seminal vesicle , coagulating gland cowper's gland; Biochemistry of semen, semen analysis and its utility in medico legal cases .

Module 2:

Female Reproduction: Reproductive cycles in mammals and their regulations; Ovulation; Implantation , types of implantation , sequence of events during implantation , decidual cell reaction , delayed implantation hormonal regulation; Pregnancy; Corpus Luteum, luteotrophic complex in different mammals; Endocrine control of pregnancy; Parturition; Activation and stimulus of uterus, hormonal mediation; Lactation, morphological and functional development of mammary glands, preparation for lactation, effect of hormones, initiation and maintenance of lactation, milk secretion; Menopause.

Module 3:

Reproductive Technologies: Amniocentesis, Male and female sterility and treatment; ART-Ovulation induction; In Vitro fertilization , Gamete Intrafallopian Transfer and other modifications, Surrogate pregnancy-gestational carrier, Fertility control in male and female-natural methods, Intra Uterine Devices, Oral contraceptives.

Module4: (Practical)

Dissection of male and female urinogenital systems in fishes, poultry bird and albino rat for comparative analysis.

Preliminary appraisal as to the live animal care and maintenance with respect to laboratory animal the albino rat.

Determination of durations of phases and length of estrous cycle in albino rat by vaginal lavage method.

Training in Surgical procedures to carry out bilateral Orchidectomy and Ovariectomy

Hormonal assay of LH/FSH/ Progesterone / Prolactin.

References:

Knobil E and Neil JD, *Physiology of Reproduction (Vol. I and II)*, Raven Press Ltd., New York.

Mandal A, *A Handbook of Neuroendocrinology*, Emkay Publication, New Delhi

Nelson RJ, *An Introduction to Behavioral Endocrinology*, Sinauer Associates, Inc., USA

Pablo De, Scanes CG and Weintraub BD, *Handbook of Endocrine Research Techniques*, Academic Press Inc., USA

Saidapur SK, *Reproductive Cycles of Indian Vertebrates*, Allied Publishers Ltd. New Delhi.

Schatten H and Constantinescu GM, *Comparative Reproductive Biology*, Willey Blackwell Publications, UK

ZOO 405 Biochemical techniques

NO. OF CREDITS: 2

CONTACT HOURS: 30

Module 1:

Radiant energy: nature and properties of electromagnetic radiation; interaction of radiant energy with matter, Mono chromators; sources of radiant energy, spectrophotometry, x-ray diffraction

Radioactive transformation: isotopes; radioactivity detection and quantification; Geiger – Muller Detectors; liquid scintillation detectors; Autoradiography.

Ultra Centrifugation: Centrifuge component; Theory of Centrifugation, Types of rotor, Density gradient Centrifugation; Isopycnic Centrifugation; Measurement of Centrifugal force.

Module 2:

Electrokinetic Phenomena: concepts of Electrophoresis and Electro-osmosis; Basis of electrophoretic separation; chemistry of Acrylamide Polymerization; Isoelectric focusing; SDS – PAGE electrophoresis, Recovery of materials from Electrophoretic gels.

Chromatography: Adsorption Chromatography, Partition Chromatography, Affinity Chromatography; Exclusion Chromatography, Gas Chromatography, Liquid Chromatography, HPLC.

References:

Cooper TG (1977), *The Tools of Biochemistry*, John Wiley publication, India

Dryer R and G. Lata G (1989), *Experimental Biochemistry*, Oxford University Press, Oxford

Ewing GW (2006), *Instrumental Methods for Chemical Analysis*, Mc Graw Hill Book Co., London

Freifelder D (1982), *Physical Biochemistry*, W. H. Freeman & Co., New York.

Holme D and Peck H (1998), *Analytical Biochemistry*, Longman Scientific & Technical Publication, England

ZOO 406: Application of Animal Biotechnology

NO. OF CREDITS: 2

CONTACT HOURS: 30

Module 1:

Biotechnology in improvement of live stock: Fish breeding; Androgenesis and Gynogenesis in fish ; Gene manipulation in aquaculture.

Reproductive biotechnology: Cryopreservation and Cryoprotection and gamete banking Assisted reproductive technology, In vitro fertilization and embryo transfer, ICSI, Sperm sexing.

Medical Biotechnology: Disease diagnostic markers; Drug delivery and targeting; Forensic Biotechnology

Module 2:

Animal Production technology and Food security: Polyculture of fish for high yield; 5.2 Edible oyster and Pearl oyster production; Vermiculture and Vermi composting for alternative sustainable agriculture; Soil fauna in soil formation and fertility; Organic farming; Fish culture in flow through system and recirculation technology. Environmental Bio-technology: Bioprocess technology; Bioassay and Biosensors in ecotoxicological screening; Biomarkers in ecotoxicological screening

References:**ZOO 407: Molecular Endocrinology**

(Interdisciplinary course)

NO. OF CREDITS: 2

CONTACT HOURS: 30

Module 1:

Classification of hormones; Nature of hormone receptors; Neuroendocrine feedback and response to varied stimuli; Hypothalamic hormones - their structure and functions; Structure and functions of the GI tract hormones; Nature of hormone action; Hormone receptors—identification, quantization, purification and physico-chemical properties; Membrane receptors – structure and signal transduction mechanisms.

Module 2:

Hormonal regulation through differential gene expression; Production of hormones by DNA technologies; Biosynthesis, characteristics, functions and molecular biology of hormones of pineal gland, thyroid gland, adrenal gland; Genetic analysis and clinical management of hormonal disorders.

References:

Bolander FF, *Molecular Endocrinology*, Elsevier, UK
Hadley ME and Levine JE, *Endocrinology*, Adeson-Wesley publication, USA
Melmed S, Polonsky KS, Reed P *et al.*, *William's text book of Endocrinology*, Willey Blackwell Publication, UK

ZOO 408: Nutritional Biochemistry (Interdisciplinary course)

NO. OF CREDITS: 2

CONTACT HOURS: 30

MODULE 1:

Basic concepts of energy and energy expenditure. basal metabolic rate dietary requirements of carbohydrates, proteins and lipids- natural source of carbohydrates, protein and lipids; importance of dietary fibers; protein requirement at different stages of development; PUFA & lipid per-oxidation.

MODULE 2:

Electrolyte concentrations of body fluids; concept of acidosis and alkalosis Nutritional significance of Minerals, Biochemical functions of vitamin and specific deficiency diseases Nutritional requirements during pregnancy and lactation.

Reference:

Brody T, *Nutritional Biochemistry*, Academic Press, New York
Chattejea MN and Shindea R, *Text Book of Medical Biochemistry*, Jaypee Pub. India
Elia M, Ljungqvist O, Stratton R and Lanham SA, *Clinical Nutrition*, Willey Blackwell Publication, UK
Swaminathan MS, *Nutritional Biochemistry*, T R Publication, India

ZOO 409: Evolutionary Biology (Interdisciplinary course)

NO. OF CREDITS: 2

CONTACT HOURS: 30

Module 1:

Evolutionary theories and evidences: Contributions of Lamarckism, Darwin-Wallace postulates, Overview of evidences- -Paleontological, Embryological, - Comparative morphological, Anatomical, Genetics and Cytological, Molecular Biological evidences, limitations of Darwinism, Neo Darwinism.
Evolutionary forces that affect the allelic frequencies: Mutation, Migration, Selection - Stabilizing selection, Directional selection, disruptive selection,

Balancing selection, Frequency dependent selection, Density dependent selection, Group and kin selection, Selection coefficient, Selective value, Selection in natural Populations, Genetic drift, Nonrandom mating.

Module 2:

Concept of species and models of speciation based on distribution-sympatric, allopatric, stasipatric, based on genetic drift-genetic revolution, genetic transience, Founder-flush theory, hybridization and speciation, phylogenetic gradualism, punctuated equilibrium, chromosomal phylogeny, molecular phylogeny, neutral theory, molecular clock, isolating mechanisms, Creation and evolution models.

Reference:

Andrew Ferguson, *Biochemical Systematics and Evolution*, Blackie Publ., London
Douglas J Futuyma, *Evolutionary Biology (3rd Edition)*, Sinauer Associates, New York.
Douglas J Futuyma, *Evolution*, Sinauer Associates, New York
Mark Ridley, *Evolution (3rd edition)*, Blackwell Publishers, New York
Michael R Rose and Laurence D Mueller, *Evolution and Ecology of the Organism*,
Prentice Hall, New York

**ZOO 410 Medical entomology
(Interdisciplinary course)**

NO. OF CREDITS: 2

CONTACT HOURS: 30

Module1:

Insect as disease vectors; Innate behavior of insects; taxonomy , morphology of disease vectors and their life cycles; Life cycles of major vector borne diseases; Factor in disease transmission.

Module 2:

Vector ecology; Vector behavior; modern vector biology; Proteogeomics of vectors; Chemical and biological and environmental control of vectors; Integrated vector management.

Reference Books:

Bruce ED, Eldridge F and Edman JD, *Medical Entomology*, Kluwer Academic Publishers, UK.
Kahn HA, *Introduction of Epidemiology Methods*, Oxford University Press, New York.
Snodgrass RE , *Principles of Insect Morphology* Tata Mcgraw Hill publishing co. India

ZOO 411: Field work

Contract Hours: 90 Hrs*

Credits: 2

1. Estimation of Biodiversity on a beach following transect and quadrat method.
2. Study of Avian diversity in agricultural area/undisturbed area/monoculture area.
3. Study of insect diversity on a plateau/agricultural field/undisturbed area/wild.
4. Study of wildlife and birds in a National park/Sanctuary/Zoo/Western Ghats.
5. Study of Ichthyofauna in local market/along the coastal zone.
6. Study of Molluscan diversity along the coast.
7. Study of Crustacean diversity in estuarine ecosystem.
8. Study of Nematode diversity in Agricultural Field/Mangroves/Coconut plantation.
9. Visit to various National Research Institutes of Zoological importance /Animal Breeding Centers/Fishery Research Institute/.

*** 60 hours in Goa and 30 hours outside Goa and to be completed during 1st to IVth semester.**

Out of 9 Field Work mentioned above, any 5 have to be compulsorily undertaken. Every student will be evaluated based on attendance, performances in the field, field note book entries and consolidated field report followed by Viva – voce by Departmental Council.

ZOO 412: Dissertation

Credits: 12