

CBCS ZOOLOGY SYLLABUS

(B.Sc. Sem I,II,III,IV General Course) and B.ScSem V, VI(Honours Course)

SEMESTER I (F.Y. B.Sc)				
PAPER CODE	TITLE		CREDITS	TOTAL CREDITS
ZOC 101	Diversity of Non Chordates&Cell Biology	Theory Practical	04 02	06
ZOG 101	Food, Nutrition and Health	Theory	04	04
SEMESTER II (F.Y. B.Sc)				
ZOC 102	Diversity of Chordates & Genetics	Theory Practical	04 02	06
ZOG 102	Animal Behavior	Theory	04	04
SEMSTER III (S.Y.B.Sc)				
ZOC 103	Anatomy of animal body system	Theory Practical	04 02	06
ZOS 101	Aquarium fish keeping	Theory Practical	03 01	04
SEMESTER IV (S. Y. B.Sc)				
ZOC 104	Animal Physiology and Biochemistry	Theory Practical	04 02	06
ZOS 102	Wild life and Eco tourism	Theory Practical	03 01	04
SEMESTER V (T. Y. B.Sc)				
ZOC 105	Endocrinology	Theory Practical	04 02	06
ZOC 106	Biochemistry and metabolic processes	Theory Practical	04 02	06
ZOC 107	Molecular biology & Evolution	Theory Practical	04 02	06
ZOD 101	Research Methodology and Biostatistics	Theory Practical	03 01	04
ZOD 102	Applied Zoology	Theory Practical	03 01	04
ZOD 103	Fish and Fisheries	Theory Practical	03 10	04
SEMESTER VI (T. Y. B.Sc)				
ZOC 108	Developmental Biology	Theory Practical	04 02	06
ZOC 109	Environmental Biology & Toxicology	Theory Practical	04 02	06
ZOC 110	Parasitology	Theory Practical	04 02	06
ZOD 104	Animal biotechnology	Theory Practical	03 01	04
ZOD 105	Environmental Impact assessment	Theory Practical	03 01	04
ZOD 106	Fundamentals of Zoology Applications	Theory Practical	03 01	04
ZOP 101	Project work			04

COURSE CURRICULUM:(B.Sc. Sem I,II,III,IV General Course) and B.ScSem V, VI(Honours Course)**SEMESTER I (ZOC-101, ZOG-101)****PAPER CODE: ZOC 101****TITLE: DIVERSITY OF NON-CHORDATES AND CELL BIOLOGY****Theory****Credits:04**

Learning Objective: To know the general characters and classification of Nonchordates and understand the structure and function of animal cell.

Learning Outcome: On completion of the course the student should be able to know the general organization of Non-chordates as a group and know the taxonomy and characteristic features of the various Non-chordate phyla. The student should also understand the architecture and functions of a cell and its organelles.

Topics	Duration - 60 (Clock hours)
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

3

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*

Unit 10: Introduction to Cell biology

2

Overview of general organization of cells (Prokaryotic cells and Eukaryotic cells); Brief information about PPLO (Pleuro Pneumonia Like Organism)

Unit 11: Cell Environment

05

- Chemical bonds
- Inorganic- water, salts and ions
- Organic- proteins, carbohydrates, lipids, nucleic acids, vitamins
- Effect of radiation on cells (UV radiations, photodynamics sensitization)

Unit 12: Cell Organelles

15

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)

Unit 13: Nucleus

04

Nuclear envelope, Nucleoplasm, Euchromatin and Heterochromatin, Nucleolus, Nucleosomes

Unit 14: Cancer Biology

04

Characteristics of cancer cell

Carcinomas, Sarcomas, Lymphomas, Leukemia

Carcinogenesis – Mutation and Viral theories of Carcinogenesis

PRACTICALS

Credits: 02

- 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, Nephridia 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

SUGGESTED READINGS

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
- 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
- Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson
- Jordan E.L., Verma P.S. (2001), *Invertebrates Zoology*., S. Chand and company, New Delhi
- Barnes, R.D. *Invertebrate Zoology* (1982) VI Edition. Holt Saunders International Edition.
- D.W. and J.I., Spicer (2002) *The Invertebrates: A New Synthesis*. III Edition. Blackwell Science.
- Boradale, L.A. and Potts, E.A. (1961) *Invertebrates: A Manual for the use of Students*. Asia Publishing Home.
- Bushbaum, R. (1964) *Animals without Backbones*. University of Chicago Press.
- Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- 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.
- Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- 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.

PAPER CODE: ZOG 101**TITLE: FOOD, NUTRITION AND HEALTH****THEORY****(Credits-4)****Learning Objective:** To know the basic concepts of food, nutrients and its impact on health.**Learning Outcome:** On completion of the course the student should be able to know the concept of balanced diet, special nutritional requirements in various age groups and the diet related disorders in humans.

Topics	Duration - 60 (Clock hours)
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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

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, if any.

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: **15**

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

Suggested Readings

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

SEMESTER II (ZOC 102, ZOG 102)**PAPER CODE: ZOC-102****TITLE: DIVERSITY OF CHORDATES & GENETICS****Theory****Credits:04**

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

Learning Outcome: On completion of the course the student should be able to identify and classify the Chordates and also know about the abnormalities of the chromosomes and the pattern of inheritance of genetic traits

Topics	Duration- 60 (Clock hours)
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 **5**

General features and Classification up to orders; Volant adaptations in birds, Migration in Birds.

Unit 7: Mammals **5**

Salient features of mammals,
Classification up to orders; Origin of mammals,

Unit 8: Mendelian Genetics & its Extension **10**

Overview of Mendelian Genetics

Epistasis and Hypostasis, Multiple genes and multiple alleles, Sex linked, sex limited and sex influenced inheritance (with one example each)

Unit 9: Chromosome Structure: **06**

Eukaryotic Chromosome, Types of Eukaryotic Chromosome (based on centromere position), Eukaryotic and prokaryotic chromosomal organisation, Giant chromosomes (polytene and lampbrush)

Unit 10: Gene Mutation **05**

Natural and Induced Mutations, Types of gene mutation (base pair substitution and frame shift) Types of chromosomal aberration, Causative agents of Mutation.

Unit 11: Inbreeding and Heterosis **04**

Definition of Inbreeding, Inbreeding depression, Practical applications of Inbreeding. Heterosis – Genetic basis; Application and Evolutionary significance.

Unit 12: Inheritance of Human traits **05**

Human karyotype, Pedigree analysis

Inheritance of human traits: Brown eyes, Polydactyly, Diabetes insipidus, Sickle cell anemia, PKU Eugenics and Genetic counseling

PRACTICALS

Credits:02

- 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.

SUGGESTED READINGS

- Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
- Pough H. *Vertebrate life*, VIII Edition, Pearson International.
- Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger PubCo.
- Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.
- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India
- Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings
- Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition. Benjamin Cummings
- 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.

PAPER CODE: ZOG 102**TITLE: ANIMAL BEHAVIOUR****THEORY****(Credits 4)**

Learning Objective: To know the theories and patterns of animal behavior.

Learning Outcome: On completion of the course the student should be able to understand stereotyped and social behaviors of animals and know about the biological rhythms governing the behavior of animals.

Topics	Duration- 60 (Clock hours)
Unit 1: Introduction to Animal Behaviour	10
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 behaviour	
Unit 2: Patterns of Behaviour	15
Stereotyped Behaviours (Orientation, Reflexes); Individual Behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, classical and operant conditioning, Habituation, Imprinting.	
Unit 3: Social and Sexual Behaviour	15
Social Behaviour: 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.	
Unit 4: Biological Rhythm	15
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.

Unit 5: Biological Clocks

05

Relevance of biological clocks; Chronopharmacology, Chronomedicine, Chronotherapy.

Suggested Readings

- David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.
- Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge, University Press, UK.
- John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
- Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
- Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
- Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.) R.D. Lewis. (3rd Ed) 2002 Barends and Noble Inc. New York, USA
- Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/Springer-Verlag, Germany.

COURSE CURRICULUM: (B.Sc. Sem I,II,III,IV General Course) and B.ScSem V, VI (Honours Course)

SEMESTER III (ZOC-103, ZOS 101)

PAPER CODE: ZOC-103

TITLE: ANATOMY OF ANIMAL BODY SYSTEMS

THEORY

(Credits: 04)

Learning Objective: To know structure and functions of the different systems in the vertebrates.

Learning Outcome: On completion of the course the student should be able to know the general plan and functioning of different components of the systems in the body.

Topics	Duration- 60 (Clock hours)
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

PRACTICALS

(Credits: 02)

- Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
- Disarticulated skeleton of Frog, *Varanus*, Fowl, Rabbit
- Carapace and plastron of turtle /tortoise
- Mammalian skulls: One herbivorous and one carnivorous animal
- Dissection of rat to study arterial and urinogenital system (subject to permission)
- 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)
- Project on skeletal modifications in vertebrates (may be included if dissection not permitted)

Suggested Readings

- Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies
- Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons
- Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House

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PAPER CODE: ZOS-101
TITLE: AQUARIUM FISH KEEPING

THEORY

(CREDITS: 03)

Learning Objective: To know the technique of rearing /maintaining fishes in an aquarium.

Learning Outcome: On completion of the course the student should 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.

Topics	Duration- 45 (Clock hours)
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

Practicals

(Credits: 01)

- Identification of common Aquarium fishes
- Identification of live feed organisms
- Study of different types of formulated feeds
- Preparation of formulated feed
- Study of slides of parasites and diseases
- Setting up of an aquarium
- Study of ornamental plants

Suggested Readings

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

SEMESTER IV (ZOC104, ZOS 102)**PAPER CODE: ZOC 104****TITLE: ANIMAL PHYSIOLOGY & BIOCHEMISTRY****THEORY****(Credits: 04)**

Learning Objective: To understand the physiology of the different processes of the body systems and the micromolecules and macromolecules of the cells.

Learning Outcome: On completion of the course the student should be able to know mechanism of body functions and the basic knowledge of chemistry of biomolecules.

Topics	Duration- 60 (Clock hours)
Unit 1: Physiology of Digestion	6
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.	
Unit 2: Physiology of Respiration	7
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	
Unit 3: Renal Physiology	5
Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance	
Unit 4: Cardiovascular Physiology	6
Composition of blood, blood volume, Origin and conduction of the cardiac impulse, Cardiac cycle, Regulation of blood pressure and heart rate.	
Unit 5: Muscle Physiology	6
Types of muscles, Ultrastructure of skeletal muscles, properties of skeletal muscles, theories of muscle contraction,	
Unit 6: pH and buffer	1
Definition of pH, buffer, types of buffer.	
Unit7: Carbohydrates	7
Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates	

Unit 8: Lipids

7

Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Triacylglycerols, Phospholipids, Glycolipids, Steroids

Unit 9: Proteins

8

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 conjugate proteins

Unit 10: Enzymes

7

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.

PRACTICALS

(Credits: 02)

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

Suggested Readings

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

PAPER CODE: ZOS 102

PAPER TITLE: WILDLIFE AND ECOTOURISM

THEORY

Credits: 03

Learning Objective: To learn the objectives and strategies of wildlife conservation and monitoring.

Learning Outcome: On completion of the course the student should be able to know the current status and conservation strategies for wildlife conservation and management.

Topics	Duration- 45 (Clock 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	04
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
Unit 3: Wildlife Conservation-Objectives & Methods Meaning of conservation, Objectives of wildlife conservation Conservation strategies, <i>Ex situ</i> & <i>In situ</i> 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)	06
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

15

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

Reference Books

- S K Singh (2010) *Text Book of wildlife Management* International Book Distributing Company, Lucknow
- Vivek Menon (2014) *Indian Mammals : A Field Guide* Hachette Book Publishing India Pvt Ltd, Gurgaon
- S S Negi (1992) *Himalayan Wildlife*. Indus Publishing Company, New Delhi
- Mohan Pai (2005) *The Western Ghats*. M/S Narainvadmodar Naik Margao, Goa
- Richard Carmichael (2007). *Indian Wildlife*. Apa Publications GmbH Co. Verlag KG (Singapore)
- Ravee Chauhan (2006) *Ecotourism Trends & Challenges*. Vista International Publishing House Delhi
- David Newsome, Susan Moore and Ross K Dowling (2006) *Natural Area Tourism Ecology, Impacts and Management*. Viva Books Pvt Ltd Ac Delhi
- C. Michael Hall and Stephen Boyd (2006) *Nature based tourism in peripheral areas - Development or disaster ?* Viva Books Pvt Ltd New Delhi
- Ministry of Environment & Forests GoI, (2002), *National Biodiversity Strategy & Action Plan*

Practicals

Credits: 01

- Use of Maps and other GIS resources to understand the biogeographic zones of India and understand the location of our State in this scheme.
- 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
- Visit to a state WPA and CCA to understand and prepare Report on the management and conservation action.
- 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:

CBCS Course structure and Curriculum (General) B.Sc. Zoology, Goa University

- 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)
- 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)
- Population enumeration by Lincoln & Peterson's Index Method (Coloured Beads to represent marked to unmarked individuals)

References

1. William 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
1. Issac Kehimkar (2011) *The Book of Indian Butterflies*. Oxford.
6. Luigi Boitani & Roger Powell (2012) *Carnivore Ecology and Conservation*. Oxford University Press
7. Romulus Whitaker & Ashok captain (2008) *Snakes of India*. Draco Books Tamil Nadu
8. Asad R Rehmani (2012) *Threatened Birds of India*. Oxford University Press
9. Ravee Chauhan (2006) *Ecotourism Trends & Challenges*. Vista International Publishing House Delhi
10. David Newsome, Susan Moore and Ross K Dowling (2006) *Natural Area Tourism Ecology, Impacts and Management*. Viva Books Pvt Ltd Ac Delhi
11. *The Wildlife (Protection) Act*, (1972) Natraj Publishers

CBCS Course structure and Curriculum (Honours) B.Sc. Zoology, Goa University

CBCS ZOOLOGY SYLLABUS

(B.Sc. Sem I, II, III, IV General Course) and B.ScSem V, VI (Honours Course)

SEMESTER I (F.Y.B.Sc)				
PAPER CODE	TITLE		CREDITS	TOTAL CREDITS
ZOC 101	Diversity of Non Chordates & Cell Biology	Theory Practical	04 02	06
ZOG 101	Food, Nutrition and Health	Theory	04	04
SEMESTER II (F.Y.B.Sc)				
ZOC 102	Diversity of Chordates & Genetics	Theory Practical	04 02	06
ZOG 102	Animal Behavior	Theory	04	04
SEMESTER III (S.Y.B.Sc)				
ZOC 103	Anatomy of animal body system	Theory Practical	04 02	06
ZOS 101	Aquarium fish keeping	Theory Practical	03 01	04
SEMESTER IV (S.Y.B.Sc)				
ZOC 104	Animal Physiology and Biochemistry	Theory Practical	04 02	06
ZOS 102	Wild life and Eco tourism	Theory Practical	03 01	04
SEMESTER V (T.Y.B.Sc)				
ZOC 105	Endocrinology	Theory Practical	04 02	06
ZOC 106	Biochemistry and metabolic processes	Theory Practical	04 02	06
ZOC 107	Molecular biology & Evolution	Theory Practical	04 02	06
ZOD 101	Research Methodology and Biostatistics	Theory Practical	03 01	04
ZOD 102	Applied Zoology	Theory Practical	03 01	04
ZOD 103	Fish and Fisheries	Theory Practical	03 01	04
SEMESTER VI (T.Y.B.Sc)				
ZOC 108	Developmental Biology	Theory Practical	04 02	06

CBCS Course structure and Curriculum (Honours) B.Sc. Zoology, Goa University

ZOC 109	Environmental Biology & Toxicology	Theor y Practic al	04 02	06
ZOC 110	Parasitology	Theory Practical	04 02	06
ZOD 104	Animal biotechnology	Theory Practical	03 01	04
ZOD 105	Environmental Impact assessment	Theory Practical	03 01	04
ZOD 106	Fundamentals of Zoology Applications	Theory Practica l	03 01	04
ZOP 101	Project work			04

SEMESTER V
CBCS B.Sc Zoology (Honours Course)
ZOC 105: ENDOCRINOLOGY

Learning objective: To learn the mechanism of integrative physiology.

Learning outcome: On completion of the course, the students will know the internal methods on integrating the functions of different internal systems to maintain homeostasis through hormonal regulation.

THEORY

Credits: 04
Duration – 60 Hrs.

Unit 1: Introduction

07

Endocrinology, Endocrine glands.

Concept of homeostasis - Glucose and Calcium Homeostasis.

Unit II: Endocrine Hypothalamus

07

Hypothalamohypophyseal portal system, Hypothalamohypophysealneurosecretory tracts, Hypothalamic nuclei, - Magnocellular and Parvicellular elements. Hypothalamic releasing and inhibitory hormones/factors.

Unit III: Hormones

07

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.

Unit IV: Hypophysis

12

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.

Unit V: Thyroid

07

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.

Unit VI: Endocrine Pancreas

06

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).

Unit VII: Adrenal

08

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, Catacholamines and their roles in metabolism. Adrenocortical disorders – Cushing's syndrome and Virilism.

Unit VIII: Gonads as endocrine structures

06

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.

PRACTICALS

Credits: 02

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 / photomicrograph.

CBCS Course structure and Curriculum (Honours) B.Sc. Zoology, Goa University

References:

1. Bloom and Fawcett (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 correlated cell and Molecular Biology, Walter Kluwer health- Lippincott 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

CBCS Course structure and Curriculum (Honours) B.Sc. Zoology, Goa University

SEMESTER-V

CBCS B.Sc Zoology (Honours Course)

Paper Code: ZOC 106 BIOCHEMISTRY AND METABOLIC PROCESSES

Learning Objective: To provide students with theoretical and practical understanding of Biochemistry and metabolic processes

Learning Outcome: The student should be able to understand intricacies of Biochemistry and Its role in metabolic processes.

THEORY

Credits: 04
Duration: 60 Hrs

Unit 1: Overview of Metabolism 10

Metabolism, Stages of catabolism, Sub divisions of Metabolism, Catabolism vs. Anabolism, regulation of Metabolic pathways, Shuttle systems and membrane transporters;

Unit 2: Bioenergetics 05

Concept of Energy, Laws of Thermodynamics, Free energy, ATP as “energy currency” of the cell.

Unit 3: Carbohydrate Metabolism 15

Sequence of Reactions and Regulation of Glycolysis, Pentose phosphate pathway, Oxidative decarboxylation, Citric acid cycle, Gluconeogenesis, Glycogenolysis and Glycogenesis., Mitochondrial respiratory Chain,

Unit 4: Oxidative Phosphorylation 10

Mechanism of oxidative phosphorylation - Chemical coupling Hypothesis, Conformational coupling Hypothesis, Chemiosmotic Coupling Hypothesis. Inhibitors and Uncouplers of Electronic Transport system.

Unit 5: Amino acid metabolism 10

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)

Unit 6: Lipid Metabolism 10

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

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PRACTICALS:

Credit: 02

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

References:

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

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

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

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

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

CBCS Course structure and Curriculum (Honours) B.Sc. Zoology, Goa University

SEMESTER-V CBCS B.Sc Zoology (Honours Course)

Paper Code: ZOC 107: MOLECULAR BIOLOGY AND EVOLUTION

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

Learning Outcome: The student should be able to appreciate and know the scope of molecular biology in terms of evolution of the major groups of organisms.

THEORY

Credits: 04
(Duration 60hrs)

Unit 1: DNA Replication and Repair mechanism

07

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

Unit 2: Transcription, Post-Transcriptional Modifications and Processing of Eukaryotic RNA

08

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

Unit 3: Translation

09

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, aminoacyltRNAsynthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation

Unit 4: Gene Regulation

06

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.

Unit 5: Concept of Evolution, Origin of Life and speciation

10

Basic concept of organic evolution (Micro, macro and mega); Theories of evolution (Lamarckism, Darwinism, Neo-Darwinism, Contribution of Weisman, De Vries, Huxley, Haeckel); Origin of Earth; Chemogeny; Biogeny; Cognogeny; concept of species (morphological, genetic, biological) Species categories (monotypic, polytypic, sibling) subspecies; origin of species (allopatric, sympatric, parapatric).

CBCS Course structure and Curriculum (Honours) B.Sc. Zoology, Goa University

Unit 6: Variability and Mutations

06

Nature, kind, causes and role of variability. Mutations : definition, characteristics, types, causes, and effects. Induced, natural and gene mutation.

Unit 7: Isolation and Adaptation

08

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.

Unit 8: Genetic basis of evolution and study of fossils

06

Population genetics; gene pool, frequency and equilibrium; Hardy Weinberg's Law of equilibrium. Fossils (types, formation, dating and significance)

PRACTICALS

Credit: 02

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) Transcription (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.

CBCS Course structure and Curriculum (Honours) B.Sc. Zoology, Goa University

References:

Arora, M. P. (2000) Organic Evolution. 2nd Ed. Himalaya Publishing House, Mumbai.

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.

De Robertis, E. D. P. and E. M. F. De Robertis, (2006) Cell and Molecular Biology. 8th Ed. Lippincott Williams and Wilkins, Philadelphia.

Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th Ed. John Wiley and Sons. Inc.

McLennan A., Bates A., Turner, P and M. White, (2015) Molecular Biology. 4th Ed. GS, Taylor and Francis Group, New York and London.

Rastogi, V. B., (1998) Organic Evolution. 11th Ed. KedarNath Ram Nath, Meerut.

SEMESTER-V
CBCS B.Sc Zoology (Honours Course)

Paper Code ZOD 101: RESEARCH METHODOLOGY AND BIOSTATISTICS

Learning objective: To understand the basic principles in research methodology and biostatistics

Learning outcome: Students will gain knowledge on conducting research and data analysis. Students will also know how to report research effectively in a scientific manner

Theory

Credits 03

Duration 45 Hrs

Unit 1: Foundation of Research

05

Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Quantitative vs Qualitative, Basic vs Applied

Unit 2: Research Design

08

Need for research design: Features of a good design, Important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Formulating hypotheses, Experimentation, Determining experimental and sample designs

Unit 3: Data Collection, Analysis and Report Writing

12

Observation and Collection of Data-Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies, Technical Reports and Thesis writing, Preparation of Tables and Bibliography, Data Presentation using digital technology

Unit 4: Biostatistics

10

Brief introduction to biostatistics- Meaning, functions and importance, Statistical tools: Mean, Median, Mode, Standard Deviation, Standard Error, Correlation, Regression, Chi-Square test, Student's t-test, Fisher's test, ANOVA

Unit 5: Introduction to Biostatistical Software

05

Use of computers for data analysis, Significance of biostatistical software, understanding various statistical software packages such as Microsoft Excel and SPSS. Interpreting outputs of statistical analyses

Unit 6: Ethical Issues

05

Intellectual property rights, Commercialization, Copyright, Royalty, Patent law, Plagiarism, Citation, Acknowledgement

CBCS Course structure and Curriculum (Honours) B.Sc. Zoology, Goa University

Practicals

Credit: 01

1. Manual calculation of statistical methods such as mean, median, mode
2. Manual calculation of statistical methods such as standard deviation, standard error, correlation, regression
3. Calculation of statistical methods using basic statistical software
4. Data collection on the field: mapping and surveying
5. Data collection on the field: sampling
6. Data collection in the lab: Experimentation
7. Data collection from questionnaires
8. Digital presentation of data in the form of graphs, tables, charts

References:

- Anthony M, Graziano, A. M. and M. L. Raulin (2009) Research Methods: A Process of Inquiry, Allyn and Bacon
- Walliman, N. (2011) Research Methods: The Basics. Taylor and Francis, London, New York
- Wadhera, B. L (2002) Law Relating to Patents, Trademarks, Copyright Designs and Geographical Indications, Universal Law Publishing
- Kothari, C. R (2009) Research Methodology, New Age International, New Delhi
- Coley, S. M. and C. A. Scheinberg (1990) Proposal Writing. Stage Publications
- Arora, P. N. and P. L. Malhan (2003) Biostatistics. Himalaya Publications, Mumbai

CBCS Course structure and Curriculum (Honours) B.Sc. Zoology, Goa University

Semester V

CBCS B.Sc Zoology (Honours Course)

ZOD-102 APPLIED ZOOLOGY

Learning Objectives: To learn the interrelationship of animal life with special reference to human life

Learning outcome: On the completion of the course students will get acquainted with the different branches of Applied Zoology.

THEORY

Credits: 03

Duration: 45 Hrs.

Unit 1: Introduction to Applied Zoology 02

Nature, scope & major branches of applied Zoology

Unit 2: Vermiculture 06

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.

Unit 3: Apiculture 06

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.

Unit 4: Sericulture 06

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.

Unit 5: Poultry 09

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.

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Unit 6: Piggery

06

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.

Unit 7: Dairy

10

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.

PRACTICALS

Credit: 01

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.

CBCS Course structure and Curriculum (Honours) B.Sc. Zoology, Goa University

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, Lac Culture, Agricultural Pests and their control).Discovery publishing house, New Delhi.
8. Sukumar De (2001) Outlines of Dairy Technology, Oxford University Press, New Delhi.
9. Tarit Kumar Banerjee (2017) Applied Zoology, New Central Book Agency.
10. Tomer and Bhatnagar (2002) A Textbook of Applied Zoology. Emkay Publication, Delhi

CBCS Course structure and Curriculum (Honours) B.Sc. Zoology, Goa University

SEMESTER-V

CBCS B.Sc Zoology (Honours Course)

Paper Code: ZOD 103 FISH AND FISHERIES

Learning objectives: To provide students with theoretical and practical understanding of Fish and fisheries

Learning Outcome: The student should be able to understand structure, function and behaviour of fishes and role of fisheries in improving human welfare

Theory

Credits 03
(Duration: 45hrs)

Unit 1: Introduction: 02

General description of fish, Classification based on feeding habit, habitat and manner of reproduction.

Unit 2: Morphology, Physiology and behavior 08

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 Elasmobranchs; Reproduction. Migration.

Unit 3: Fisheries 16

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.

Unit 4: Aquaculture 16

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

Unit 5: Fish in research 03

Transgenic fish, Zebra fish as a model organism in research

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Practicals:

(Credit: 01)

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)

References:

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

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

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

Norman, J. R. (1998) A history of Fishes, Hill and Wang Publishers.

Srivastava, C. L. B. (2013) Fish Biology, Narendra Publishing House

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

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

SEMESTER-VI

CBCS B.Sc Zoology (Honours Course)

Paper Code: ZOC 108: DEVELOPMENTAL BIOLOGY

Learning Objectives: To provide students with theoretical and practical understanding of animal developmental Biology

Learning Outcome: The student should be able to describe the science of developmental Biology and its role in advancement of research in Science

THEORY

Credits 04

(Duration 60 Hrs)

Unit 1: Introduction

14

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

Unit 2:

10

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.

Unit 3: Early Embryonic Development of Chick

12

Structure of hen's egg, cleavage, blastula, Gastrulation, Development of chick embryo up to 3 days of incubation.

Unit 4: Late Embryonic Development

07

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)

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Unit 5: Regeneration and ageing

07

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

Unit 6: Implications of Developmental Biology:

10

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)

PRACTICALS:

(Credits: 02)

- 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).

References:

Armugam (2014) A text book of Embryology, Saras Publications

Balinsky, B. I., (2016) An introduction of embryology, Saunders College pub., Philadelphia.

Berril N. J., (1971) Developmental Biology, McGraw Hill, New Delhi.

Boby Jose (2017) Developmental Biology, Reproductive Biology and teratology, Manjusha Publ. Calicut

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

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Gilbert, S. F. (2017) Developmental Biology, Sinauer Associates, Sunderland.

Jain, P.C. (2001) Elements of Developmental Biology, Vishal Publications, Jalandhar

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.

Nair, P. K. G. and K. P.Achar (2013) Principles of Animal Embryology, Himalaya Publishing House.

Sastry, K. V. R. and Shukla (2010) Developmental Biology; Rastogi publications. Meerut

Subramanian, M. A. (2014) Developmental Biology, MJP Publications,

Suresh C. Goel, (2016) Principles of Animal Developmental Biology, Himalaya Publishing House.

Verma, P. S. and V. K. Agarwal (2010) Chordate Embryology (Developmental Biology) S. Chand and Company Ltd., Ram Nagar, N. Delhi.

SEMESTER-VI

CBCS B.Sc Zoology (Honours Course)

Paper Code: ZOC 109: -ENVIRONMENTAL BIOLOGY AND TOXICOLOGY

Learning objectives: To understand the concepts and application of Environmental biology and Toxicology.

Learning outcome: On completion of the course the student will have reasonable understanding of the natural resources, population dynamics & conservation biology. They will also have basic and applied knowledge of toxicology and fate of toxicants in the environment.

THEORY

Credits: 04

(Duration: 60 hrs.)

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.

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Unit5: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, NO_x, NH₃, and SO₂ and H₂S, hydrocarbons, O₃, 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:

06

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, classification and toxic effects of pesticides on public health.

Unit.7:Radioactive substances

06

Introduction and definition of radioactive substances, 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 :

06

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

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assessment (Definition, objectives and Key steps in EIA process). Risk assessment (Definition and steps in Risk assessment) and safety evaluation programme.

PRACTICAL

Credits: 02

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

References:

- 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.
- Arora, M. P. (2004) Ecology, Himalaya Publishing House, New Delhi.
- Ballantyne, B. Mars, T. and P. Turner (1993) General & Applied Toxicology.Eds, Vol I & II, ISBN: 0333498011, McMillon, Stockton Press,
- Gad. S. C. and Chengelis, C. P (1998) Animal Models in Toxicology, ISBN: 0824784561.
- Kumar, H. D. (2014) Modern concepts of Ecology.Eighth Revised edition, Vikas publishing house Pvt. Ltd.
- MahuaBasu and S. Xavier (2016) Environmental Studies Cambridge University Press, Delhi.

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Pandey, K. Shukla, J. P. and S. P. Trivedi (2009) Fundamentals of toxicology. New Central Book Agency Pvt. Ltd. Pune.

Puspesh J. (2017): Wildlife and Forest Conservation a Status Report. Swastik publications, New Delhi.

Singh, J. S., Singh, S. P. and S. R. Gupta (2014) Ecology, Environmental Science & Conservation, S. Chand & Company Pvt. Ltd. New Delhi.

Sharma, S. P., Rastogi and Lamporary (1994) Environmental Biology & Toxicology. Sood A Swarup and Sons, New Delhi

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. Lu, ISBN: 1560323809.

Verma P. S. and V. K. Agarwal (2017) Environmental Biology (Principles of Ecology.

SEMESTER VI
CBCS B.Sc Zoology (Honours Course)
Paper Code: ZOC 110: PARASITOLOGY

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

Learning outcome: On completion of the course students will be able to know prevalence, epidemiology, pathogenicity, diagnosis and treatment of the various parasites under the study.

THEORY

Credits: 04
(Duration: 60hrs.)

Unit 1: Introduction to Parasitology **10**

Scope of parasitology, historical perspective, parasites and parasitism; parasitoid and vectors (Mechanical and Biological Vector), host- parasite relationship.

Unit 2: Parasitic Protists **12**

Study of Morphology, Life cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of the following:

- 1) *Entamoebahistolytica* 2) *Giardia lamblia* 3) *Leishmania donovani* 4) *Plasmodium vivax* and *P. falciparum*

Unit 3: Parasitic Platyhelminthes **10**

Study of morphology, life cycle, prevalence, epidemiology, pathogenicity, diagnosis, prophylaxis and treatment of the following:

- 1) *Fasciolopsisbuski* 2) *Schistosomahaematobium* 3) *Taenia solium* 4) *Hymenolepis nana*

Unit 4: Parasitic Nematodes **12**

Study of morphology, life cycle, prevalence, epidemiology, pathogenicity, diagnosis, prophylaxis and treatment of the following:

- 1) *Ascarislumbricoides* 2) *Ancylostomaduodenale* 3) *Wuchereriabancrofti* 4) *Trichinellaspinalis*

Unit 5: Parasitic Arthropoda **10**

Biology, importance and control measures of ticks, mites, *Pediculushumanus* (Head and Body louse), *Xenopsyllacheopis* and *Cimexlectularius*

Unit 6: Parasitic Vertebrates **06**

A brief account of parasitic vertebrates: Cookicutter shark, Candiru, Hood Mockingbird and Vampire bat.

PRACTICAL

Credits: 02

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)

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References:

- Ahmed, N., Dawson, M., Smith, C. and Wood, (Ed.) (2007) Biology of Disease. Taylor and Francis Group
- Arora, D. R and B. Arora (2001) Medical Parasitology.II Edition. CBS Publications and Distributors
- Chakraborty, P. (2010) Textbook of Medical parasitology, New Central Book Agency (P) Ltd. London- Delhi
- Chatterjee, K. D. (2009) Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers and Distributors (P) Ltd.
- Meyer, Olsen and Schmidt's (2015) Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers
- Noble E. R. and G.A. Noble (1982) Parasitology: The biology of animal parasites. V Edition, Lea &Febiger
- 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
- Rajan T.V (2009): Textbook of Medical Parasitology, BI Publications Pvt. Ltd. New Delhi
- Rajesh Karyakarte, AjitDample (2008): Medical Parasitology Books and Allied (P) Ltd. Kolkata.
- Rattan LalIchhpujani and Rajesh Bhatia (2010) Medical Parasitology, III Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi

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SEMESTER-VI CBCS B.Sc Zoology (Honours Course)

Paper Code: ZOD 104: ANIMAL BIOTECHNOLOGY

Learning Objective: To provide students with theoretical and practical understanding of animal biotechnology

Learning Outcome: The student should be able to describe the science of biotechnology and how biotechnology methods are used to conduct experiments and develop products for bioethical use.

THEORY

**Credits: 03
(Duration: 45 hrs)**

Unit 1: Introduction

03

Concept, History, Disciplines, Importance and Scope of Biotechnology

Unit 2: Microbiology

03

Introduction to microbes, Classification of bacteria, Structure of bacterial cell, Nutritional requirements

Unit 3: Molecular Techniques (Enzymes and Vectors) in Gene manipulation

15

Cloning vectors: Plasmids, Cosmids, Phagemids, Shuttle Vectors, Lambda Bacteriophage, M13, BAC, YAC, MAC, pBR, pUC, SV40 and Expression vectors (characteristics). Restriction enzymes: Nucleases (Endonucleases, Exonucleases, Nomenclature, recognition sites, sequences, cleavage patterns), DNA ligases, Transcriptases, Polynucleotide Kinases, Alkaline Phosphatase and NucleotidylTransferase,

Unit 4: Transformation methods and techniques:

12

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.

Unit 5: Genetically Modified Organisms

12

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.

PRACTICAL

Credit: 01

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

References:

Brown, T. A. (1990) Gene Cloning an Introduction, VNR International Publ.

Dubey and Maheswari (2007) Practical Microbiology, S. Chand & Co. Ltd.

Dubey, R. C. (2014) A textbook of Biotechnology, 5th Ed. S. Chand & Co. Pvt. Ltd. New Delhi

Freshney, R. I. (2000) Culture of Animal Cells – A manual of Basic Techniques, 4th Ed, A. John Wiley & Sons, Inc. Publ.

Pelczar, (1998) Microbiology, (Reprint, 2001) Tata McGraw-Hill Publishing Co. Ltd.

Purohit, S. S., (2000) Biotechnology Fundamentals and Applications, Agrobios Publ. New Delhi

Ranga, M. M., (1999) Animal Biotechnology, Agrobios Publ. New Delhi

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SEMESTER VI

CBCS B.Sc Zoology (Honours Course)

Paper Code: ZOD 105: ENVIRONMENT IMPACT ASSESSMENT

Learning objectives: To understand the theory and application of Environmental Impact Assessment, for fostering sustainable development.

Learning outcome: On completion of the course the student will have clear understanding of Environmental Impact Assessment (EIA) as an Environmental Management Tool. The course shall impact competence for employment in EIA sector.

THEORY

Credits: 03

(Duration: 45 hrs.)

Unit 1: Introduction and an overview of Environment Impact Assessment and its sustainability contexts.

08

EIA- Genesis, history and progression: Global Overview, Evolution of EIA in India, purpose and principles of EIA. A brief idea of Cost-Benefit analysis of EIA, EIA Notification, 2006 and Institutional frame work for conduct of EIA in India (Constitution and role of EAC of MoEF& CC, GoI, SEIAA and SEAC), project Categorization and Public involvement and participation in Key stages of the EIA process, Effectiveness and Benefits of Public Participation in EIA.

Unit 2: Stages of an EIA Process and Environmental Clearance for Projects

11

Flowchart of a Generalized EIA process: Screening: Purpose and screening methods. Scoping: Role and purpose of Scoping in EIA, Guiding principle and objectives of scoping, steps involved in scoping, Terms of References (ToR), Identification and consideration of alternatives. Baseline Data-Collection, collation and analyses for Impact Identification and Assessment Methods by Checklists, Matrices, Wind Rose Diagrams, Networks, Overlays and Geographic information system (GIS). Public Hearing, Appraisal, Grant or Rejection of Environmental Clearance (EC), Validity of the Environmental Clearance, Environmental Management Plan, Post EC Monitoring.

Unit 3: Functional areas in appraisal of environmental impact

08

Capacity Building in various Functional Areas of EIA, Quality and Quality Control in EIA, The convention of Environmental Impact Assessment in a Trans-boundary Context. Brief idea of Prediction and Assessment of Impact on the Land Use, Air Environment, Surface-Water

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Environment, Soil and Groundwater Environments, Noise Environment, Biological Environment including Wildlife Conservation Plan, Cultural (Architectural, Historical, and Archaeological) Environment, Socio-economic Environment, Health Impact assessment.

Unit 4: Capacity Building for effective EIA

10

EIA as a statutory requirement in India, QCI NABET as an Accreditation agency for EIA Consultants thereof, NABET secretariat, Committees (Technical, Accreditation), Assessors, and Specialist; requirements of accreditation and Key persons in an EIA Consultancy (EIA Coordinator, Associate EIA Coordinator, Functional Area Experts, Functional Area Associates, Team members and Mentors, Accreditation Cycles and Process, Punitive action for misconduct, fraudulent data and the Confidentiality clause, overview of project sectors listed by NABET.

Unit 5: EIA in practice in some important sectors and case studies.

08

Knowledge of EIA related organizations including International Association of Impact Assessment- US (IAIA), Important Consultants and NGOs working in the field of EIA, EIA generic structure for Mining, Building constructions & Township, Common Municipal Solid wastes treatment Facility, and Sea Ports; Case studies of National and state relevance for critical analysis; EIA of SardarSarovar Project and CEE's report on EIA of Iron Ore Mining in Goa.

PRACTICAL

Credit: 01

1. Determination of the Suspended Particulate Matter (SPM) using plant leaves from control and polluted sites. (For assessment during exams exposed leaves from control and polluted sites be given with data on pre exposure)
2. Calculating Density, Frequency & Abundance of flora in a plot using Quadrature sampling (For assessment during examination, compiled data be provided)
3. Measuring the sound levels in control and noisy sites especially during the festive season using portable digital Sound Level Meter/ Decibel Meters. The sound levels shall be compared with prescribed dB level limits.
4. Determining of Important Value Index (IVI) of different plant species in a forest /garden plot
5. Measuring the wind Speed and Direction using Portable Anemometer.
6. Determining of Calcium, Magnesium, Carbonates and Bicarbonates from water samples collected from control and polluted sites by titrimetric methods.
7. Compiling an inventory of the Birds based on Snap-Shot survey of a nearby area and classify the species based on the IWPA, 1972 Schedule and IUCN categories
8. Preparing a Concise Wildlife Conservation Plan for any TWO IWPA Schedule I mammalian species found in Goa.

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9. Preparing an inventory of local tree Species for Green Belt Plantation in the following sectors.
- a) Mining
 - b) Common Municipal Solid Waste Treatment Facility
10. Visit to any NABET accredited EIA consultancy firm in Goa to get acquainted with EIA process and submission of report.

References:

- Charles H. Eccleston (2011) Environmental Impact Assessment A Guide To Best Professional Practices, CBS Publ, New Delhi
- Colombo, A. G. (Ed.) (1992) Environmental Impact Assessment, Springer Publ. New York
- Marriott, B. B. (1997) Environmental impact assessment: a practical guide. McGraw Hill. Inc. New York
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- RikiTherivel and Graham Wood (2017) Methods of Environmental and Social Impact Assessment
- 4th Edition Routledge, Taylor and Francis Group, New York*
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Semester VI

CBCS B.Sc Zoology (Honours Course)

Paper code: ZOD 106: Fundamentals of Zoology application

Learning objective: To introduce the students for the possible application of Zoology knowledge to aspects of Agricultural Entomology and human health.

Learning outcome: Students will be equipped with better knowledge and understanding of applied and allied aspects of Zoology.

Theory Credit : 03

Duration : 45 Hours

Unit I: Agricultural pest management

12

Introduction; Concept of pest management; Classification; General appearance; life history; damage and control of the following pests: (1) pests of paddy (paddy stem borer), (2) pests of fruits (banana weevil), (3) pests of vegetables (brinjal shoot and fruit borer), (4) Polyphagous pests (termite); Integrated pest management (IPM), Major components of IPM (Pest forecasting management tactics, Decision making, implementation); Achievements in IPM implementation.

Unit II: Medical Entomology

06

Medical pests: Introduction; direct effects (annoyance, dermatosis, myiasis, envenomization, anaphylaxis, entomophobia); indirect effects (disease transmission); Host/Pathogen relationships; Vector/Host relationships; Vector/Pathogen relationships, Pest management of Medical and Veterinary pests.

Unit III: Fish Products

10

Introduction; Traditional fermented fishery products and fish preservation in fermented media; Diversified fish products (Fish cake, Pickle, fish oil, fish concentrated protein); Fish silage and its types; fish processing and packaging, Marketing and Economics of fish products, value addition and quality control.

Unit IV: Haematology

09

Introduction; Blood composition- inorganic and organic constituents, formed elements: (i) Erythrocytes- Morphology, variation in numbers, Erythropoiesis, functions; (ii) Leucocytes- Morphology, types, normal count, differential count, leucopoiesis; (iii) Thrombocytes- Morphology, Normal count, functions; Blood clotting process; Bleeding disorders, Anaemia, ESR, Packed cell volume (Clinical significance to be stressed wherever applicable); Blood transfusion and Blood replacement.

Unit V: Forensic Science

08

Introduction; Basic principles and significance, History and development of forensic science, Nature and scope of forensic science, Fundamentals and significance of forensic science in wildlife; Collection, Preservation and analysis: Blood, Semen and other biological stains,

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Tissues, Fingerprint, Viscera, Hair, Saliva, Sweat, Urine and Feces.

Practicals:

Credit: 01

1. Determination of Total RBC and WBC count
2. Differential count of Leucocytes
3. Determination of ESR
4. Study of Agricultural pests with reference to life history, damage caused and control- Paddy stem borer, banana weevil, melon fruit fly, Brinjal shoot borer, termite (Through museum specimen or e-contents).
5. Study of medical pests with reference to life history, disease caused (house fly, cockroach, mosquito, human lice, ticks, cattle blood sucking lice).
6. Preliminary and confirmatory tests for fresh and dried blood stains
7. To examine human hair for cortex and medulla.
8. Determination of blood group from dried blood sample.
9. Preparation of fish cake and pickles by using locally available fishes
10. Visit to fish cold storage / processing unit

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References:

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- Larry P. Pedigo (2007): Entomology and Pest management, Pearson Prentice Hall, Pearson Education Inc.
- Lalit Kumar Jha (1987): Applied Agricultural Entomology. New Central Book Agency, Calcutta.
- Elaine N. Marieb (2006): Human anatomy and Physiology. Pearson Education Inc. Delhi.
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- B. B. Nanda and R. K. Tiwari (2001): Forensic science in India: A vision for the Twenty First Century. Select Publishers, New Delhi.
- S. H James and J. J. Nordby (2005): Forensic Science: An Introduction to Scientific and Investigative Techniques. 2nd Edition CRC Press Buca Raton.
- Alton L. Thygerson, Steven M. Thygerson, Benjamin Gulli, Gina Piazza (2011): First aid, CPR and AED Standard (Sixth Edition), Jones and Bartlett India Pvt. New Delhi.
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