List of Courses for B.Sc. Zoology Honours Program (CBCS)

	Course Name	Credits	
		Theory	Practical
A. Discipline Specific Core Courses (DSC)- Code: ZOC; (6 Credits each)			
1	**Semester I** ZOC 101 Diversity of Non-Chordates & Cell Biology	**4**	**2**
2	**Semester II** ZOC 102 Diversity of Chordates & Genetics	**4**	**2**
3	**Semester III** ZOC 103 Anatomy of animal body system	**4**	**2**
4	**Semester IV** ZOC 104 Animal Physiology and Biochemistry	**4**	**2**
5	**Semester V:**		
	ZOC 105 Endocrinology	**4**	**2**
	ZOC 106 Biochemistry and metabolic processes	**4**	**2**
	ZOC 107 Molecular biology & Evolution	**4**	**2**
6	**Semester VI:**		
	ZOC 108 Developmental Biology	**4**	**2**
	ZOC 109 Environmental Biology & Toxicology	**4**	**2**
	ZOC 110 Parasitology	**4**	**2**
B. Discipline Specific Elective (DSE); Code: ZOD (4 Credits each)			
7	**Semester V**		
	ZOD 102 Applied Zoology	**3**	**1**
	ZOD 103 Fish and Fisheries	**3**	**1**
8	**Semester VI**		
	ZOD 104 Animal biotechnology	**3**	**1**
	ZOP- 101 Project	**4**	
C. Generic Elective (GE); Code: ZOG (4 Credit each)			
9	**Semester I** ZOG 101 Food, Nutrition and Health	**4**	-
10	**Semester II** ZOG 102 Animal Behavior	**4**	-
D. Skill Enhancement Course (SEC); Code: CHS(4 Credits each)			
11	**Semester III** ZOS 101 Aquarium fish keeping	**3**	**1**
12	**Semester IV**		
	ZOS 102 Wild life and Eco tourism	**3**	**1**

Year	Semester	Discipline Specific Core DSC (ZOC)	Discipline Specific Elective DSE (ZOD)	Generic Elective GE (ZOG)	Skill Enhancement Course SEC (ZOS)
Credits		**6 Credits each**	**4 Credits each**	**4 credits each**	**4 Credits each**
First Year	I	ZOC 101 Diversity of Non - Chordates & Cell Biology		ZOG 101 Food, Nutrition and Health	
	II	ZOC 102 Diversity of Chordates & Genetics		ZOG 102 Animal Behavior	
Second Year	III	ZOC 103 Anatomy of animal body system			ZOS 101 Aquarium fish keeping
	IV	ZOC 104 Animal Physiology and Biochemistry			ZOS 102 Wild life and Eco tourism
Third Year	V	ZOC 105 Endocrinology ZOC 106 Biochemistry and metabolic processes ZOC 107 Molecular biology & Evolution	ZOD 102 Applied Zoology ZOD 103 Fish and Fisheries		
	VI	ZOC 108 Developmental Biology ZOC 109 Environmental Biology &Toxicology ZOC 110 Parasitology	ZOD 104 Animal Biotechnology ZOP- 101 Project		

PROGRAMME SPECIFIC OUTCOME (PSO)		
• Students will acquire knowledge on basic, important concepts in the field of Zoology such as Physiology, Taxonomy, Evolution, Genetics, Wildlife Biology, Developmental Biology and Comparative Anatomy and can be applied to fields such as Animal Biotechnology. • Students will learn how to identify organisms, understand animal body systems, understand population dynamics in the environment as well as apply these concepts when conducting field surveys. • Students will also gain a sense of responsibility, appreciation and conservation with regards to nature and environment		
ZOC-101	**Diversity of Non-Chordates And Cell Biology (SEMESTER I)**	**Credits: 06 (Theory: 04 & Practical: 02)**

COURSE OBJECTIVES:

THEORY:

To know the generalcharacters and classification of Non-chordates and understand the structure and function of animal cell.

Theory:	
Unit 1: Phylum Protozoa General characters and classification up to classes; Locomotion in Protozoa	**3**
Unit 2: Phylum Porifera General characters and classification up to classes; Canal System in Sponges – Ascon, Sycon, Leucon, Rhagon	**3**
Unit 3: Phylum Cnidaria General characters and classification up to classes; Concept of Polymorphism and types of Zooids.	**3**
Unit 4: Phylum Platyhelminthes General characters and classification up to classes; Overview of Parasitic adaptations in Platyhelminthes	**3**
Unit 5: Phylum Nematoda General characters and classification up to classes; Free living forms of Nematodes	**4**
Unit 6: Phylum Annelida General characters and classification up to classes; Metamerism in Annelida	**3**
Unit 7: Phylum Arthropoda General characters and classification up to classes; Vision in Arthropoda, Metamorphosis in Insects	**5**
Unit 8: Phylum Mollusca General characters and classification up to classes; Torsion in gastropods	
Unit 9: Phylum Echinodermata	**3**

General characters and classification up to classes; Water-vascular system in Asteroidea	**3**
Unit 10: Introduction to Cell biology Overview of general organization of cells (Prokaryotic cells and Eukaryotic cells); Brief information about PPLO (Pleuro Pneumonia Like Organism)	**2**
Unit 11: Cell Environment Chemical bonds Inorganic- water, salts and ions Organic- proteins, carbohydrates, lipids, nucleic acids, vitamins Effect of radiation on cells (UV radiations, photodynamics Sensitization)	**5**
Unit 12: Cell Organelles Structure and function of the following: i) Plasma membrane ii) Mitochondria iii) Endoplasmic reticulum iv) Ribosomes v) Golgi complex vi) Lysosomes (polymorphism of lysosomes) vii) Microbodies (Peroxisomes and Glyoxysomes) viii) Cytoskeleton (Microtubules, microfilaments and centrioles)	**15**
Unit1 13: Nucleus Nuclear envelope, Nucleoplasm, Euchromatin and Heterochromatin, Nucleolus, Nucleosomes	**4**
Unit 14: Cancer Biology Characteristics of cancer cell Carcinomas, Sarcomas, Lymphomas, Leukemia Carcinogenesis –Mutation and Viral theories of Carcinogenesis	**4**

Practical:

- Study of animals belonging to Protozoa, Porifera, Cnidaria, Ctenophora, Platyhelminthes, Nematoda, Annelida, Onychophora, Arthropoda, Mollusca, Echinodermata with special reference to systematic position up to class level, habit, habitat, characteristic features and binomic importance (one example of each class and Local examples are to be given more emphasis) with the help of Museum specimens, models, charts, Microslides, Photographs and Digital sources.
- Identification of Protozoans and Coelenterates in pond water sample
- Digestive system of Earthworm (Museum specimen/digital sources)
- Nervous system of Earthworm (Museum specimen/digital sources)
- Parapodium of Nereis, Nephredia and Setae in earthworm.
- Larval forms of liverfluke with the help of Permanent slides/ Microphotographs/ digital sources
- Study of Prokaryotic cells using Gram's staining technique
- Study of Eukaryotic Cell using suitable staining technique- (Buccal epithelial Cells)
- Method of protozoan culture (Any one)
- Study of cytoplasmic movements in Paramecium
- Study of osmosis using human RBC's

- Localization of Mitochondria by Janus Green stain
- Study of Cancer cells through permanent slides
- Study of cell organelles through electron micrographs

LEARNING OUTCOMES:

At the end of the course students will be able to:

- Gain knowledge on the different non chordate taxa and their characteristics.
- Distinguish between organisms in the laboratory as well as in the environment.
- Gain knowledge on the structure and functioning of cells.
- Understand how abnormalities within cells can lead to a cancerous state.

Reference Books

1. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson
4. Jordan E.L., Verma P.S. (2001), Invertebrates Zoology., S. Chand and company, New Delhi
5. Barnes, R.D. Invertebrate Zoology (1982) VI Edition. Holt Saunders International Edition.
6. D.W. and J.I., Spicer(2002)The Invertebrates: A New Synthesis. III Edition. Blackwell Science.
7. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia PublishingHome.
8. Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.
9. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
10. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
11. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates,MA.
12. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, SanFrancisco.
13. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York and London.

ZOG 101	GENERIC ELECTIVE FOOD, NUTRITION AND HEALTH (Semester I)	Credits:04 (Theory: 04)

COURSE OBJECTIVES:

- To know the basic concepts of food, nutrients and its impact on health.

SYLLABUS

Theory: **Number of hours: 60**

Unit 1: Basic concept of food and nutrition **10**

Food Components and food-nutrients

Concept of a balanced diet, nutrient needs and dietary pattern for various groups adults, pregnant and nursing mothers, infants, school children, adolescents and elderly

Unit 2: Nutrients **20**

Dietary source and role of Carbohydrates, Lipids, Proteins **20**

Vitamins- Fat-soluble and Water-soluble vitamins- their dietary source and importance

Minerals- Iron, calcium, phosphorus, iodine, selenium and zinc: their biological functions

Unit 3: Health **15**

Introduction to health- Definition and concept of health Major nutritional Deficiency diseases- Protein Energy Malnutrition (kwashiorkor and marasmus), Vitamin A deficiency disorders, Iron deficiency disorders, Iodine deficiency disorders- their causes, symptoms, treatment, prevention and Government programmes, ifany. **15**

Life style related diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention through dietary and lifestyle modifications Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS) - their causes, treatment and prevention. Common ailments- cold, cough, and fevers, their causes and treatment

Unit 4: Food hygiene:

Potable water- sources and methods of purification at domestic level.

Food and Water borne infections: **Bacterial infection**: Cholera, typhoid fever, dysentery; **Viral infection**: Hepatitis, Poliomyelitis, **Protozoan infection**: amoebiasis, giardiasis; **Parasitic infection**: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention **15**

Brief account of food spoilage: Causes of food spoilage and their preventive measures.

LEARNING OUTCOMES:

At the end of the course students will be able to

- Know the concept of balanced diet,
- Understand the special nutritional requirements in various age groups
- Explain the various diet related disorders in humans.
- Identify various sources of food contamination and understand their effects on human health.

Reference Books for Theory:

1. Mudambi, SR and Rajagopal, MV. Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; 2007; New Age International Publishers
2. Srilakshmi B. Nutrition Science; 2002; New Age International (P)Ltd.
3. Srilakshmi B. Food Science; Fourth Ed; 2007; New Age International (P)Ltd.
4. Swaminathan M. Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.
5. Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; 2009; Oxford &IBH Publishing Co. Pvt Ltd.
6. Wardlaw GM, Hampl JS. Perspectives in Nutrition; Seventh Ed; 2007; McGrawHill.
7. Lakra P, Singh MD. Textbook of Nutrition and Health; First Ed; 2008; Academic Excellence.
8. Manay MS, Shadaksharaswamy. Food-Facts and Principles; 1998; New Age International (P)Ltd.
9. Gibney et al. Public Health Nutrition; 2004; Blackwell Publishing

ZOC-102	Diversity of Chordates & Genetics (Semester II)	Credits: 06 (Theory: 04 & Practical: 02)

COURSE OBJECTIVES:

To know the general characters and classification of Chordates and understand the fundamentals of genetics.

Theory:

Unit 1: Introduction to Chordates Salient features of Chordates General features and Phylogeny of Protochordata (Brief mention of Hemichordates as a prelude to Chordates)	**2**
Unit 2: Agnatha General features of Agnatha and classification of cyclostomes up to classes; Extinct Agnatha - Ostracoderms	**3**
Unit 3: Pisces General features and Classification up to orders; Migration and parental care in Fishes	**5**
Unit 4: Amphibia General features and Classification up to orders; Parental care in Amphibia	**5**
Unit 5: Reptiles General features and Classification up to orders, Mesozoic Reptiles(Dinosaurs), Venomous and non-venomous snakes	**5**
Unit 6: Aves General features and Classification up to orders; Volant adaptations in birds, Migration in Birds.	**5**
Unit 7: Mammals Salient features of mammals, Classification up to orders; Origin of mammals,	**5**
Unit 8: Mendelian Genetics & its Extension Overview of Mendelian Genetics Epistasis and Hypostasis, Multiple genes and multiple alleles, Sex linked, sex limited and sex influenced inheritance (with one example each)	**10**
Unit 9: Chromosome Structure: Eukaryotic Chromosome, Types of Eukaryotic Chromosome (based on centromere position), Eukaryotic and prokaryotic chromosomal organisation, Giant chromosomes (polytene and lampbrush)	**06**
Unit 10:Gene Mutation Natural and Induced Mutations, Types of gene mutation (base pair substitution and frame shift) Types of chromosomal aberration, Causative agents of Mutation.	**05**

Unit 11: Inbreeding and Heterosis Definition of Inbreeding, Inbreeding depression, Practical applications of Inbreeding. Heterosis – Genetic basis; Application and Evolutionary significance.	**04**
Unit 12: Inheritance of Human traits Human karyotype, Pedigree analysis Inheritance of human traits: Brown eyes, Polydactyly, Diabetes insipidus, Sickle cell anemia, PKU Eugenics and Genetic counseling	**05**

Practical **Number of Hours: 60**

Study of following specimens:

Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis, Any six common birds from different orders, Bat, Funambulus,Loris

Key for Identification of poisonous and non-poisonous snakes

- Problems on multiple alleles, multiple genes and epistasis (one on each)
- Inheritance problems based on Epistatic interactions
- ABO blood grouping and Rh factor in humans
- Study of Polytene chromosome in Drosophila/Chironomous larva
- Determination of genetic sex by Barr body
- Study of Human Karyotype (Normal male and female, Turner's syndrome and Down's syndrome)
- Determination of allelic frequency of following Mendelian human traits: Tongue rolling, earlobes, Widow's peak, hand clasping, folding of arms, thumb cross pattern, Hitch-hiker's thumb.

LEARNING OUTCOMES:

At the end of the course students will be able to:

- Identify and classify the Chordates
- Know about the abnormalities of the chromosomes and the pattern of inheritance of genetic traits

REFERENCES:

1. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
2. Pough H. Vertebrate life, VIII Edition, Pearson International.
3. Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger PubCo.
4. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
5. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008).
6. Principles of Genetics. VIII Edition. Wiley India
7. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc
8. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012).
9. Concepts of Genetics. X Edition. Benjamin Cummings
10. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings
11. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction to Genetic

Analysis. IX Edition. W. H. Freeman and Co
Fletcher H. and Hickey I. (2015). Genetics. IV Edition. GS, Taylor and Francis Group, New York and London.

ZOG 102	GENERIC ELECTIVE ANIMAL BEHAVIOUR (Semester II)	Credits:04 (Theory: 04)

COURSE OBJECTIVES:

- To know the theories and patterns of animal behavior.

SYLLABUS

Theory: **Number of hours: 60**

Unit 1: Introduction to Animal Behaviour Origin and history of Ethology; Brief profiles of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Proximate and ultimate causes of behaviour, Methods and recording of a behavior.	**10**
Unit 2: Patterns of Behaviour Stereotyped Behaviours (Orientation, Reflexes); Individual Behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, classical and operant conditioning, Habituation, Imprinting.	**15**
Unit 3: Social and Sexual Behavior Social Behavior: Concept of Society; Communication and the senses; Altruism; Insects' society with Honey bee as example; Foraging in honey bee and advantages of the waggle dance. Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care.	**15**
Unit 4: Biological Rhythm Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; Photoperiod and regulation seasonal reproduction of vertebrates; Role of melatonin.	**15**
Unit 5: Biological Clocks Relevance of biological clocks; Chronopharmacology, Chronomedicine, Chronotherapy.	**05**

LEARNING OUTCOMES:

At the end of the course students will be able to

- Understand stereotyped and social behaviors of animals
- Understand the biological rhythms governing the behavior of animals.

Reference Books:

1. David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.
2. Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge, University Press, UK.

3. John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
4. Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
5. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
6. Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.) R.D. Lewis. (3rdEd) 2002 Barens and Noble Inc. New York, USA
7. Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/Springer-Verlag, Germany.

ZOC-103	Anatomy of Animal Body Systems (Semester III)	Credits: 06 (Theory: 04 & Practical: 02)

COURSE OBJECTIVES:

- To know structure and functions of the different systems in the vertebrates.

Theory:

Unit 1: Integumentary System Structure, functions and derivatives of integument	**8**
Unit 2: Skeletal System Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches	**8**
Unit 3: Digestive System Alimentary canal and associated glands, dentition	**8**
Unit 4: Respiratory System Skin, gills, lungs and air sacs; Accessory respiratory organs	**8**
Unit 5: Circulatory System General plan of circulation, evolution of heart and aortic arches	**8**
Unit 6: Urinogenital System Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri	**6**
Unit 7: Nervous System Comparative account of brain, Autonomic nervous system, Spinal cord, Cranial nerves in mammals	**8**
Unit 8: Sense Organs Classification of receptors Brief account of visual and auditory receptors in man	**6**

Practical:

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Disarticulated skeleton of Frog, Varanus, Fowl, Rabbit
3. Carapace and plastron of turtle /tortoise
4. Mammalian skulls: One herbivorous and one carnivorous animal
5. Dissection of rat to study arterial and urinogenital system (subject to permission)
6. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording/models/charts (may be included if dissection not permitted)
7. Project on skeletal modifications in vertebrates (may be included if dissection not permitted)

LEARNING OUTCOMES:

At the end of the course students will be able to

- know the general plan and functioning of different components of the systems in the body

REFERENCES:

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. Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons
4. Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House

ZOS-101	Skill Enhancement Course AQUARIUM FISH KEEPING (Semester III)	Credits:04 (Theory: 03 & Practical: 01)

COURSE OBJECTIVES:

- To know the technique of rearing /maintaining fishes in an aquarium

SYLLABUS

Theory: **Number of hours: 45**

Unit 1: Introduction to Aquarium Fish Keeping The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes	**5**
Unit 2: Biology of Aquarium Fishes Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish	**7**
Unit 3: Food and feeding of Aquarium fishes Use of live fish feed organisms. Preparation and composition of formulated fish feeds	**6**
Unit 4: Fish Transportation Live fish transport - Fish handling, packing and forwarding techniques.	**6**
Unit 5. Common Aquarium Fish diseases Fin rot, swim bladder disorders, body flukes and dropsy, Ich	**6**
Unit 6: Maintenance of Aquarium General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry	**7**
Unit 7: Introduction to Aquarium plants Introduction to aquarium plants and their export potential, profiles of some selected aquarium plants, Indigenous ornamental plants of Western Ghats, management of ornamental aquatic plants and its trading.	**8**

Practical

1. Identification of common Aquarium fishes
2. Identification of live feed organisms
3. Study of different types of formulated feeds
4. Preparation of formulated feed
5. Study of slides of parasites and diseases
6. Setting up of an aquarium
7. Study of ornamental plants

LEARNING OUTCOMES:

At the end of the course students will be able to

- Know the biology of aquarium fishes, their nutritional requirements and care. The student should be able to know the requirements for setting up an aquarium.

Reference Books for Theory and Practicals:

1. Rath, R.K. (2000) Freshwater Aquaculture. Scientific Publishers (India). PO Box:91, Jodhpur. Jhingran, AVG (1991) Fish and Fisheries of India. Hindustan Publishing Co.
2. Baradach, JE, JH Ryther and WO McLarney (1972). Aquaculture. The Farming and Husbandry of Freshwater and Marine Organisms. Wiley Interscience, NewYork.
3. Jameson, J.D. and R. Santhanam (1996). Manual of ornamental fisheries and farming technology. Fisheries College and Research Institute, Thoothukudi.
4. Mitchell Beazley, 1998. The complete guide to tropical aquarium fish care. Read and Consumes Book Ltd.,London.
5. Everything for the aquarist. Tetra Werke Publication, West Germany.
6. Jameson, J.D. Alangara Meen Valarpu (in Tamil). National Book House, New Delhi.

ZOC104	Animal Physiology & Biochemistry (Semester IV)	Credits: 06 (Theory: 04 & Practical 02)

COURSE OBJECTIVES:

- To understand the physiology of the different processes of the body systems and the micro molecules and macromolecules of the cells.

SYLLABUS

Theory: **Number of hours: 60**

Unit 1: Physiology of Digestion Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Hormonal control of secretion of enzymes in Gastrointestinal tract.	**6**
Unit 2: Physiology of Respiration Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves and the factors influencing it; Control of respiration	**7**
Unit 3: Renal Physiology Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance	**5**
Unit 4: Cardiovascular Physiology Composition of blood, blood volume, Origin and conduction of the cardiac impulse, Cardiac cycle, Regulation of blood pressure and heart rate.	**6**
Unit 5: Muscle Physiology Types of muscles, Ultrastructure of skeletal muscles, properties of skeletal muscles, theories of muscle contraction,	**6**
Unit 6: pH and buffer Definition of pH, buffer, types of buffer.	**1**
Unit7: Carbohydrates Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates	**7**
Unit 8: Lipids Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri- acylglycerols, Phospholipids, Glycolipids, Steroids	**7**

Unit 9: Proteins Amino acids: Structure, Classification and General Properties of α-amino acids; Physiological importance of essential and non-essential α-amino acids Proteins: Bonds stabilizing protein structure; Levels of organization in proteins; Denaturation; Introduction to simple and conjugateproteins	**8**
Unit10: Enzymes Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions, Concept of Michaelis-Menten equation, Lineweaver-Burk plot, Enzyme inhibition.	**7**

Practical:

1. Measurement of blood pressure Hemoglobin estimation Preparation of Haemin crystals.
2. Observation of Pulse rate under normal and stressed condition Respiratory rate of cockroach/any insect
3. Qualitative tests to identify functional groups of carbohydrates in given solutions (Glucose, Fructose, Sucrose, Lactose)
4. Estimation of total protein.
5. Study of activity of salivary amylase under optimum conditions (pH, temperature) Study of normal and abnormal constituents in Urine
6. Study of different types of muscle cells.

LEARNING OUTCOMES:

At the end of the course, students will be able to

- Know mechanism of body functions and the basic knowledge of chemistry of biomolecules.

REFERENCES:

1. Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc.
2. Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander's Human Physiology, XI Edition., McGraw Hill
3. Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
4. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
5. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry.IV Edition. W.H. Freeman and Co.
6. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). Harper's Illustrated Biochemistry. XXVIII Edition. Lange Medical Books/McGraw3Hill.

ZOS 102	Skill Enhancement Course WILDLIFE AND ECOTOURISM (Semester IV)	Credits: 04 (Theory: 03 & Practical: 01)

COURSE OBJECTIVES:

- To learn the objectives and strategies of wildlife conservation and monitoring.

SYLLABUS

Theory:	**45 Hours**
Unit1: Introduction to Wildlife, Current Scenario &Conservation categories Meaning, Values, Global & Indian scenario Biogeographic zonation and wildlife endowments of India, Wildlife as a sustainable tourism resource. Contemporary status of Indian Wildlife and Impediments to conservation of wildlife in India	**4**
Unit2: Causes of depletion, extinction of wildlife &Conservation Categories Causes of Wild Depletion -Proximate & Root causes. Extinct Species, Drivers of Extinction & Extinction Threshold North East and Western Ghats; as 'Centers of Endemicity' Conservation categories with relevant examples (Endangered, Vulnerable, Rare, Threatened, Out of Danger, Indeterminate, Insufficiently Known, Extinct, Extinct in Wild , Critically Endangered, Lower Risk, Conservation Dependent, Near Threatened, Least Concern, Data Deficient, Not Evaluated) IWPA 1972, Schedule I species (Mammals, Birds and Reptiles).	**10** **6**
Unit 3: Wildlife Conservation-Objectives & Methods Meaning of conservation, Objectives of wildlife conservation Conservation strategies, Ex situ &In situ methods of wildlife Conservation (PAN, CCA, Zoos, Aquaria, Captive Breeding & Ranching etc) Centrally Sponsored Schemes for Wildlife Conservation (Integrated Development of Wildlife Habitats, Project Tiger, Project Elephant)	
Unit 4: Wildlife Tourism in India: Prospects& Challenges Difference between Tourism, leisure and recreation Ecotourism versus Conventional Mass tourism, a SWOT analysis. Natural area Tourism (Adventure tourism, Wildlife tourism and Ecotourism) Wildlife Tourism: Advantages (Sustainability of enterprise, Assured backflow of profits to local communities, Upholding conservation ethos) Wildlife Tourism: Impacts (Altered landscape, Impact of roads on wildlife habitats, Tourism generated litter, Introduction of Invasive species, Zoonotic disease transmissions, Violation of 'Visitors carrying Capacity' & visitor induced stress and disturbance Tour to wildlife)	**10**
Unit 5: Planning, Management & Monitoring of Wildlife Tourism Wildlife as a specific component of ecosystem and major wildlife destinations in India. (Wildlife of Indian Himalayas, Indian Deserts, Indian Coral Reefs, Western Ghats) Rationale for Visitor Planning and stakeholder involvement Carrying Capacity & 'Acceptable' Change Visitor Management: Zoning, Roads & Trails, Regulating Visitor numbers, Visitor Communication &Education. Interpretation: Fundamental Principles & major interpretation techniques (Publication & Websites, Visitor Centres, Self-guided Trails, Guided Tours Visitor Monitoring: Reasons for	**15**

Monitoring, Monitoring Techniques (Countingvisitors, Questionnaires & Interviews, Observing visitors, Focus Groups)	

Practical

1. Use of Maps and other GIS resources to understand the biogeographic zones of India and understand the location of our State in this scheme.
2. Prepare an Inventory of state's Wildlife Resources (Forest Types, Carnivores, Wild Ungulates, Birds, Reptiles) from secondary sources and classify them under them under various PAN, IUCN conservation categories & IWPA Schedules
3. Visit to a state WPA and CCA to understand and prepare Report on the management and conservation action.
4. To prepare an inventory of your Taluk's existing and potential Ecotourism sites with special reference to Birdlife. Evaluate any one extant ecotourism site with reference to:

- Visitor's Carrying Capacity
- Visitor Education &Interpretation
- Visitor Facility

• Observing the effect Habitat improvement on diversity of butterflies (Diversity estimation pre and post food plants introduction)

5. Understanding Carnivore Pug Biometry by analysis of Pug Marks/Whisker Spot study in Asiatic Lion (Printed Lion Pug Imprints / Lion Head sketches with Reference Rows & Identification Rows of Whisker Spots to be provided)
6. Population enumeration by Lincoln & Peterson's Index Method (Colored Beads to represent marked to unmarked individuals)

LEARNING OUTCOMES:

At the end of the course students will be able to

- Know the current status and conservation strategies for wildlife conservation and management.

REFERENCES:

1. Willian J. Sutherland, Lynn V. Dicks, Nancy Ockendon& Rebecca K. Smith (2015) What works in conservation. Open Book Publishers, UK
2. S K Singh (2010) Text Book of wildlife Management International Book Distributing Company, Lucknow
3. Paresh Porb, Raman Kulkarni and Varad Giri (2014) Biodiversity of Goa. Pug Marks Art Gallery, Kolhapur
4. Goa State Biodiversity Board (2014) Island Biodiversity, Goa: Biological Treasure of Chorao, Divar and St Jacinto Island. National Biodiversity Authority.
5. Richard Grimmet, Tim Inskipp (2005) Birds of Southern India. Om Books International
6. 1. Issac Kehimkar (2011) The Book of Indian Butterflies. Oxford.
7. Luigi Boitani & Roger Powell (2012) Carnivore Ecology and Conservation.
8. Oxford University Press
9. Romulus Whitaker &Ashok captain (2008) Snakes of India. Draco Books Tamil Nadu
10. Asad R Rehmani (2012) Threatened Birds of India. Oxford University Press
11. Ravee Chauhan (2006) Ecotourism Trends & Challenges. Vista International Publishing House Delhi
12. David Newsome, Susan Moore and Ross K Dowling (2006) Natural Area Tourism Ecology, Impacts and Management. Viva Books Pvt Ltd Ac Delhi
13. The Wildlife (Protection) Act, (1972) Natraj Publishers.

ZOC 105	ENDOCRINOLOGY (Semester V)	Credits: 06 (Theory: 04 & Practicals: 02)

COURSE OBJECTIVES:

- To learn the mechanism of integrative physiology.

SYLLABUS

Theory: **Number of hours: 60**

Unit 1: Introduction Endocrinology, Endocrine glands. Concept of homeostasis - Glucose and Calcium Homeostasis.	**7**
Unit II: Endocrine Hypothalamus Hypothalamohypophyseal portal system, Hypothalamohypophysealneurosecretary tracts, Hypothalamic nuclei, - Magnocellular and Parvicellular elements. Hypothalamic releasing and inhibitory hormones/factors.	**7**
Unit III: Hormones Chemical messengers, type of chemical messengers. Hormones, types of hormones (proteins and steroids).Hormonal regulation of secretion – Feedback system- long loop, short loop, positive and negative feedback.	**7**
Unit IV: Hypophysis Gross anatomy, blood supply, histology of Adenohypophysis- identification of cell types based on staining affinities. Division and nomenclature of hypophysis. Hormones of Adenohypophysis, their functions and effect on target organs, Disorders of growth hormones.Neurohypophysis – Hormones of the neurohypophysis, Biological effects of Oxytocin and Vasopressin, Diabetes insipidus.	**12**
Unit V: Thyroid Structure, blood supply and nerves.Structure of thyroid follicles, principal cells and parafollicular cells. Biochemistry of Thyroid Hormones, Factors affecting thyroid functions. Clinical aspects of thyroid functions (Cretinism, Myxoedema, and Graves‟ disease) Parathyroid – Histology, hormones, Regulation of Blood Calcium level, Parathyroid tetany.	**7**
Unit VI: Endocrine Pancreas Histology of Pancreas, Endocrine pancreas- Islets of Langerhans, types of cells (α,β,γ and δ).Effects of Insulin and Glucagon.Regulation of blood glucose level – Diabetes Mellitus (IDDM and NIDM).	**6**
Unit VII: Adrenal Anatomy of adrenal gland, functional morphology of adrenal cortex, zones of adrenal cortex – histology. Adrenal steroid hormones – Glucocorticoids, Mineralo corticoids and adrenal sex steroids. Regulation of adrenocortical function. Adrenal medulla – functional morphology of adrenal medulla, hormones of medulla, catecholamines and their roles in metabolism. Adrenocortical disorders – Cushing's syndrome and virilism.	**8**
Unit VIII: Gonads as endocrine structures Testes – endocrine component of testes (Leydig cells and Sertoli cells). Hormones of testes – androgens and their biological role. Ovary – endocrine components of ovary (follicular wall theca and granulosa. Corpus luteum and interstitial cells. Hormones of ovary and their biological function. Placenta – placenta and its hormones.	**6**

Practical	**Number of hours: 60**
1. Study of histological structure of following endocrine glands a) Pituitary b) Thyroid c) Parathyroid, d) Adrenal, e) Islets of Langerhans f) Testis g) Ovary. 2. Dissect and display of endocrine glands in Laboratory bred rat. 3. Surgical techniques of Adrenalectomy and Ovariectomy in Laboratory bred rat. 4. Pregnancy test using human urine sample. 5. Histological technique using Testis/ Ovary/ Adrenal gland. 6. Study of hypothalamohypophysial portal system &neuro secretory tracts through permanent slide / photomicrogragh.	

LEARNING OUTCOMES:

At the end of the course students will be able to

- Know the internal methods on integrating the functions of different internal systems to maintain homeostasis through hormonal regulation.

REFERENCES:

1. Bloom and Fawcet (1982). A Textbook of Histology, W. B. Saunders publications
2. Copenhaver, W.M., Kelly D.E. and R. L. Wood (1978). Bailey‟s Textbook of Histology, Williams & Wilkins Co., Baltimore.
3. Eckert and Randall (2005) Animal Physiology. CBS publishers.
4. Guyton A. C. and Hall J. E. (2010), text book of Medical Physiology, W.B. Saunders publications, Philadelphia
5. Hadley M. E. and Levin J. E, (2009). Endocrinology. Dorling Kindersley India Pvt.Ltd.
6. Ross M. H. and W. Pawlina (2010) Histology- a text & Atlas with correated cell and Molecular Biology, Walter Kluver health- Lippineotl Williams & Wilkins Baltimore.
7. Shambulingam K. and P. Shambulingam (2010) Essentials of Medical Physiology, Jaypee Brothers, Med Publication.
8. Singh, H. R. (2012) Animal Physiology & Biochemistry, Vishal Publ. Co.
9. Turner C.D. and J. T. Bagnara (1976). General endocrinology W.B. Saunders publications, Philadelphia

ZOC 106	BIOCHEMISTRY AND METABOLIC PROCESSES (SEMESTER V)	Credits: 06 (Theory: 04 & Practical :02)

COURSE OBJECTIVES:

- To provide students with theoretical and practical understanding of Biochemistry and metabolic processes

SYLLABUS

Theory:	**60 Hours**
Unit 1: Overview of Metabolism Metabolism, Stages of catabolism, Sub divisions of Metabolism, Catabolism vs. Anabolism, regulation of Metabolic pathways, Shuttle systems and membrane transporters	**10**
Unit 2: Bioenergetics Concept of Energy, Laws of Thermodynamics, Free energy, ATP as "energy currency" of the cell.	**05**
Unit 3: Carbohydrate Metabolism Sequence of Reactions and Regulation of Glycolysis, Pentose phosphate pathway, Oxidative decarboxylation, Citric acid cycle, Gluconeogenesis, Glycogenolysis and Glycogenesis., Mitochondrial respiratory Chain	**15**
Unit 4: Oxidative Phosphorylation Mechanism of oxidative phosphorylation - Chemical coupling Hypothesis, Conformational coupling Hypothesis, Chemiosmotic Coupling Hypothesis.Inhibitors and Uncouplers of Electronic Transport system**.**	**10**
Unit 5: Amino acid metabolism Catabolism of amino acids: Transamination, Deamination, Urea Cycle, Fate of C-skeleton of Glucogenic and Ketogenic amino acids,inborn errors of Amino acid catabolism (Albinism, Alkaptonuria, Phenylketonuria)	**10**
Unit 6: Lipid Metabolism Beta-oxidation of fatty acids – a. Palmitic acid {saturated (C 16:0) b. Linoleic acid {unsaturated (C 18:2) Alpha and Omega oxidation of fatty acids, ketogenesis-Ketogenic and Antiketogenic substances, Regulation of ketogenesis	**10**

Practical's

1. Estimation the concentration of plasma glucose in the given sample by colorimetric/ Spectrophotometric method
2. Estimation of cholesterol concentration in the given blood sample.
3. Separation of lipids by thin layer chromatographic method in a given sample.
4. Separation of amino acids by paper chromatography.
5. Estimation of glycogen in the given sample by colorimetric / Spectrophotometric method
6. Determination of saponification value of oil.
7. Determination of iodine number of oil.
8. Estimation of amino acids by Ninhydrin method

LEARNING OUTCOMES:

At the end of the course students will be able to

- Understand intricacies of Biochemistry and Its role in metabolic processes.

REFERENCES:

1. Berg, J. M., Tymoczko, J. L. and L. Stryer (2007) Biochemistry, VI Edition, W.H. Freeman and Co., New York

2. Cox, M. M and D. L. Nelson (2008) Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.

3. Hames, B. D. and N. M. Hooper (2000) Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K. CBCS U

4. Jain, J. L., Sunjay Jain, and Jain Nitin (2016) Fundamentals of biochemistry, S. Chand and Company limited, New Delhi.

5. Murray, R. K., Bender, D. A., Botham, K. M., Kennelly, P. J., Rodwell, V. W. and P. A. Well, (2009) Harper‟s Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc

ZOC 107	MOLECULAR BIOLOGY AND EVOLUTION (Semester V)	Credits:6 (Theory:04 & Practicals:02)

COURSE OBJECTIVES:

- To understand the principles of inheritance from molecular mechanisms and evolution as the central unifying concept in biological sciences.

SYLLABUS

Theory:	**60 Hours**
Unit 1: DNA Replication and Repair mechanism Introduction to nucleic acids. DNA Replication in eukaryotes: mechanism, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, replication of telomeres, pyrimidine dimerization and mismatch repair	**07**
Unit 2: Transcription, Post-Transcriptional Modifications and Processing of Eukaryotic RNA RNA polymerase and transcription Unit, mechanism of transcription in eukaryotes, synthesis of rRNA and mRNA, transcription factors, Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA	**08**
Unit 3: Translation Genetic code, evolution and degeneracy of genetic code and Wobble Hypothesis; Process of protein synthesis in eucaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyltRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation	**09**
Unit 4: Gene Regulation Transcription regulation in prokaryotes: Principles with examples from lac operon and trp operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing, Genetic imprinting**.**	**06**
Unit 5: Concept of Evolution, Origin of Life and speciati Basic concept of organic evolution (Micro, macro and mega); Theories of evolution (Lamarckism, Darwinism, Neo-Darwinism, Contribution of Weisman, De Vries, Huxley, Haekel); Origin of Earth; Chemogeny; Biogeny; Cognogeny; concept of species (morphological, genetic, biological) Species categories (monotypic, polytypic, sibling) subspecies; origin of species (allopatric, sympatric, parapatric).	**10**
Unit 6: Variability and Mutations Nature, kind, causes and role of variability.Mutations : definition, characteristics, types, causes, and effects. Induced, natural and gene mutation.	**06**
Unit 7: Isolation and Adaptation Classification and types of isolating mechanisms; reproductive isolation, role of isolation in evolution; types of adaptations; Convergent, Divergent and Parallel adaptations; Pre, post and Co-adaptations.	**08**
Unit 8: Genetic basis of evolution and study of fossil Population genetics; gene pool, frequency and equilibrium; Hardy Weinberg‟s Law of equilibrium. Fossils (types, formation, dating and significance)	**06**

Practical

1. Extraction and qualitative Detection of DNA and RNA
2. Quantitative estimation of DNA and RNA.
3. Study and interpretation of electron micrographs / photograph showing
   (a) DNA replication
   (b) Transcriptio
   (c) Split genes
4. Electrophoretic separation of Protein
5. Study of fossils, homology and analogy from models / pictures, suitable specimens
6. Study and verification of Hardy-Weinberg Law by chi square analysis
7. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies
8. Graphical representation and interpretation of data of height / weight of a sample of 100 humans in relation to their age and sex.

LEARNING OUTCOMES:

At the end of the course students will be able to

- Appreciate and know the scope of molecular biology in terms of evolution of the major groups of organisms.

REFERENCES:

1. Arora, M. P. (2000) Organic Evolution. 2nd Ed. Himalaya Publishing House, Mumbai.
2. Becker, W. M., Kleinsmith, L. J., Hardin. J. and G. P., Bertoni, (2009) The World of the Cell. 7th Ed. Pearson Benjamin Cummings Publishing, San Francisco.
3. De Robertis, E. D. P. and E. M. F. De Robertis, (2006) Cell and Molecular Biology.8th Ed. Lippincott Williams and Wilkins, Philadelphia.
4. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th Ed. John Wiley and Sons.Inc.
5. McLennan A., Bates A., Turner, P and M. White, (2015) Molecular Biology. 4th Ed. GS, Taylor and Francis Group, New York and London.
6. Rastogi, V. B., (1998) Organic Evolution. 11th Ed. KedarNath Ram Nath, Meerut.

ZOD-102	APPLIED ZOOLOGY (SEMESTER V)	Credits: 04 (Theory: 03 & Practical: 01)

COURSE OBJECTIVES:

- To learn the interrelationship of animal life with special reference to human life

SYLLABUS

Theory:	**60 Hours**
Unit 1: Introduction to Applied Zoology Nature, scope & major branches of applied Zoology	**2**
Unit 2: Vermiculture Introduction; varieties of earthworms, types of earthworms suitable for vermicomposting, Economic importance of earthworms; Methods of vermicomposting; basic requirements, preparation of vermibed; Collection of Compost and separation of earthworms, Vermiwash; effect of vermiwash on yield and quality of crops.	**6**
Unit 3: Apiculture Introduction; types of honey bees; Colonial organization and division of labour; honey comb; lifecycle of honey bee; Bee products (honey, wax & royal jelly); Bee keeping equipments; Bee management; Role of bees in pollination.	**6**
Unit 4: Sericulture Introduction; different types of silk and silk worm in India (Mulberry, Tasar, Muga, Eri); Rearing of Bombyxmori; harvesting of cocoons & quality assessment of silk fibres; Silk worm diseases (Pebrine, Flacheria, Grasserie&Muscardine) & their management; silkworm pest & parasites (Uzi fly, Dermastis beetles) & their management.	**6**
Unit 5: Poultry Introduction; types of poultry birds; breeds of fowls, exotic breeds (birds of American class, English class, Mediterranean class); culling the flock; selection of good layers; feeding and management of laying birds; management of Young Chickens; Indian brooders; grading & marketing of eggs; poultry manure; diseases of fowls Ranikhet disease, fowl pox, fowl cholera, fowl typhoid) & their prevention.	**9**
Unit 6: Piggery Introduction; country pig; advantages of pig production; selection of breeds (The English & American class);feeding and management of herd; Products of piggery(Pork, Bristles, Sausages, Lard); Diseases & their Control.	**6**
Unit 7: Dairy Introduction, Dairy farm and farm organization, Indigenous and exotic breeds of cow; feed and medical care of breeds. Milk- Composition and its types (Toned milk, Standardized, Homogenized, Fortified, Condensed and Synthetic); Milk products: composition, preparation and uses (cream, butter, curd, ghee, cheddar cheese and paneer). Commercial importance of Dairy.	**10**

Practical

1. Mounting of mouthparts and appendages of honey bee.
2. Test to determine the homogenous / heterogeneous honey.
3. Study of types of silkworm cocoons (Mulberry, Tasar, Muga, Eri)
4. Determination of quality of egg.(fresh and aged egg)
5. Determination of Lactose content in milk.
6. Determination of adulterant in ghee (sesame oil).
7. Isolation of casein from milk.
8. Study of different breeds of pigs through digital source (English and American Class)
9. Study of different varieties of earthworms through museum specimens/digital source.
10. Demonstration of vermiculture technique.

LEARNING OUTCOMES:

At the end of the course students will get

- Acquainted with the different branches of Applied Zoology.

REFERENCES:

1. Arumugam N., Murugan T., Johnson Rajeshwar, and R. Ram Prabhu (2013) Applied Zoology, Saras Publication.

2. Clarence Henry Eckles, Willes Barnes Combs and Harold Macy (2012) Milk and milk products, Tata McGraw-Hill Publ. Co., Ltd, New Delhi.

3. Jagadish Prasad (2016) Principles and Practices of Dairy Farm Management. Kalyani publishers, New Delhi.

4. Jayasurya , ArumugamN.Thangamani , Prasannakumar, and L. M. Narayanan (2013) Economic Zoology ,Saras Publication.

5. Kishore, R. Pawar, DamaL. B., Ashok E Desai and R. N. Patil (2016) A Textbook of Ecology, Ethology , Evolution and Applied Zoology. NiraliPrakashan

6. ManjuYadam (2003) Economic Zoology, Discovery Publishing House, New Delhi.

7. Pradip V. Jabde (2005) Textbook of Applied Zoology (Vermiculture, Apiculture, Sericulture,

8. Lac Culture, Agricultural Pests and their control).Discovery publishing house, New Delhi.

9. Sukumar De (2001) Outlines of Dairy Technology, Oxford University Press, New Delhi.

10. Tarit Kumar Banerjee (2017) Applied Zoology, New Central Book Agency.

11. Tomer and Bhatnagar (2002) A Textbook of Applied Zoology. Emkay Publication, Delhi

ZOD 103	FISH AND FISHERIES (SEMESTER V)	Credits: 04 (Theory: 03 & Practical: 01)

COURSE OBJECTIVES:

- To provide students with theoretical and practical understanding of Fish and fisheries

SYLLABUS

Theory:	**60 Hours**
Unit 1: Introduction: General description of fish, Classification based on feeding habit, habitat and manner of reproduction.	**2**
Unit 2: Morphology, Physiology and behavior Types of fins and their modifications; Locomotion in fishes: Types of Scales, Use of scales in Classification and determination of age of fish; Gills and gaseous exchange; swim bladders and their role in Respiration; Osmoregulation in Elasmobranches; Reproduction. Migration.	**8**
Unit 3: Fisheries Definition, Scope, Global scenario, Present status of Fisheries in India , Inland Fisheries; Marine Fisheries; EEZ, Environmental factors influencing the seasonal variations in fish catches in the Arabian Sea and the Bay of Bengal: Fishing crafts and Gears with special reference to Goa; Important fin fishes of west coast of India (sardine,Mackerel, Pomfret, Bombay Duck, King - fish, Shark). Shell fishery: prawn, crab, Oyster, clams, Cuttle Fish. Inland Fisheries: Indian major carps. Depletion of fishery resources.Application of remote sensing and GIS in fisheries. Deep sea fishing: policies and problems. Fishery law, regulations and conservation.	**16**
Unit4: Aquaculture Types of aquaculture: Extensive, semi-intensive, intensive and super intensive aquaculture in different types of water bodies viz., freshwater, brackish water inland saline and marine water, Pond, Pen and cage culture. Mono, poly and integrated culture systems. Running water culture and zero water exchange system. Sustainable Aquaculture, Composite fish culture. Brood stock management; Induced fish breeding. Fish diseases: Bacterial,viral and parasitic. Preservation and processing of harvested fish, Fishery by-products	**16**
Unit 5: Fish in research Transgenic fish, Zebra fish as a model organism in research	**3**
Practical	

1. Morphometric and meristic characters of fishes (Any Two)
2. Study of sardine, Mackerel, Pomfret, Bombay Duck, King fish, Shark, Shell fishery: prawn, crab, Oyster, clams, Cuttle Fish, Inland Fisheries: Indian major carps.
3. Study of different types of scales
4. Study of crafts and gears used in Fisheries
5. Water quality criteria for Aquaculture: Assessment of pH, conductivity, Total solids, Total dissolved solids
6. Demonstration of induced breeding in Fishes (video)
7. Demonstration of parental care in fishes (video)
8. Visit to any fish farm/ pisciculture unit / Zebrafish rearing Lab / fish breeding unit. (Project Report)

LEARNING OUTCOMES:

At the end of the course students will

- Understand structure, function and behaviour of fishes, and applications of fisheries in improving human welfare

REFERENCES:

1. Bone, Q and R. Moore (2008) Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.

2. Evans, D. H. and J. D. Claiborne (2013) The Physiology of Fishes, (4" Edn) Taylor and Francis Group, CRC Press,U. K

3. Khanna, S. S. and H. R. Singh (2012) A text book of Fish Biology and Fisheries, Narendra Publishing House, NewDelhi.

4. Norman, J. R. (1998) A history of Fishes, Hill and Wang Publishers. Srivastava, C. L. B. (2013) Fish Biology, Narendra Publishing House

5. Gupta S. K. and P. C. Guptu (2018) General and applied Ichthyology, S. Chand & Co., New Delhi

6. Von der Emde, R. J., Mogdans and B. G. Kapoor (2004) The Senses of Fish: Adaptations for the Reception of Natural Stimuli, Springer, Netherlands

ZOC 108	DEVELOPMENTAL BIOLOGY (SEMESTER VI)	Credits: 06 (Theory :04 & Practicals: 02)

COURSE OBJECTIVES:

- To provide students with theoretical and practical understanding of animal developmental Biology

SYLLABUS

Theory: **60 Hours**

Unit 1: Introduction Branches of embryology. Scope of embryology. Gametogenesis: Spermatogenesis, Oogenesis, Vitellogenesis, Types of Eggs, Egg membranes. Fertilization: Definition, activation and Amphimixis. Types of Fertilization, Biochemical changes during fertilization, Significance of Fertilization. Parthenogenesis, planes and Patterns of cleavages. Gastrulation (Emboly and Epiboly) Fate maps and Cell lineage. Organogenesis, growth and differentiation.	**14**
Unit 2: Transplantation, embryonic inductions, concept of organizer and competence Definition of transplantation, nuclear transplantations, embryonic induction: Types, Concept of primary organizer, Experiments by Brachets, Spemann, and Mangold, Characteristics of an organizer, Regional specificity of organizer. Neural induction:, mechanism. Surface interaction and chemical interaction, Gradient theory of neural induction, Secondary, Tertiary and Quaternary organizers, Eye as an example of sequential induction, Competence.	**10**
Unit 3: Early Embryonic Development of Chick Structure of hen's egg, cleavage, blastula, Gastrulation, Development of chick embryo up to 3 days of incubation.	**12**
Unit 4: Late Embryonic Development Fate of Germ Layers; Extra-embryonic membranes of chick (Development, structure and functions of yolk sac, Amnion, Chorion and Allantois, Placenta (Structure, types and functions of placenta)	**07**
Unit 5: Regeneration and ageing Types, Regenerative ability in different animal groups, Mechanism of regeneration, Stimulus and suppression of regeneration, Polarity in regeneration. Introduction to Ageing: Concepts and models. Apoptosis	**07**
Unit 6: Implications of Developmental Biology: Teratology. stage sensitivity of foetus, twins – Identical, fraternal, and conjoined - equal and unequal. Malformations in external structures of body.Causative factors in teratogenesis. Infertility, Artificial insemination, Surrogacy, ART (Assisted Reproductive technologies), IVF and Test tube babies, GIFT (Gamete intra fallopian transfer) ZIFT (Zygote intra fallopian transfer) ICSI (Intra cytoplasmic Sperm Injection)	**10**

Practical	**60 Hours**
1. Observation of different types of eggs – amphibian egg, hen's egg, insect egg. 2. Observation of developmental stages of frog's egg: cleavage, blastula, gastrula. 3. Study of morphogenetic movement in vivo in hen's egg using vital staining technique by preparing a window opening. 4. In vitro observation of the different extra embryonic membranes in a 6 days old chick embryo. 5. Mounting of eye vesicle and limb buds of a 6 day old chick embryo. 6. Preparation of permanent slides of chick embryo. 24 hrs., 36 hrs., 48 hrs., 72 hrs. 7. To study the regenerative ability in vertebrates (fish fin).	

LEARNING OUTCOMES:

At the end of the course students will be able to

- Describe the science of developmental Biology and its role in advancement of research in Science

REFERENCES:

Text Books:

1. Armugam (2014) A text book of Embryology, Saras Publications
2. Balinsky, B. I., (2016) An introduction of embryology, Saundus College pub., Philadelphia. Berril N. J., (1971) Developmental Biology, McGraw Hill, New Delhi.
3. Boby Jose (2017) Developmental Biology, Reproductive Biology and teratology, Manjusha Publ. Calicut
4. Bruce M. Carlson (2008) Patten's Foundations of Embryology 6th Edn. McGraw Hill, Inc. Ghose, K. C. and B. Manna (2007) Practical Zoology, New Central Book Agency. New Delhi
5. Gilbert, S. F. (2017) Developmental Biology, Sinauer Associates, Sunderland.
6. Jain, P.C. (2001) Elements of Developmental Biology, Vishal Publications, Jalandhar
7. Lal, S. S. (2018) A Text book of practical zoology (vertebrates) Rastogi publications, Meerut McEwen, R. S. (1953) Vertebrate Embryology, Oxford and IBH publishing company, New Delhi.
8. Nair, P. K. G. and K. P.Achar (2013) Principles of Animal Embryology, Himalaya Publishing House.
9. Sastry, K. V. R. and Shukla (2010) Developmental Biology; Rastogi publications. Meerut Subramanian, M. A. (2014) Developmental Biology, MJP Publications,
10. Suresh C. Goel, (2016) Principles of Animal Developmental Biology, Himalaya Publishing House.
11. Verma, P. S. and V. K. Agarwal (2010) Chordate Embryology (Developmental Biology) S. Chand and Company Ltd., Ram Nagar, N. Delhi.

ZOC 109	ENVIRONMENTAL BIOLOGY AND TOXICOLOGY (Semester VI)	Credits: 06 (Theory: 04 & Practical: 02)

COURSE OBJECTIVES:

- To understand the concepts and application of Environmental biology and Toxicology

SYLLABUS

Theory: **60 Hours**

Unit 1: Introduction to Environmental Biology **02**

Definition of ecology and environmental biology, brief idea of Ecological scales: levels of organization (species to Biosphere).

Unit 2: Natural Resources **08**

Introduction, resource cycle, mineral resources (Distribution and Classification of minerals, Mineral wealth of India), Marine living resources, Energy resources (Renewable and Non- renewable), Nuclear energy (Uranium and Thorium), Forest resources, Water: a vital resource. Human impact on Natural Resources.

Unit 3: Population Dynamics **10**

Introduction to population ecology, Natality, Mortality, Fecundity, Life tables, Age distribution of population, Age pyramids, Sex ratio, Biotic potential and Environmental resistance, growth form and Growth rate of population. Population dispersion: Emigration, Immigration, Migration. Regulation of Population size.

Unit 4: Conservation Biology **10**

History, scope and global conservation efforts, India‟s Biodiversity: Mega diversity status and Biodiversity Hotspots, Concerns and conservation challenges (Proximate and Root causes of biodiversity loss), Global conservation priorities and IUCN Conservation categories, IUCN- RED Data Book, Drivers of Extinction , Extinct Indian species. Strategic Species Concept: Keystone species, Indicator species ,Umbrella species and Flagship species. Restoration Ecology: Scope and application.

Unit 5: Environmental toxicology **12**

Introduction to toxicology:

Definition, history, disciplines and importance of toxicology. Brief introduction of toxicants, classification of toxicants,Toxicity, poisons, classification of poisons, Environmental carcinogens, pollutants and classification of pollutants (On the basis of physical properties, primary and secondary pollutants, biodegradable and non-biodegradable pollutants)

Definition and classification of environmental toxicants-Toxicants in atmosphere- sources and effects on public health (CO, NO, NOx, NH3, and S02 and H2S, hydrocarbons, 03, photochemical products like benzopyrene, peroxybenzoyl nitrate (PB2N) and Peroxyacetyl Nitrate (PAN). lead from automobile emission and Particulate matter (mist, smoke, fumes and dusts)

Toxicants in hydrosphere- Sources and effects on environment and public health (Domestic sewage, Industrial effluents, Agricultural discharges, Fertilizers, Detergents, Toxic metals, Silts, Oils, Thermal pollutants, Radioactive materials and Pesticides). Environmental levels and toxicity of

heavy metals e.g. mercury, lead, arsenic and cadmium. **Unit 6: Food toxicants and Pesticides:** Food toxicants and effects on public health: Food additives: incidental or indirect additives, intentional or direct additives (Antioxidants, Emulsifiers, Enzymes, Flavoring agents, Colour and Preservatives). Artificial sweetening agents (Saccharin and Urea derivatives). Food contaminants. Pesticides: Definition,classificationand toxic effects of pesticides onpublic health. **Unit 7: Radioactive substances** Introductionanddefinitionofradioactivesubstances, Definition, unit and classification of radiation: Ionizing Radiations - electromagnetic radiation (X- rays, gamma rays) and corpuscular radiation (Alpha and beta particles, neutrons). Non ionizing radiation. Sources of radiations: Natural and Anthropogenic sources. Radiation episodes (Atom bomb explosion at Hiroshima and Nagasaki). Harmful effects of Radiations on Public health and Brief information about Maximum Permissible Doses. Beneficial aspects of Radiation. **Unit 8: Introduction to toxicants** Translocation, Absorption, Distribution, Storage , Biotransformation and excretion . Bio- concentration, Bioaccumulation, Bio magnification, Bioassays, Toxicity tests, Acute and Chronic toxicity tests, LC50, LD50 and EC50 value. Safety evaluation of toxicants.Environment impact assessment (Definition, objectives and Key steps in EIA process). Risk assessment (Definition and steps in Risk assessment) and safety evaluation programme.	**06** **06** **06**
Practicals	**60 Hours**
1. Determination of Calcium and Magnesium in water. 2. Determination of Salinity of water sample. 3. Estimation of Total Dissolved Solids in given water sample. 4. Estimation of Inorganic phosphates in the given water sample by Spectrophotometric method. 5. Quantitative and qualitative estimation of zooplanktons and calculation of alpha diversity indices (Shanon Simpson Evenness) 6. Tricho-taxonomical catalogue of captive wild ungulate mammalian species found in Goa. 7. Determination of species density (Sample Area Plot) and Richness (Using Chao Estimators) by simulation (Printed Sample Forest data) 8. Identification and characterization of any five common mineral resources of Goa. 9. Effect to pesticide on Oxygen consumption in fish/bivalve. 10. Analysis of Pesticide residues by Finger printing technique 11. Detection of metals in a suspected sample by means of the „spot test". **12.** Detection of Formaldehyde in Milk and fish sample	

LEARNING OUTCOMES:

At the end of the course students will be able to

- Understand the natural resources, population dynamics & conservation biology. They will also have basic and applied knowledge of toxicology and fate of toxicants in the environment.

REFERENCES:

Theory

1. Agarwal, V. K. (2017) Zoology for Degree students.Non- Chordates & Ecology. B.Sc. (Hons.) Sem–I. As per UGC CBCS, S. Chand and Company Ltd. New Delhi.
2. Arora, M. P. (2004) Ecology, Himalaya Publishing House, New Delhi.
3. Ballantyne, B. Mars, T. and P. Turner (1993) General & Applied Toxicology.Eds, Vol I & II, ISBN: 0333498011, McMillon, Stockton Press,
4. Gad. S. C. and Chengelis, C. P (1998) Animal Models in Toxicology, ISBN: 0824784561.
5. Kumar, H. D. (2014) Modern concepts of Ecology.Eighth Revised edition, Vikas publishing house Pvt. Ltd.
6. Mahua Basu and S. Xavier (2016) Environmental Studies Cambridge University Press, Delhi.
7. Omkar (2006) Concepts of Toxicology. Vishal Publishing Company. Jalandhar.
8. Pandey, K. Shukla, J. P. and S. P. Trivedi (2009) Fundamentals of toxicology.New Central Book Agency Pvt. Ltd. Pune.
9. Puspesh J. (2017): Wildlife and Forest Conservation a Status Report. Swastik publications, New Delhi.
10. Singh, J. S., Singh, S. P. and S. R. Gupta (2014) Ecology, Environmental Science & Conservation,
11. S. Chand & Company Pvt. Ltd. New Delhi.
12. Sharma, S. P., Rastogi and Lamporary (1994) Environmental Biology & Toxicology.Sood A Swarup and Sons, New Delhi
13. Shaw, L. C. and J. Chadwick.(1998) Principles of environmental toxicology, Taylor and Francis Ltd. Taylor and Francis, 1996 Basic Toxicology: Fundamentals, Target Organ & Risk Assessment. F.C.
14. Lu, ISBN: 1560323809.
15. Verma P. S. and V. K. Agarwal (2017) Environmental Biology (Principles of Ecology.

ZOC 110	PARASITOLOGY (Semester VI)	Credits: 06 (Theory:04 & Practicals:02)

COURSE OBJECTIVES:

Theory: **(60 Hours)**

- To study the different types of parasites with respect to morphology, lifecycle and control measures.

SYLLABUS

Theory:

Unit 1: Introduction to Parasitology Scope of parasitology, historical perspective, parasites and parasitism; parasitoid and vectors (Mechanical and Biological Vector), host- parasite relationship.	**10**
Unit 2: Parasitic Protists Study of Morphology, Life cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of the following: *1) Entamoebahistolytica2) Giardia lamblia3) Leishmania donovani4) Plasmodium vivax and P. falciparum*	**12**
Unit 3: Parasitic Platyhelminthes Study of morphology, life cycle, prevalence, epidemiology, pathogenicity, diagnosis, prophylaxis and treatment of the following: 1) *Fasciolopsisbuski2) Schistosomahaematobium3) Taenia solium4) Hymenolepis nana*	**10**
Unit 4: Parasitic Nematodes Study of morphology, life cycle, prevalence, epidemiology, pathogenicity, diagnosis, prophylaxis and treatment of the following: 1) Ascarislumbricoides2) Ancylostomaduodenale 3) Wuchereriabancrofti4)Trichinellaspiralis	**12**
Unit 5: Parasitic Arthropoda Biology, importance and control measures of ticks, mites, Pediculushumanus (Head and Body louse), Xenopsyllacheopis and Cimexlectularius	**10**
Unit 6: Parasitic Vertebrates A brief account of parasitic vertebrates: Cookicutter shark, Candiru, Hood Mockingbird and Vampire bat	**06**

Practical **60 hours**

1. Study of life stages of the following through permanent slides or microphotographs: Entamoebahistolytica,
Giardia intestinalis, Leishmaniadonovani Plasmodium vivax Plasmodium falciparum

2. Study of adult and life stages of the following using specimen / slides / microphotographs Fasciolopsisbuski,
Schistosomahaematobium, Taeniasolium Hymenolepis nana

3. Study of adult and life stages of the following:
Ascarislumbricoides, Ancylostomaduodenale, Wuchereriabancrofti Trichinellaspiralis

4. Study of the following specimen: Pediculushumanus (Head louse and Body louse), *Xenopsyllacheopis Cimexlectularius*

5. Study of monogenea from the gills of fresh/ marine fish (Gills can be procured from fish market as byproduct of the industry)

6. Study of nematode / cestode parasites from the intestines of Poultry bird (Intestine can be procured from poultry/ market as a byproduct)

LEARNING OUTCOMES:

At the end of the course students will be able to

- Know prevalence, epidemiology, pathogenicity, diagnosis and treatment of the various parasites under the study.

REFERENCES:

1. Ahmed, N., Dawson, M., Smith, C. and Wood, (Ed.) (2007) Biology of Disease. Taylor and Francis Group
2. Arora, D. R and B. Arora (2001) Medical Parasitology.II Edition. CBS Publications and Distributors
3. Chakraborty, P. (2010) Textbook of Medical parasitology, New Central Book Agency (P) Ltd.London- Delhi
4. Chatterjee, K. D. (2009) Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers and Distributors (P) Ltd.
5. Meyer, Olsen and Schmidt‟s (2015) Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers
6. Noble E. R. and G.A. Noble (1982) Parasitology: The biology of animal parasites. V Edition, Lea &Febiger
7. Parija, S. C.(2013) Textbook of Medical Parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi
8. Rajan T.V (2009): Textbook of Medical Parasitology, BI Publications Pvt. Ltd. New Delhi
9. Rajesh Karyakarte, AjitDample (2008): Medical Parasitology Books and Allied (P) Ltd. Kolkata.
10. Rattan LalIIchhpujani and Rajesh Bhatia (2010) Medical Parasitology, III Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi

ZOD 104	ANIMAL BIOTECHNOLOGY (SEMESTER VI)	Credits: 04 (Theory:04)

COURSE OBJECTIVES:

- To provide students with theoretical and practical understanding of animal biotechnology

SYLLABUS

Theory:

Unit 1: Introduction Concept, History, Disciplines, Importance and Scope of Biotechnology	**3**
Unit 2: Microbiology Introduction to microbes, Classification of bacteria, Structure of bacterial cell, Nutritional requirements	**3**
Unit 3: Molecular Techniques (Enzymes and Vectors) in Gene manipulation Cloning vectors: Plasmids, Cosmids, Phagemids, Shuttle Vectors, Lambda Bacteriophage, M13, BAC, YAC, MAC, pBR, pUC, SV40 and Expression vectors (characteristics). Restriction enzymes: Nucleases (Endonucleases, Exonucelases, Nomenclature, recognition sites, sequences, cleavage patterns), DNA ligases, Transcriptases, Polynucleotide Kinases, Alkaline Phosphatase and NucleotidylTransferase,	**15**
Unit 4: Transformation methods and techniques: Calcium chloride method and electroporation, Construction of genomic and cDNA libraries and screening by colony and plaque hybridization, Southern, Northern and Western blotting DNA sequencing: Sanger method Polymerase Chain Reaction, DNA Finger Printing and DNA micro array.	**12**
Unit 5: Genetically Modified Organisms Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection, Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knockout mice.	**12**

PRACTICAL

1. Sterilization techniques
2. Preparation of media for cell culture (agar plate, slants, deep)
3. Isolation and enumeration of bacteria (spread plate and streak plate method)
4. Motility study by hanging drop and stab culture methods.
5. Biochemical tests: IMViC.
6. Separation and Collection of Serum.
7. Viable count of a given cell sample

LEARNING OUTCOMES:

At the end of the course students will be able to

- Describe the science of biotechnology and how biotechnology methods are used to conduct experiments and develop products for bioethical use.

REFERENCES:

1. Brown, T. A. (1990) Gene Cloning an Introduction, VNR International Publ. Dubey and Maheswari (2007) Practical Microbiology, S. Chand & Co. Ltd.
2. Dubey, R. C. (2014) A textbook of Biotechnology, 5th Ed. S. Chand & Co. Pvt. Ltd. New Delhi
3. Freshney, R. I. (2000) Culture of Animal Cells – A manual of Basic Techniques, 4th Ed, A. John Wiley & Sons, Inc. Publ.
4. Pelczar, (1998) Microbiology, (Reprint, 2001) Tata McGraw-Hill Publishing Co. Ltd.
5. Purohit, S. S., (2000) Biotechnology Fundamentals and Applications, Agrobios Publ. New Delhi Ranga, M. M., (1999) Animal Biotechnology, Agrobios Publ. New Delhi
6. Singh, B. D., (2010) Biotechnology, 3rd Ed., Kalyani Publ. Calcutta