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**SEMESTER - I**

**COURSE NAME: ANIMAL PHYSIOLOGY**

**Course Code: ZOO 415** **Credit: 02**

**Course Learning Objectives:**

- To enable the students to know about all the physiological processes going on in animal/human body.
- To make the students understand the functions of hormones and their mode of action at molecular level.

**Course Learning Outcomes:** Upon completion of the course, students should be able to:

- Recognize and explain how all physiological systems work in unison to maintain homeostasis in the body; and use of feedback loops to control the same.
- Learn an integrative approach to understand the interactions of various organ systems resulting in the complex overall functioning of the body.

**Course contents:**

**UNIT I: DIGESTION AND RESPIRATION**

Composition of bile, saliva, pancreatic, gastric, and intestinal juices. Mechanism of digestion & absorption of carbohydrates, proteins, lipids and nucleic acids.

Exchange of gases, Transport of $O_2$ and $CO_2$, Oxygen dissociation curve, and Chloride shift.

**UNIT II: CIRCULATION AND CARDIAC SYSTEM**

Composition of blood, plasma proteins and their role, blood cells, hemopoiesis and mechanism of coagulation of blood.

Mechanism of working of heart: cardiac output, cardiac cycle, origin, and conduction of heart beat.

**UNIT III: EXCRETION AND MUSCLE CONTRACTION**

Modes of excretion, ornithine cycle and mechanism of urine formation.

Structure of cardiac, smooth & skeletal muscles. Threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction. Physical, and chemical & electrical events of mechanism of muscle contraction.

**SEMESTER - I**

**UNIT IV: NERVOUS SYSTEM AND NEUROTRANSMITTER**

Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture.

Mechanism of generation and propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction and neurotransmitters.

**UNIT V: ENDOCRINOLOGY AND REPRODUCTION**

Mechanism of hormone action (insulin and steroids). Different Endocrine glands- hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

Male and female reproductive system, spermatogenesis, and oogenesis.

**Suggested Books:**

1. Ruegg, J.C., Calcium in muscle activation, Springer Verlag Berlin Heidelberg, New York. 25
2. Hoar, W.S. General and comparative physiology, Prentice, Hall Inc./England Wood cliffs, New Jersey.
3. Guyton, A.C. and Hall, J.E.; Text book of medical physiology, 10th Ed, Saunders, Harcourt, India.
4. Heilmeyer, L.M.G. Cellular regulation of protein phosphorylation, springer-verlag, Berlian Heidelberg, New York.
5. Prosser, C.L. and Brown, F.A. comparative Animal Physiology 2nd Ed. W.B. Sunders, Philadelplina.
6. Karpati, G., Jones, D.H. and Griggs. R.C. Disorders of Voluntary Muscle, 7th Edn, Cambridge University Press.
7. Turner, C.D. General Endocrinology, 4th Ed. W.B. Saunders, Philadelphia London.
8. Prosser, C.L., Comparative Animal Physiology, W.B. Saunders, Toppen Publication.

**SEMESTER - I**

**COURSE NAME: STRUCTURE AND FUNCTION OF INVERTEBRATE**

**Course Code: ZOO 416** **Credit: 02**

**Course Learning Objectives:**

- To enable the students to develop an appreciation for the biodiversity of invertebrate species.
- To impart knowledge about co-existence of different forms of living organisms ranging from unicellular to multicellular animals.

**Course Learning Outcomes**: Upon completion of the course, students should be able to:

- Learn about the importance of systematics, taxonomy, and structural organization of animals. Appreciate the diversity of non-chordates living in varied habit and habitats.
- Critically analyse the organization, complexity and characteristic features of non-chordates making them familiarize with the morphology and anatomy of representatives of various animal phyla.

**Course contents**

**UNIT I: PROTOZOA AND PORIFERA**

Protozoa: General organization of Protozoa with special reference to feeding, locomotory organelles and locomotion, reproduction.

Porifera: General organisation of phylum Porifera with special reference to canal system, skeleton and development.

**UNIT II: PHYLUM COELENTERATA AND PLATYHELMINTHES**

Coelenterata: General organisation of phylum Coelenterata with special reference to polymorphism, development, and alternation of generation of corals and coral reefs.

Platyhelminthes: General organisation of phylum Platyhelminthes with special reference to body wall. Digestive system, excretory system, reproductive system and development and life cycles of *Fasciola* and *Taenia*.

**UNIT III: PHYLUM ASCHELMINTHES AND ANNELIDA**

Aschelminthes: General organisation of phylum Aschelminthes. Biology of *Ascaris lumbricoides*.

Annelida: General organisation of phylum Annelida (*Pheretima posthuma*) with special reference to segmentation, digestive, excretory and reproductive systems.

**SEMESTER - I**

**UNIT IV: PHYLUM ARTHROPODA**

Arthropoda: General organisation of Arthropoda (Grasshopper)- digestive, respiratory, and reproductive systems.

**UNIT V: PHYLUM MOLLUSCA AND ECHINODERMATA**

Mollusca: General organisation of Mollusca with special reference to feeding, respiration and shell diversity, podium or foot in Mollusca, torsion and detorsion in Gastropod.

Echinodermata: General organisation of Echinodermata, Comparative account of water vascular system, haemal and perihaemal systems. Larval forms in Echinodermata.

**Suggested books:**

1. Invertebrate Zoology ------- EL Jordan; P.S. Verma
2. A Text Book of Zoology Vol. I ------ P.S. Dhami; JK. Dhami.
3. A Text Book of Invertebrate zoology ----- R.L. Kotpal.
4. Biology of Animals --- Cleveland P. Hickman JR Larryds. Roberts.
5. Hyman, L.H. The invertebrates. Vol. I protozoa through Ctenophora, McGraw Hill Co.,
6. New York.
7. Barrington, E.J.W. Invertebrate structure and function. Thomas Nelson and sons Ltd. London.
8. Jagerstein, G. Evolution of Metazoan life cycle, Academic Press, New York & London.
9. Hyman, I. H. the Invertebrates. Vol. 2 Mc Graw Hill. Co., New York.
10. Hyman, L.H. The Invertebrates Vol. 8, McGraw Hall. Co., New York. & London.
11. Barnes, R.D. Invertebrate Zoology, III edition, W.B. Saunsders Co., Philadelphia
12. Russel Hunter, W.D.A biology of higher invertebrates, the Macmillan co. Ltd. London.
13. Hyman, L.H. The invertebrate's smaller coelomate groups. Vol. V Mc Graw Hill Co. New York.
14. Parker, T.J. Haswell, W.A. Text book of Zoology, Macmillan co., London.

**SEMESTER - I**

**COURSE NAME: CELL AND MOLECULAR BIOLOGY**

**Course Code: ZOO 417** **Credit: 02**

**Course Learning Objectives**: The objective of the course is to help the students

- To learn and develop an understanding of a cell as a basic unit of life.
- To understand the functions of cellular organelles and how a cell carries out and regulates cellular functions.

**Course Learning Outcomes:** The students will be able to

- Understand how the cell functions as a unit of life.
- Draw parallels between the physiological processes at the cellular and organismic levels.

**Course contents:**

**UNIT I: CELL STRUCTURE AND FUNCTIONS**

Introduction to Cell biology, Basic properties of cells. Structural organization and function of intracellular organelles: nucleus, mitochondria, endoplasmic reticulum, golgi complex, lysosomes, and peroxisomes.

**UNIT II: CELLULAR MEMBRANE**

An overview of membrane functions. Membrane models. Chemical composition of cell membrane. Structure and functions of membrane proteins: Integral protein, peripheral membrane proteins and lipid-anchored membrane proteins.

**UNIT III TYPES OF CYTOSKELETONS**

Structure and organization of microtubules, intermediate filaments and microfilaments and their role in cell motility. Types of spindle fibres. Polymerisation and depolymerisation of microtubules and its role in maintaining cellular architecture.

**UNIT IV: CELL SIGNALLING AND CELL TRANSPORT**

Different mechanism of cell signalling pathways, Movement of substances across cell membranes: Diffusion, active transport, uniport, symport and antiport.

**UNIT V: FUNDAMENTAL PROCESSES IN MOLECULAR BIOLOGY**

DNA and its organization in cell; structure; A, B, and Z forms. Replication, Transcription, translation, damage, and repair. Regulation of gene expression in prokaryotes and eukaryotes.

**SEMESTER - I**

**Suggested books:**

1. Lewin, B. 2000. Genes VIII Oxford University, Press, New York
2. Alberts, B. Bray, D., Lewis, J. Raff, M., Roberts, K. and Watson, J.D. 1999, Molecular biology of the cell. Garland Publishing, Inc. New York.
3. Wolfe, S.L. 1993, Gruissem, W. and Jones, R.L. 2000, Biochemistry and molecular biology of plants, American society of plant physiologists, Maryland, USA
4. Frifelder, D. Molecular Biology. John and Bartlett Publishers, inc., Boston, USA

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**SEMESTER - I**

**COURSE NAME: CELL AND MOLECULAR BIOLOGY & ANIMAL PHYSIOLOGY LAB.**

**Course Code: ZOO 418** **Credit: 02**

**Course Learning Objective:**

- To enable the students to know about all the physiological processes going on in animal/human body.
- Provide knowledge about the complex organization in the eukaryotic cell and the molecular mechanisms of the cellular processes that exist in all cell types.

**Course Learning Outcome:** Upon completion of the course, students should be able to:

- Learn an integrative approach to understand the interactions of various organ systems resulting in the complex overall functioning of the body.
- Gain knowledge about the techniques and experiments that contributed to the understanding of molecular mechanisms of the cellular processes.

**Course contents**

1. Study of permanent histological slides of testis and ovaries of insects/ mice/rat.
2. Basis of reaction and demonstration of the sites of proteins, nucleic acids, lipids & carbohydrates in ovaries of insects/rat/mice through slides and photographs.
3. Study of stages of mitosis and meiosis from permanent slides from animal and plant materials through slides/charts/photographs.
4. To demonstrate that the optimum activity of salivary amylase is pH dependent.
5. Demonstration of estimation of Haemoglobin.
6. Demonstration of determination of TLC, DLC, RBC &Count.
7. Demonstration of determination of bleeding and clotting time.
8. Demonstration of determination of blood groups.
9. Demonstration of measurement of blood pressure.
10. Demonstration of estimation of ESR.
11. To study the effect of exercise on cardiovascular and respiratory systems.
12. Demonstration of estimation of the glucose level in blood of mammal.

**SEMESTER - I**

**Suggested books**:

1. Lewin, B. 2000. Genes VIII Oxford University, Press, New York
2. Alberts, B. Bray, D., Lewis, J. Raff, M., Roberts, K. and Watson, J.D. 1999, Molecular biology of the cell. Garland Publishing, Inc. New York.
3. Wolfe, S.L. 1993, Gruissem, W. and Jones, R.L. 2000, Biochemistry and molecular biology of plants, American society of plant physiologists, Maryland, USA
4. Frifelder, D. Molecular Biology. John and Bartlett Publishers, inc., Boston, USA
5. Prosser, C.L. and Brown, F.A. comparative Animal Physiology 2nd Ed. W.B. Sunders, Philadelphian.
6. Karpati, G., Jones, D.H. and Griggs. R.C. Disorders of Voluntary Muscle, 7th Edn, Cambridge University Press.
7. Turner, C.D. General Endocrinology, 4th Ed. W.B. Saunders, Philadelphia London.
8. Prosser, C.L., Comparative Animal Physiology, W.B. Saunders, Toppen Publication.

**SEMESTER - I**

**COURSE NAME: STRUCTURE AND FUNCTION OF INVERTEBRATE LAB.**

**Course Code: ZOO 419** **Credit: 02**

**Course Learning Objectives:**

- To make the students know about the habitat, habits, morphology and economic importance of various types of invertebrates.

**Course Learning Outcomes**: Upon completion of the course, students should be able to: ·

- Comprehend the economic importance of non-chordates, their interaction with the environment and role in the ecosystem.

**Course contents**

**1. PORIFERA**

a) Specimens: *Scypha, Spongilla, Euplectella, Hyalonema, Euspongia.*
b) Prepared slides: Spicules, gemmules, *Sycon* (T.S and L.S) gemmules and spicules.

**2. COELENTERATA**

a) Specimens: *Physalia, Aurelia, Metridium, Madrepora, Fungia, Gorgonia* and *Pennatula.*
b) Prepared slides: Hydra (W.M.), T.S. through regions of testis and ovary, *Obelia* (colony, medusa and polyp), *Sertularia, Bougainvillea, Aurelia, Obelia, Sertularia* and *Plumularia*

**3. PLATYHELMINTHES**

a) Specimens: *Planaria, Fasciola, Taenia,* and *Echinococcus.*
b) Slides: *Fasciola* (miracidium, sporocyst, redia and cercaria), scolex and proglottids of *Taenia* (Mature and gravid L.S. & T.S.).
c) Stained preparation of: Amphistome, proglottid of a cestode.

**4. ASCHELMINTHES**

a) Specimens: *Ascaris* (Male and female)
b) Slides: *Ascaris* (T.S. of male and female gravid).

**5. ANNELIDA**

a) Demonstration of dissection of Earthworm (digestive, nervous and reproductive systems) through video clippings/models/charts.
b) Specimens: *Nereis, Heteronereis, Aphrodite, Chaetopterus, Arenicola, Amphitrite* and *Hirudinaria.*

**SEMESTER - I**

**6. ARTHROPODA**

a) Specimens: *Peripatus, Lepisma*, Cockroach, Grasshopper, Praying mantis, Earwig, Dragonfly, Termite (queen and other castes), Ant, Butterfly, Moth, Beetles, Wasp, Honeybee, Crab, Prawn, *Limulus*, Scorpion, Spider, *Millepede* and *Centipede.*

**7. MOLLUSCA**

a) Demonstration of dissection of *Anodonta* (digestive and nervous systems) through video clippings/models/charts.
b) Specimens: *Anodonta, Mytilus, Pecten, Haliotis, Aplysia, Doris, Limax, Pila, Sepia, Octopus, Nautilus, Chiton* and *Dentalium.*

**8. ECHINODERMATA**

a) Specimens: *Asterias, Echinus, Cucumaria, Antedon, Ophiothrix*.

**Suggested books:**

1. Invertebrate Zoology ------- EL Jordan; P.S. Verma
2. A Text Book of Zoology Vol.I ------ P.S. Dhami; Jk.Dhami.
3. A Text Book of Invertbrate zoology ----- R.L.Kotpal.
4. Biology of Animals --- Cleveland P. Hickman JR Larryds. Roberts.
5. Hyman, L.H. The ivertebrates. Vol. I protozoa through Ctenophora, McGraw Hill Co.,
6. New York.
7. Barrington, E.J.W. Invertebrate structure and function. Thomoes Nelson and sons Ltd. London.
8. Jagerstein, G. Evolution of Metazoan life cycle, Academic Press, New York & London.
9. Hyman, I. H. the Invertebrates. Vol. 2 Mc Graw Hill. Co., New York.
10. Hyman, L.H. The Invertebrates Vol. 8, McGraw Hall. Co., New York. & London.
11. Barnes, R.D. Invertebrate Zoology, III edition, W.b. Saunsders Co., Philadelphia
12. Russel Hunter, W.D.A biology of higher invertebrates, the Macmillan co. Ltd. London.
13. Hyman, L.H. The invertebrate's smaller coelomate groups. Vol. V Mc Graw Hill Co. New York.
14. Parker, T.J. Haswell, W.A. Text book of Zoology, Macmillan co., London.

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**SEMESTER - I**

**COURSE NAME: ENTOMOLOGY**

**Course Code: ZOO 420** **Credit: 02**

**Course Learning Objectives:**

- To make the students aware of various pests of food crops and food products and various insect control methods.
- To educate the students about economic importance and techniques of Apiculture and sericulture
- To introduce students to the various orders and some of the most important families of insects so that they can distinguish between harmful and beneficial insects, which form the basis of entomology.

**Course Learning Outcomes:** After completion of the course, the students will be able to:

- Appreciate the diversity of insects.
- Understand the physiology of Insects which has made them the most successful animals in terms of numbers and variety of species.
- Get a glimpse of the highly organized social life of insects.

**Course Contents:**

**UNIT I: INTRODUCTION TO CLASS INSECTA**

General Introduction of Class Insecta: Characteristic and adaptive features for diversity, basis of classification and classification up to orders.

General anatomical description of insect body: segmentation and tagmosis; integument- structure and function of cuticle, sclerotization and colouration; Head: structure of head, appendages, antennae and types of antennae; Thorax- generalized thoracic structure, appendages of thorax, types of legs, and types of wings; Abdomen- structure, appendages and external genitalia.

**UNIT II: DIGESTION, RESPIRATION AND CIRCULATION IN INSECTS**

Digestive system: Mouth parts, types and feeding mechanism, structure of alimentary tract and accessary glands, mechanism of digestion and absorption

Respiratory system: Aerial respiration- spiracles, trachea and tracheoles; aquatic respiration, and mechanism of gas exchange.

Circulatory system: Organs and mechanism of circulation, hemolymph and hemocytes.

**SEMESTER - I**

**UNIT III**: **EXCRETION, REPRODUCTION AND NERVOUS SYSTEM OF INSECTS**

Excretory system: Organs and physiology of excretion, and osmoregulation.

Reproductive system: Female & male reproductive systems; modes of reproduction.

Nervous system- Structure of compound eye and sound production organs. Mechanism of sound production.

**UNIT IV: SOCIAL INSECTS**

Social Insects: Life cycle and social organization of termites, honeybees, and ants. Importance of insect pollinator.

Beneficial and Harmful Insects: Pollinator and Edible insects, Insect pests of agricultural and medical importance.

**UNIT V: INSECT DEVELOPMENT AND COMMUNICATION**

Endocrine system: Insect hormones, Metamorphosis, types; Insect development: Types of larvae and pupae.

Chemical Communication in Insects: Semi chemicals and its function.

**Suggested books:**

1. Imams, A. D., A general text book of entomology, Chapman & Hall, UK
2. Borror, D. J., Triplehorn, C. A., and Johnson, Introduction to the study of insects, N. F., M Saunders College Publication, USA
3. Gullan, P. J., and Cranston, P. S.,The Insects, An outline of Entomology, Wiley Blackwell, UK
4. Snodgrass, R. E., Principles of Insect Morphology, Cornell Univ. Press, USA
5. Chapman, R. F., The Insects: Structure and function, Cambridge University Press, UK
6. Wilson, E. O., The Insect Societies, Harvard Univ. Press, UK.
7. Wigglesworth, Vincent B, The Principles of Insect Physiology, Chapman & Hall Ltd. USA.
8. Klowden, M. J., Physiological system in Insects, Academic Press, USA

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**SEMESTER - I**

**COURSE NAME: ECOLOGY, ENVIRONMENT AND BIODIVERSITY**

**Course Code: ZOO 421** **Credit: 02**

**Course Learning Objectives:**

- To acquaint the students with the habitat and interactions of diverse animal groups with their environment.
- To educate the students about the basic environmental phenomena like ecosystem, energy flow through the ecosystem and biogeochemical cycles.
- To enable the students to develop an appreciation for the biodiversity of invertebrate and vertebrates.

**Course Learning Outcomes:**

- Students will be exposed to the fundamental aspects of ecology.
- They will get idea about the impact of anthropogenic activities on the environment.
- Students will get idea about the natural resources and their conservation.
- Apply the basic principles of ecology in wildlife conservation and management.

**Course Contents:**

**UNIT I: CONCEPT AND STRUCTURE OF ECOSYSTEM**

Physical environment; biotic and abiotic factors, Ecosystem and its types, Ecosystem structure, function productivity and energy flow. Habitat, ecological niche, fundamental and realized niche; resource partitioning; character displacement. Ecological succession and its types.

**UNIT II: POPULATION ECOLOGY**

Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection), Species Interactions and its types.

**UNIT III: BIODIVERSITY AND ITS CONSERVATION**

Biological diversity: concepts and levels, role of biodiversity in ecosystem functions and stability, Categories of threat, terrestrial biodiversity hot spots. Conservation of biodiversity: *In-situ* and *Ex-situ* conservation of biodiversity. Government and Non-government agencies of wildlife conservation.

**SEMESTER - I**

**UNIT IV: BIODIVERSITY MANAGEMENT**

Sustainable development, natural resource management in changing environment. Molecular ecology, genetic analysis of single and multiple population, phylogeography, molecular approach to behavioral ecology, and conservation genetics.

**UNIT V: ENVIRONMENTAL POLLUTION**

Air pollution, water pollution, soil pollution, noise pollution, ozone and climate change.

**Suggested books:**

1. Charls J. Kreb. 1972. Ecology: The Experimental Analysis of Distribution and Abundance
2. Phi**l**ipson, J. 1966. Ecological Energetic, Edward Arnold Ltd. London.
3. Odum, E.P.1970: Ecology, Amerind Publ. Co. New Delhi.
4. Kormondy, E.T. 1971. Concept of Ecology. Prentice Ha**l** of India, New Delhi.
5. Ricklefs, R.E. 1973. Ecology. Thomes Nelson and sons ltd.
6. Colinbaux, P.A.1985Introductiontoecology.JohnWiley&Sons.
7. Wiegert, R.G. 1976. Ecological Energetic Dowden, Hutchinson & Ross. Inc. Pennsylvania.
8. Scuthwick, C.H. 1976. Ecology and the quality of our environment. D. Van Nestrand
9. Fahey, J.J, and Knapp, A.K. 2007. Principles and Standards for measuring primary production.
10. OxfordUniv.Press.UK.
11. Grant, W.E. and Swanmack, T.M. 2008. Ecological Modeling. Blackwe**l** Publ. Hou
12. Evolution, Barton, N. H., Briggs, D. E.G., Eisen, J. A., Goldstein, A. E., Patel, N. H., Cold Spring Harbor Laboratory Press, New York, USA
13. Evolution, Hall, B. K. and Hallgrimsson, B., Jones and Bartlett Publisher, Sudbury, USA
14. Evolution, Futuyma, D. J., Sinauer Associates, Inc., Sunderland, USA
15. What Evolution Is, Mayr, E., (2001), Basic Books, New York, USA

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**SEMESTER - I**

**COURSE NAME: IMMUNOLOGY**

**Course Code: ZOO 422** **Credit: 02**

**Course Learning Objectives:**

- To enable understanding the molecular and cellular basis of the development and function of the immune system and identification of its biological, clinical and therapeutic implications.
- To make the student understand the role of immunity in controlling the pathogenic infection.
- To acquaint the students with the defense mechanisms of animals/bodies.

**Course Learning Outcomes**: After completion of the course the students will be able to:

- Define the cellular/molecular pathways of humoral/cell-mediated adaptive responses including the role of Major Histocompatibility Complex
- Integrate knowledge of each subsystem to see their contribution to the functioning of higher-level systems in health and disease including basis of vaccination, autoimmunity, immunodeficiency, hypersensitivity and tolerance.

**Course Contents:**

**UNIT I: OVERVIEW OF IMMUNE SYSTEM**

Organ and cell of immune system, primary and secondary lymphoid organ, principles of innate and adaptive immunity, antigen and immunogenicity, clonal selection theory, evolution of immune system.

**UNIT II: B -CELL RECEPTOR (BCR) AND IMMUNOGLOBULIN**

Antigen recognition by immune cells: Innate Immunity- Pattern recognition in the innate immune system, TLRs and their role in innate immune response; antigen recognition by B lymphocytes; molecular mechanism behind BCR formation; B lymphocyte development and survival, Immunoglobulin: Basic and fine structure of Immunoglobulin, Biological function of different classification of Immunoglobulin

**SEMESTER - I**

**UNIT –III: TCR- STRUCTURE, FUNCTION AND MAJOR HISTOCOMPATIBILTY COMPLEX**

TCR structure and function: T-cell receptor gene rearrangement; T lymphocyte development and survival; Antigen recognition by T-cells, signaling through TCR and T-cell activation, co-receptors and their role in T –cell functioning, MHC-I and MHC-II and Regulation of MHC-I and MHC-II.

**UNIT –IV: EFFECTOR MECHANISM OF IMMUNE SYSTEM**

Effector mechanisms and regulation of immune responses: Complement system: Complement activation and Regulation, Humoral immune response and Cell Mediated immune response.

**UNIT –V: REGULATION OF IMMUNE SYSTEM**

Regulation of immune response: Leukocyte activation and migration, Cytokines, innate Immunological tolerance. Mucosal immunity. Allergy and hypersensitivity, Autoimmunity, Immunodeficiency diseases.

**Suggested books:**

1. Kuby Immunology, Richard, Thomas, Barbara, Janis, W. H. Freeman and Company.
2. Immuno Biology- The immune system in health and disease, Janeway, Travers, Walport and Shlomchik, Garland Science Publishing.
3. Essentials of Immunology, David, Brostoff and Roitt, Mosby & Elsevier Publishing.
4. Fundamentals of Immunology by William E. Paul, Lippincott Williams & Wilkins Publishing
5. Cellular and Molecular Immunology by Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai, Elsevier Publishing.

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**SEMESTER - I**

**COURSE NAME: ADVANCED TECHNIQUES IN BIOLOGY**

**Course Code: ZOO 423** **Credit: 02**

**Course Learning Objectives**: To acquaint the students with various instruments and methodological techniques enable them to peruse scientific research in future

**Course Learning Outcomes**:

- To demonstrate proper and safe laboratory practice, proper use of equipment, and the ability to use basic techniques in several areas and advanced techniques.

**Course Contents:**

**UNIT I: MICROSCOPY AND ITS APPLICATION**

Introduction, types, simple and compound microscope, bright field microscope, stereoscopic zoom microscope, fluorescence microscope and confocal microscope. Significance of microscopy in research.

**UNIT II: ELECTRON MICROSCOPY**

Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM). Image acquisition and data analysis.

**UNIT III: ANALYTICAL LAB. TECHNIQUES**

Basic Lab. Instruments (laminar air flow, incubator, oven, autoclave, centrifuge). Colorimetry, spectrophotometry, atomic absorption spectrophotometry (AAS). Basic sterilization techniques. Cell staining techniques, Reagent Preparation in Lab.

**UNIT IV: CHROMATOGRAPHIC TECHNIQUES**

Introduction, definition and application of chromatography, Types of chromatography (paper chromatography, thin layer chromatography (TLC), high performance liquid chromatography (HPLC), gas chromatography (GC), gas chromatography mass spectroscopy (GCMS).

**UNIT V: ELECTROPHORESIS AND PCR**

Electrophoresis and its types. PCR and its application. Enzyme-linked immunosorbent assay (ELISA), radioimmunoassay (RIA) and its application.

**SEMESTER - I**

**Suggested books:**

1. Principles and Techniques in biochemistry and molecular biology Wilson & Walkes
2. Culture of animal cells Freshman.
3. Sharma V.K. (1991), Techniques in microscopy and cell Virology, Tata-Mc Craw Hill.
4. Robert Braun Introduction to instrumental analysis Mc. Crew. Hil
5. Bisen & Mathw. Tools and Techniques in Life Sciences, CBS Publishers & distributors.
6. Principles of animal cell culture, Basant Kumar & Rinesh Kumar, Int. Bork 2008, XXII edn.

**SEMESTER - I**

**COURSE NAME: BASICS OF WILD LIFE STUDY**

**Course Code: ZOO 424** **Credit: 02**

**Course Learning Objectives:**

- To educate the students about the basic environmental phenomena like pollution, ecosystem, biogeochemical cycles, etc.
- To educate the students about the importance of wild life conservation.

**Course Learning Outcomes**:

- Identify problems in wildlife and conservation biology
- Know the principles of wildlife and conservation biology and how they are used to manage wildlife and solve environmental problems

**Course Contents:**

**UNIT I: INTRODUCTION TO WILDLIFE**

Introduction: Definition wildlife, free-living, captive, domesticated and feral animals. Justification of wildlife conservation, uses, values and negative impact of wildlife. Zoogeographic regions and biomes of the world. India's uniqueness in biodiversity, reasons and causes of wildlife depletion. Values of wildlife- positive and negative.

**UNIT II: WILDLIFE POPULATION SAMPLING**

Random sampling, systematic sampling, stratified sampling, cluster sampling (Basics). Habitat analysis: a) Physical parameters: Topography, Geology, Soil and water; b) Biological Parameters: food, cover, forage, browse and cover estimation; Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, and Hair identification; Pug marks and Census methods, Standard evaluation procedures: remote sensing and GIS.

**UNIT III: WILDLIFE CONSERVATION STRATEGIES AND POLICIES**

Estimation of carrying capacity; Human-wildlife conflict; Eco tourism / wild life tourism in forests; Climax communities: characteristics and theories and Ecology of perturbance. Wildlife Act (1972)- objectives and principles.

**UNIT IV: WILDLIFE CONSERVATION AND PROTECTED AREAS**

Aims and objectives of wildlife conservation. Wildlife wealth of India; wildlife conservation in India- through age, post-independence initiatives. Different approaches for conservation – *in situ*

and *ex situ*. Sanctuaries, national parks, community reserves and conservation reserves; biosphere reserve and concept of corridor.

**UNIT V: PROTECTION OF WILDLIFE**

Different schedule of wildlife as per 1972 act. Category of Threatened wildlife and IUCN status - concept of extinct, critically endangered, endangered, vulnerable, and rare species and red data book. Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies: WCS, CBD, Agenda 21, and projects in India. Agencies: Government and Non-government for wildlife conservation.

**Suggested books:**

1. Saha, G.K. and Mazumdar, S. (2017). Wildlife Biology: An Indian Perspective. PHI learning Pvt. Ltd. ISBN: 8120353137, 978-812035313
2. Sinclair, A.R.E., Fryxell, J.M. and Caughley, G. (2006). Wildlife Ecology, Conservation and Management. Wiley-Blackwell, Oxford, UK.
3. Singh, S.K. (2005). Text Book of Wildlife Management. IBDC, Lucknow.
4. Singh, I.K. and Maurya A.K. (2016) Basics of Environmental Studies, Book Age Publications, ISBN: 9789383281411

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**SEMESTER - I**

**COURSE NAME: PARASITOLOGY**

**Course Code: ZOO 425** **Credits: 02**

**Course Learning Objectives:**

- To enable the students to understand the basic concepts in parasitology
- To acquaint them with the different types of host parasite interactions, immune response generated during parasitic infections, ecological adaptations, and transmission of the parasites.

**Course Learning Outcomes:**

- It will enable the students to understand the different vectors involved in transmission of parasitic diseases and various aspects involved in their diagnosis.
- To enable the students to classify and study the variation in morphology, life cycle and pathogenesis of important parasites causing diseases in animals and human beings.

**Course Contents:**

**UNIT I**: **INTRODUCTION TO PARASITOLOGY**

Introduction to Parasitology: Establishment of infection: Active and Passive entry, site selection in their host, entry into specific organs and cells, animal associations and host – parasite relationship.

**UNIT II: PARASITIC PROTOZOANS**

Classification and detailed account of medically parasitic protozoans: *Leishmania, Trypanosoma, Entamoeba, Babesia.*
*Plasmodium* and *Leishmania:* Morphology, life-cycle, mode of infection, drug targets, mechanism of drug resistance and vaccine strategies

**UNIT III: MEDICALLY IMPORTANT CESTODES AND TREMATODES**

Classification and detailed account of medically important cestodes and their life cycle patterns: *Taenia saginata, T. solium*, Role of tegument in the digestion and uptake of nutrients. Classification and detailed account of medically important trematodes and their life cycle: *Fasciola hepatica, Fasciolopsis buski*.

**UNIT IV: GASTROINTESTINAL NEMATODES**

Gastro-intestinal nematodes: morphology, biology, life-cycles, modes of entry, molecular biology of nematodes, vaccine strategies in of *Ascaris lumbricoides,Dracunculus medinensis, Filarial worms, Trichinella spiralis, Trichuris trichuira*. Ultrastructure of Sense Organs of parasitic nematodes.

**SEMESTER - I**

**UNIT V: IMMUNE RESPONSE**

Immune response and self-defense mechanisms, immune evasion, and biochemical adaptations of parasites.

**Suggested Books:**

1. Bogitsh, B.J. & Cheng, T.C. (1979) Human Parasitology. Academic Press, London, ISBN: 0-12-110870-8.
2. Chandler A.C. & Read, C.P. (1961) Introduction to Parasitology. John Wiley, London. ISBN: 0471144878.
3. Chappell, L.H. (1979) Physiology of Parasites. Blackie, Glasgow & London. ISBN: 978-1-4684-7808-2.
4. Chatterjee, K. D. (2009) Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd. ISBN: 8123918100. M.Sc.. Zoology CBCS 19
5. Cheng, T.C. (1986) General Parasitology. Second Edition, Academic Press, London. ISBN 0-12-170755-5.
6. James, MT & Harwood, R.F. (1969) Herins's Medical Entomology, Sixth edition. Collier Macmillan Canada Ltd., Don Mills, Qutario. ISBN: 0023601809.
7. Mehlhorn, H. (1988) Parasitology in Focus. Springer-Verlag Berlin Heidelberg New York. ISBN: 3-540-17838-4.
8. Noble, E.R. and Noble, G.A. (1982) Parasitology: The Biology of Animal Parasites. V Edition, Lea & Febiger. ISBN: 0812111559.
9. Smyth, J.D. (1994) Animal Parasitology. Third Edition, Cambridge University Press. ISBN: 0-521-56696-7. 10. Trager, W. (1986) Living together: The Biology Of Animal Parasitism. Plenum Press, New York and London. ISBN: 0-306-42310-3.

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**SEMESTER - I**

**COURSE NAME: INDIAN KNOWLEDGE SYSTEM**

**Course Code: IKS** **Credit: 02**

**Course Objectives:**

- This course aims at introducing students with various treatises on physical as well as ancient sciences and their contribution to modern branches of sciences and also making a student to ponder over the ancient knowledge systems of India.
- The Course is designed in order to associate the young Indian minds to their ancient knowledge systems, wisdom, culture and patterns of growth of personality in order to understand the environment around them.

**Course Outcomes:** Upon completion of the course, students should be able to:

- Channelizing their mind in positive, valued and ethically rational activities.
- Understand the significance of ancient Indian wisdom and knowledge.
- Ability to understand, connect up and explain basics of Indian Traditional knowledge to modern scientific perspective.
- Understand the Holistic life style of Yogic-science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions.

**Course Contents:**

**UNIT I: BHARATIYA CIVILIZATION AND DEVELOPMENT OF KNOWLEDGE SYSTEM**

Antiquity of civilization, discovery of the Saraswati River, the Saraswati-Sindhu civilization, traditional knowledge system, the Vedas, school of philosophy (6+3), ancient education system, the Takṣasila university, and the Nalanda university

**UNIT II: ARTS, LITERATURE, AND SCHOLARS IN ANCIENT BHARAT (4 hours)**

Art, music, and dance, Nataraja- A masterpiece of Bhartiya art, literature, life and works of Agastya, Lopamudra, Ghoṣa, Valmiki, Patanjali, Vedavyasa, Yajnavalkya, Gargi, Caraka, Susruta, Kanada, Kauṭilya, Panini, Thiruvalluvar, Aryabhata, Bhaskaracharya, Madhavacharya.

**SEMESTER - I**

**UNIT III: ANCIENT BHARTIYA CONTRIBUTION TOWARDS SCIENCE & MATHEMATICS**

Sage Agastya's Model of Battery, Vedic cosmology and modern concepts, concept of zero and pi, number system, Pythagoras theorem, and Vedic mathematics; Kerala school for mathematics and history of culture of astronomy, astronomical of day, year and yuga.

**UNIT IV: ANCIENT BHARTIYA ENGINEERING, TECHNOLOGY & ARCHITECTURE**

Pre-Harappan and Sindhu Valley Civilization, Juices, Dyes, Paints and Cements, Glass and Pottery, Metallurgy, Iron Pillar of Delhi, Rakhigarhi, Mehrgarh, Sindhu Valley Civilization, Marine Technology, and Bet-Dwarka.

**UNIT-V: ANCIENT BHARTIYA CONTRIBUTION IN ENVIRONMENT & HEALTH**

Ethnic Studies, life science in plants, agriculture, ecology and environment, ayurveda, integrated approach to healthcare, surgery, and yoga, etc.

**Suggested books:**

Mahadevan, B. , Bhat, Vinayak Rajat , Nagendra Pavana R.N. 2022, Indian knowledge systems by Publisher Name PHI Learning Pvt Ltd.

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**SEMESTER - I**

# INTERDISCIPLINARY COURSE

## COURSE NAME: FOUNDATION COURSE IN ECOLOGY

**Course Code: ZOO 426** **Credit: 02**

**Course Learning Objectives:**

- To acquaint the students with the habitat and interactions of diverse animal groups with their environment.
- To educate the students about the basic environmental phenomena like ecosystem, energy flow through the ecosystem and biogeochemical cycles.
- To enable the students to develop an appreciation for the biodiversity of invertebrate and vertebrates.

**Course Learning Outcomes:**

- Students will be exposed to the fundamental aspects of ecology.
- They will get idea about the impact of anthropogenic activities on the environment.
- Students will get idea about the natural resources and their conservation.
- Apply the basic principles of ecology in wildlife conservation and management.

**Course Contents:**

**UNIT I: CONCEPT OF ECOLOGY**

Definition, principle and scope of ecology, aquatic and terrestrial ecology, freshwater ecology, marine ecology, estuarine ecology, Community concept, types of community, succession process, competition and Coexistence, types of interactions: predation, parasitism, antibiosis, commensalism, cooperation and mutualism, population growth.

Ecosystem components: Producers, consumers and decomposer, Food chains, food web and ecological pyramids, Biotic and abiotic components, Ecological pyramids, Bioaccumulation and biomagnifications, mass, and energy transfer in successive tropical level.

**UNIT II: ENERGY AND ECOLOGICAL SUCCESSION**

Flow and energy fixation, Biogeochemical cycles: hydrological cycles, carbon cycle, oxygen cycle, nitrogen cycle -its importance and applications. Primary succession, secondary succession and ecological climax, impacts of development of ecosystem, population, community ecology, predator and prey relationship.

**SEMESTER - I**

**UNIT III: CONCEPT OF BIODIVERSITY**

Biodiversity concept, Biodiversity-components, Biodiversity- Types, Biodiversity-importance, ecological importance, economic importance, key stone umbrella and flagship species, National status and Global status, hotspot; threatened species, IUCN Red list, endangered species, vulnerable species, rare species, extinct species and endemic species. Climate change, induced losses.

**UNIT IV: BIODIVERSITY CONSERVATION AND CONVENTION**

Different approaches for Biodiversity conservation- In-situ conservation and ex-situ conservation. In-vitro Conservation. IPRs, national and international programs for biodiversity conservation. Wildlife values and eco-tourism, wildlife distribution in India, problem in wildlife protection, role of WWF, WCU, CITES, TRAFFIC.

**UNIT V: ENVIRONMENTAL LEGISLATION**

Environmental legislation enforcement authorities: (i) Under the Water and Air Act-composition, powers, and functions, and (ii) Under the Environment (Protection) Act, 1986- powers Environmental dispute redress bodies: (i) National Green Tribunal – composition and jurisdiction, (ii) Trial court- jurisdiction under the environmental legislations, and (iii) Executive Magistrate' s powers The Forest (Conservation) Act 1980: Objectives and Mechanism. The Wild Life (Protection) Act 1972: Objectives, prohibition on hunting and trade. The Biodiversity Act 2002: object and National Biodiversity Authority. Convention on Climate Change: objectives, principles and commitment-India's response.

**SUGGESTED BOOKS:**


- Charls J. Kreb. 1972. Ecology: The Experimental Analysis of Distribution and Abundance
- Phi**l**ipson, J.1966.Ecological Energetic, Edward Arnold Ltd. London.
- Odum, E. P.1970: Ecology, Amerind Publ. Co. New Delhi.
- Kormondy, E. T. 1971. Concept of Ecology. Prentice Ha**l** ofI ndia, New Delhi.
- Ricklefs, R. E. 1973. Ecology. Thomes Nelson and sons ltd.
- Colinbaux, P.A.1985Introductiontoecology.JohnWiley&Sons.
- Wiegert, R. G. 1976. Ecological Energetic Dowden, Hutchinson & Ross. Inc. Pennsylvania.
- Scuthwick, C. H. 1976.Ecology and the quality of our environment. D. Van Nestrand
- Fahey, J. J,and Knapp, A.K. 2007. Principles and Standards for measuring primary production.
- Oxford Univ.Press.UK.

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**SEMESTER - I**

## COURSE NAME: INTRODUCTION TO APICULTURE

**Course Code: ZOO 427** **Credit: 02**

**Course Learning Objectives:**

- Introduction to the world of bees
- Development of understanding of beekeeping and rearing practices
- To learn about the excellent role of honey in pharmaceutical company, and cosmetic companies.

**Course Learning Outcomes:** After completion of the course student will be able to

- Develop and maintain an apiary
- Train the youths for rearing of bees
- Generate employment

### UNIT I: INTRODUCTION TO APICULTURE

Apiculture- Definition, introduction, importance, and history of beekeeping. Introduction to honey bee; Origin, systematics, and distribution; different species of Honey Bees- *Apis dorsata*, *Apis indica*, *Apis florea* and *Apis mellifera*.

### UNIT II: MORPHOLOGY AND ANATOMY OF HONEY BEE

General morphology, head, thorax, abdomen and anatomical features, life cycle, colony organization and division of labor, polymorphism, bee social behavior and bee communication. Bee dance- Round Dance, and Wag -Tail Dance.

### UNIT III: FLORA AND BEE PRODUCTS

Ancient and modern beekeeping, Urban or backyard beekeeping. Bee keeping equipment.

Identification of flora for nectar and pollen. Honey- composition, quality control, by products of honey and their beneficial role. Importance and uses of honey. Composition and importance of bee wax, pollen, and royal jelly.

### UNIT IV: HANDLING OF BEE COLONY AND MAINTENANCE OF APIARY RECORD

Selection of apiary site and bee species, examination of a bee colony, maintenance of apiary records, introduction to bee flora, qualities of a good bee flora, important honey flow sources in India.

**SEMESTER - I**

Principles of Bee Management, management during- spring, winter, summer, monsoon, and autumn, swarming and control, honey extraction, migratory bee keeping, supplementary feeding, and queen management.

**UNIT V: ENEMIES, DISEASES OF HONEY BEES AND THEIR CONTROL**

An introduction, Bee enemies – wax moth, ants, wasps, microorganisms. Diagnosis and identification of varroa mites; biology and their control. Bacterial, viral, and fungal disease of honey bee.

**Books Recommended:**

1. Graham, J M (1992) The hive and the honey bee. Dadant and Sons, Hamilton, IIIinois.
2. Mishra R.C. (1995) Honey bees and their management in India. ICAR Publication, New Delhi.
3. Singh, S. (1971) Beekeeping in India, ICAR publication.
4. Gupta, J.K., Sharma, H K and Thakur, R K. 2009. Practical Manual on Beekeeping. Department of Entomology and Apiculture, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan, p 83.
5. Gupta, J K. 2010.Spring management of honey bee colonies. In "OAPI-012 Management of honey bee colonies; Seasonal and specific management (Block 2), Indira Gandhi National open university, school of Agriculture, New Delhi, UNIT-I, pp 5-14, p 105.
6. Gupta, J K. 2010.Management in summer. In "OAPI-012 Management of honey bee colonies; Seasonal and specific management (Block 2), Indira Gandhi National open university, school of Agriculture, New Delhi, UNIT-II, pp 15-25, p 105.
7. Gupta, J K. 2010.Management in monsoon season. In "OAPI-012 Management of honey bee colonies; Seasonal and specific management (Block 2), Indira Gandhi National open university, school of Agriculture, New Delhi, UNIT-III, pp 26-33, p 105.
8. Gupta, J K. 2010.Management in autumn season. In "OAPI-012 Management of honey bee colonies; Seasonal and specific management (Block 2), Indira Gandhi National open university, school of Agriculture, New Delhi, UNIT-IV, pp 34-40, p 105.
9. Gupta, J K. 2010.Management in winter. In "OAPI-012 Management of honey bee colonies; Seasonal and specific management (Block 2), Indira Gandhi National open university, school of Agriculture, New Delhi, UNIT-V, pp 41-50, p 105.
10. Gatoria, G.S., Gupta, J. K., Thakur, R.K. and Singh, J. 2011. Mass queen bee rearing and multiplication of honey bee colonies. All India Co-ordinated project on honey bees and pollinators, ICAR, HAU, Hisar, p70.

**SEMESTER - II**

**COURSE NAME: CYTOGENETICS**

**Course Code: ZOO 465** **Credit: 02**

**Course Learning Objectives:**

- To provide an overview of genetics starting from the work of Mendel to the current understanding of various phenomena like recombination, transposition, sex determination and mutations
- To introduce the basic concepts of inheritance patterns, genetic and genomic basis of traits.
- To inculcate a holistic understanding about the genetic basis of a particular clinical disorder.

**Course Learning Outcomes:** Upon completion of the course, students will be able to:

- Have a deeper understanding of the varied branches of the biological sciences like microbiology, evolutionary biology, genomics and metagenomics.
- Gain knowledge of the basic principles of inheritance.
- Analyse pedigree leading to development of analytical skills and critical thinking enabling the students to present the conclusion of their findings in a scientific manner.

**Course Content:**

**UNIT I: CHROMOSOME ORGANISATION**

Chromatin structure, Histones, DNA, nucleosome morphology and higher-level organization. Functional states of chromatin. Metaphase chromosomes, centromere, and kinetochore. Telomere and its maintenance. Holocentric chromosomes, heterochromatin and euchromatin. Giant chromosomes like polytene and lampbrush chromosomes.

**UNIT II: FATE OF CHROMOSOME IN CELL DIVISION**

Chromosome remodeling in mitosis and meiosis, sister chromatid cohesion remodeling, regulation of exit from metaphase, chromosome movement at anaphase. Stages in karyokinesis and cytokinesis.

**UNIT III: CYTOPLASMIC INHERITANCE**

Extra chromosomal inheritance. Inheritance of mitochondrial and chloroplast genes, mechanism of maternal inheritance, Role of Mitochondrial inheritance in evolution.

**UNIT IV: DISEASE DUE TO CHROMOSOMAL ABBERATIONS AND CANCER**

**SEMESTER - II**

Chromosomal anomalies. Structural and numerical alterations of chromosomes, Deletion, duplication, inversion, translocation, ploidy and their genetic implications and common disease due to chromosomal anomalies.

**UNIT V: CANCER GENETICS**

Genetics and cancer: oncogenes- tumor inducing retroviruses and viral oncogenes; chromosome rearrangement and cancer; tumor suppressor genes- cellular roles of tumor suppressor genes, pRB, p53, pAPC, and genetic pathways to cancer.

**Suggested books:**

1. Gardner, E.J.; Simmon, M.J. and Snustad, D.P. Principles of Genetics, John wiley & Sons, inc. NY.
2. Weaver, R.F. and Hedrick, P.W. Genetics. Wm C. Brown Publishers.
3. Brown, T. A. Genetics- A Molecular, Approach, Chapman & Hall.
4. Mitra, S. Genetics-A Blueprint of life, Tata McGraw Hill
5. Dobzhansky, Th. Genetics and Origin of Species. Columbia University Press.
6. Dobzhansky, Th; Ayala, F.J.; Stebbins, G.L. and Valentine, J.M. Evolution, Surjeet Publishers, Delhi.
7. Futuyama, D.J. Evolutionary Biology, Suinuaer Associations. INC Publishers. Dunderand.
8. King, M. Species, Evolution –The role of chromosomal change. The Cambridge University Press, Cambridge.
9. Merrel, D.J. Evolution and Genetics Holt. Rinchart and Winston, Inc.
10. Strikberger, M.W. Evolution Jones and Barlett Publishers. Boston London.

**SEMESTER - II**

**COURSE NAME: COMPARATIVE ANATOMY OF VERTEBRATES**

**Course Code: ZOO 466** **Credit: 02**

**Course Learning Objectives:**

- To enable the students to develop an appreciation for the biodiversity of vertebrates.
- To draw a comparative account of anatomy of vertebrates and hence to understand the evolution of different systems in vertebrates.
- The course furnishes an understanding of evolutionary basis of morphological and anatomical differences as well as similarities that occur among vertebrates.

**Course Learning Outcomes:** Upon completion of the course, students should be able to:

- Explain comparative account of the different vertebrate systems
- Learn the comparative account of integument, skeletal components, their functions and modifications in different vertebrates.
- Understand the evolution of heart, modification in aortic arches, structure of respiratory organs used in aquatic, terrestrial and aerial vertebrates; and digestive system and its anatomical specializations with respect to different diets and feeding habits.

**Course Content:**

**UNIT I: INTRODUCTION AND INTEGUMENTARY SYSTEM**

Introduction to chordates. Organization and affinities of *Herdmania* and *Amphioxus*. Comparative account of following systems of the vertebrates with evolutionary trends from Pisces to Mammals. Integumentary system: Integument and its derivatives.

**UNIT II: SKELETAL AND DIGESTIVE SYSTEM**

Skeletal system: chondrocranium, splanchnocranium, dermatocranium, and jaw suspension. Digestive system: Alimentary canal and associated glands. (types of teeth, dental formulae and functions, types of stomach, small and large intestines, glands: salivary, gastric, pancreas and liver).

**UNIT III: CIRCULATORY AND RESPIRATORY SYSTEM**

Circulatory system: Evolution of heart & aortic arches in different classes of vertebrates. Respiratory system: Respiratory organs. Types of respiratory mechanisms (gills, lungs, skin and accessory respiratory organs).

**SEMESTER - II**

**UNIT IV: URINOGENITAL SYSTEM**

Urinogenital system: Succession of kidney (archinephros, pronephros, mesonephros, and metanephros), osmoregulation, evolution of gonads and urinogenital ducts.

**UNIT V: NERVOUS SYSTEM AND SENSE ORGANS**

Nervous system: Comparative account and evolution of brain, spinal cord and cranial nerves. Sense organs: Chemoreceptors, photoreceptors, and mechanoreceptors

**Suggested books:**

1. A Text Book of Zoology, Vol. II Vertebrates by A.J. Marshall, MacMillan & Co. Ltd., New York (1972). 2. Anatomy of Chordates by C.K. Weichert, McGraw Hill Book Co. Inc. London (1958).
2. Biology of Vertebrates by H.E. Walter and L.P. Sayles, McMillan Co. New York (1949).
3. Comparative Anatomy of Vertebrates by G.C. Kent, Torpen Co. Ltd., Tokyo (1954).
4. Anatomy of Comparative Vertebrates. Hyman, L. H. Satish Serial Pub. House 2004.

**SEMESTER - II**

**COURSE NAME: BIOSYSTEMATICS AND EVOLUTION**

**Course Code: ZOO 467** **Credit: 02**

**Course Learning Objectives:** The study of evolutionary biology is essential for anyone who seeks to obtain an understanding of life and natural world. It is a unifying thread which joins all organisms from prokaryotes to highest of eukaryotes. This course emphasizes on the development of evolutionary thought by dealing in general with the process and pattern of biological evolution. On one hand, it offers a chance to students to learn about deciphering evidences ranging from fossil records to molecular data and arranges them to establish phylogenetic relationships of species, while, on the other, it provides a platform to understand various forces which bring about variations among populations of a species and cause them to diversify into new species.

**Course Learning Outcomes:** Upon completion of the course, students should be able to:

- Acquire problem solving and high order analytical skills by attempting numerical problems as well as performing simulation studies of various evolutionary forces in action..
- Apply knowledge gained, on populations in real time, while studying speciation, behaviour and susceptibility to diseases.
- Gain knowledge about the relationship of the evolution of various species and the environment they live in.

**Course Content:**

**UNIT I: DEFINITION AND BASIC CONCEPTS OF BIOSYSTEMATICS**

Definitions and perspectives of systematics, classification and taxonomy, goals and importance, taxa, taxonomic keys-different kinds, their merits and demerits, polytypic species, race, variety, cline, subspecies, semi-species, super species. Trends in biosystematics, concepts of different conventional and newer aspects- chemotaxonomy, cytotaxonomy, molecular taxonomy

**UNIT II: TAXONOMIC PROCEDURES**

Taxonomic collections, preservation, curetting, process of identification, international code of zoological nomenclature (ICZN)- its operative principles, interpretation and application of important rules, zoological nomenclature; formation of scientific names of various taxa.

**UNIT III: INTRODUCTION TO EVOLUTION**

Lamarckism; Darwinism, evolutionary history, adaptation, struggle, fitness and natural selection, types of natural selection, stabilizing selection, sexual selection, group selection, directional selection, disruptive selection concepts of Oparin and Haldane, and Miller's experiment.

**SEMESTER - II**

**UNIT IV: ORIGIN AND EVOLUTION OF SPECIES**

Speciation, Species concepts - typological species concept, nominalistic species concept, biological species concept, evolutionary species concept, difficulties in applying biological species concept.

**UNIT V: EVOLUTION FROM FISH TO MAMMALS**

Origin of Vertebrates: fishes, amphibians, reptiles, aves and mammals, evolutionary history of man.

**Suggested books:**

1. M. Kato. The Biology of Biodiversity. Springer.
2. E.O. Wilson, biodiversity. Academic Press, Washington.
3. G.G. Simpson, Principle of animal taxonomy. Oxford IBH Publishing company.
4. E. Mayer. Elements of Taxonomy. Oxford IBH Publishing company.
5. E.O. Wilson. The diversity of Life (The College edition W.W. Northam & Co.
6. B.K. Tikadar. Threatened Animal of India, ZSI publication Calcutta
7. V.C. Kapoor. Theory and Practice of Animal Taxonomy. Oxford & IBH Publishing Co.
8. J.C. Avise, Molecular Markers, Natural History and Evolution, Chapman & Hall, New York.
9. Dobzhansky, Th. Genetics and Origin of Species. Columbia University Press.
10. Dobzhansky, Th; Ayala, F.J.; Stebbins, G.L. and Valentine, J.M. Evolution, Surjeet Publishers, Delhi.
11. Futuyama, D.J. Evolutionary Biology, Suinuaer Associations. INC Publishers. Dunderand.
12. King, M. Species, Evolution –The role of chromosomal change. The Cambridge University Press, Cambridge.
13. Merrel, D.J. Evolution and Genetics Holt. Rinchart and Winston, Inc.
14. Strikberger, M.W. Evolution Jones and Barlett Publishers. Boston London.

**SEMESTER - II**

**COURSE NAME: DEVELOPMENTAL BIOLOGY**

**Course Code: ZOO 468** **Credit: 02**

**Course Learning Objectives:**

- The course explains the basic principles and concepts underlying the developmental processes at the cellular and molecular level.
- The main objective of Developmental Biology course is to provide four-dimensional thinking of students to truly understand the patterns and process of embryonic development, body plan, fate map, induction, competence, regulative and mosaic development, molecular and genetic approach for the study of developing embryo which is not necessarily shared with any other disciplines in the biological sciences.

**Course Learning Outcomes:** Upon completion of the course, students should be able to:

- Understand the events that lead to formation of a multi cellular organism from a single fertilized egg, the zygote.
- Describe the general patterns and sequential developmental stages during embryogenesis; and understand how the developmental processes lead to establishment of body plan of multi cellular organisms.
- Discuss the general mechanisms involved in morphogenesis and to explain how different cells and tissues interact in a coordinated way to form various tissues and organs.

**Course Contents:**

**UNIT I: BASIC CONCEPTS OF DEVELOPMENT**

Basic concepts of developmental biology- cell division, cell differentiation, signaling and patterning.

Model systems: Invertebrate model organism- *Drosophila melanogaster* and vertebrates model organisms- *Xenopus laevis.*

**UNIT II: GAMETOGENESIS, CLEAVAGE AND GASTRULATION**

Embryonic development in invertebrates (sea urchin) and vertebrates (frog): Structure of the gametes– the sperm and the egg; molecular basis of spermatogenesis and oogenesis. Fertilization and polyspermy.

Morphogenesis- movement and formation of germ layers, fate maps and vital dyes.

**SEMESTER - II**

**UNIT III: EMBRYONIC DEVELOPMENT OF INVERTEBRATES AND VERTEBRATES**

Early embryonic development of invertebrates and vertebrates - Cleavage and formation of blastula, gastrulation, neural tube formation, and cell migration.

General concept of potency, commitment, specification, induction, competence, and determination.

**UNIT IV: ORGANOGENESIS**

Concept of organogenesis- Development and patterning of vertebrate limb, homeobox genes in patterning, signalling in patterning of the limb. Regeneration- epimorphic and morphollaxis Postembryonic development: growth, cell proliferation, growth hormones; aging- genes and senescence.

**UNIT V: TERATOGENETICS**

Medical implications of developmental biology-Teratogenesis: environmental assaults on development; teratogenic agents and teratological abnormalities.

**Suggested books:**

1. Developmental Biology, Scott F Gilbert, 12$^{th}$ed, Sinauer.
2. Essentials of Developmental Biology, JMW Slack 3$^{rd}$ ed, Wiley-Blackwell.
3. Principles of Development, Louis Wolpert, 3$^{rd}$ ed 2007, Oxford.
4. An introduction to Embryology, Balinsky, 5$^{th}$ed 1981, Saunders.
5. Analysis of Biological development, Kalthoff, 1996, McGraw.

**SEMESTER - II**

**COURSE NAME: CYTOGENETICS AND DEVELOPMENTAL BIOLOGY LAB**

**Course Code: ZOO 469** **Credit: 02**

**Course Learning Objectives:**

- The course explains the basic principles and concepts underlying the developmental processes at the cellular and molecular level.
- To introduce the basic concepts of inheritance patterns, genetic and genomic basis of traits.

**Course Learning Outcomes:** Upon completion of the course, students will be able to:

- Understand the events that lead to formation of a multicellular organism from a single fertilized egg, the zygote.
- Acquire basic knowledge of the cellular processes of development and the molecular mechanisms underlying these.
- Gain knowledge of the basic principles of inheritance.
- Analyse pedigree leading to development of analytical skills and critical thinking enabling the students to present the conclusion of their findings in a scientific manner.

**Course Contents:**

1. Techniques in the study of chromosomes and their applications: short term (lymphocyte) and long term (fibroblast) cultures, chromosome preparations, karyotyping, chromosome labelling, in situ hybridization, chromosome painting.
2. Study banding pattern of chromosome.
3. Giant chromosome polytene from Chironomus/Drosophila larva.
4. Preparation of solutions for Molecular Biology experiments.
5. Isolation of chromosomal DNA from bacterial cells.
6. Isolation of Plasmid DNA by alkaline lysis method
7. Agarose gel electrophoresis of genomic DNA & plasmid DNA
8. Evolution study through collection of specimens.
9. Study of morphological characters of local Amphibians and Reptiles.
10. Study of Homologous and Analogous organs from suitable specimens.
11. Study of fossil evidences from plaster cast models and pictures.
12. Visit to Forest/National Park/Wild life Sanctuary to study the behaviour of animals.
13. Developmental stages study of drosophila
14. Developmental stages study of amphibian embryo
15. Developmental stages study of Chick embryo
16. Developmental stages study of mammal embryo

**SEMESTER - II**

**Suggested books:**

1. Gardner, E.J.; Simmon, M.J. and Snustad, D.P. Principles of Genetics, John wiley & Sons, inc. NY
2. Weaver, R.F. and Hedrick, P.W. Genetics. Wm C. Brown Publishers.
3. Brown, T.A. Genetics- A Molecular, Approach, Chapman & Hall.
4. Mitra, S. Genetics-A Blueprint of life, Tata McGraw Hill

**SEMESTER - II**

**COURSE NAME: COMPARATIVE ANATOMY OF VERTEBRATE AND BIOSYSTEMATICS LAB**

**Course Code: ZOO 470** **Credit: 02**

**Course Content:**

1. Classification upto orders, excepting Pisces and Aves, where classification upto subclasses is required, Habits, Habitats, external characters and economic importance (if any) of the following animals:
   Chondrichthyes: *Zygaena, Pristis, Trygon, Rhinobatus, Chimaera.*
   *Actinopterygii: Polypterus, Acipenser, Muraena, Catla. Hippocampus, Syngnathus, Exocoetus, Anabas, Tetradon, Echeneis* and *Solea*.
   *Dipneusti* (Dipnoi): *Protopterus* (Lung fish)
   Amphibia: *Uraeotyphlus, Necturus, Ambystoma* and its *Axolotl* larva*, Salamandra, Hyla, Rhacophorus.*
2. Reptilia: *Hemidactylus, Calotes, Draco, Varanus, Phrynosoma, Chamaeleon. Typhlops, Python, Bungarus, Naja, Hydrus, Vipera, Crocodilus. Gavialis, Chelone* and *Testudo.*
3. Demonstration of dissection of *Labeo* through video clipping/models/charts: Digestive and reproductive systems, Circulatory system: heart, afferent and efferent branchial arteries, Nervous system: cranial nerves and internal ear.
4. Study of the skeleton of *Labeo, Rana* and *Varanus.*
5. Study of poison apparatus in snakes through charts.
6. Aves: *Anas, Milvus, Pavo, Eudynamis, Tyto* and *Alcedo.*
7. Mammalia: *Ornithorhynchus, Echidna, Didelphis, Macropus, Loris, Macaca,Manis, Hystrix, Funambulus, Panthera, Canis, Herpestes, Capra,Pteropus.*
8. Demonstration of dissection of Chick and White Rat through video clipping/models/charts. Chick: Digestive, arterial, venous and urinogenital systems. White Rat: Digestive, arterial, venous and urinogenital systems.

**Suggested books:**

1. A Text Book of Zoology, Vol.II Vertebrates by A.J. Marshall, MacMillan & Co. Ltd., New York (1972). 2. Anatomy of Chordates by C.K. Weichert, McGraw Hill Book Co. Inc. London (1958).
2. Biology of Vertebrates by H.E. Walter and L.P. Sayles, McMillan Co. New York (1949).
3. Comparative Anatomy of Vertebrates by G.C. Kent, Torpen Co.Ltd., Tokyo (1954).
4. Anatomy of Comparative Vertebrates. Hyman, L. H. Satish Serial Pub. House 2004.

**SEMESTER - II**

**COURSE NAME: ENDOCRINOLOGY AND NEURAL PHYSIOLOGY**

**Course Code: ZOO 471** **Credit: 02**

**Course Learning Objectives:**

- To provide students with a basic understanding of human endocrine glands, neuro-endocrine glands and their structure, function and signalling pathways.
- To facilitate the understanding of the biosynthesis and biochemistry of hormones.
- To integrate the basic and clinical aspects of endocrinology to enhance the understanding of students about the consequences due to hyposecretion, hypersecretion and absence of hormones leading to various diseases and metabolic disorders.

**Course Learning Outcomes:** After completion of the course the students will be able to:

- Understand endocrine system and the basic properties of hormones.
- Appreciate the importance of endocrine system and the crucial role it plays along with the nervous system in maintenance of homeostasis.
- Gain insight into the molecular mechanism of hormone action and its regulation.
- Identify principles /mechanism underlying various neurological disorders.

**Course Content:**

**UNIT I: INTRODUCTION TO ENDOCRINOLOGY**

Introduction to endocrine system and common endocrine organs: Chemical nature of hormones. hormone secretions (apocrine, holocrine, and merocrine) hormone delivery, and hormonal feedback in homeostasis.

**UNIT II: MECHANISM OF HORMONE ACTION**

Mechanism of hormone action: Protein hormones, membrane receptors, G-proteins and control of adenylate cyclase, cyclic AMP cascade, other signal transduction systems (PLC and PLA pathways). Steroid hormones, hypothalamus-hypophysial system, general organization, neurohypophysial octapeptides (oxytocin and vasopressin). Hypophysiotropic hormones: chemistry localization and actions. Aden-hypophysial hormones: Chemistry and physiological roles.

**SEMESTER - II**

**UNIT III: NEURAL CONTROL OF HORMONES**

Somatotropin and prolacin, glycoprotein hormones (FSH, LH and TSH), Pro-opiomelanocortin (ACTH, MSH, β-LPH & β-endorphin), Neural control of adenohypophysis. Thyroid Gland: Biosynthesis of thyroid hormones. Control of secretion and Physiological roles of thyroid hormones.

**UNIT IV: STEROID HORMONES**

Steroid hormone biosynthesis and pathways: Testis - Physiological roles of androgens. Ovary - Physiological roles of estrogen, progesterone and relaxin.

**UNIT –V: ADRENAL HORMONES**

Adrenal Cortex - Control of mineralocorticoid and glucocorticoid secretions. Physiological roles of glucocorticoid and mineralocorticoid, Neural control of endocrine system and sense organ. Adrenal Medulla: Catecholamine biosynthesis, release, and its physiological roles of these hormones.

**SUGGESTED BOOKS:**

1. Hadley: Endocrinology, Prentice Hall. International Edition. 2000
2. Norris: Vertebrate Endocrinology (2nd ed). Lea & Febriger. 1997
3. Brooks and Marshall: Essentials of Endocrinology, Blackwell Science. 1995
4. Turner and Bagnara: General Endocrinology, W. B. Saunders Company Philadelphia. 1984
5. Larson: Williams Text Book of Endocrinology, 10th edition. W. B. Saunders Company, Philadelphia. 2002.

**SEMESTER - II**

**COURSE NAME: PRINCIPLES OF BIOCHEMISTRY**

**Course Code: ZOO 472** **Credit: 02**

**Course Learning Objectives:**

- To comprehend the fundamental principles of chemistry that govern complex biological systems.
- To make the study relevant, interesting, encouraging to the students to join the industry or to prepare them for higher studies including research.

**Course Learning Outcomes**: Upon completion of the course, students should be able to:

- Gain knowledge and skill in the fundamentals of biochemical sciences, interactions and interdependence of physiological and biochemical processes.
- Get exposed to various processes used in industries and gain skills in techniques of chromatography and spectroscopy.
- Demonstrate foundation knowledge in biochemistry; synthesis of proteins, lipids, nucleic acids, and carbohydrates; and their role in metabolic pathways along with their regulation.

**Course Content:**

**UNIT I: INTRODUCTION**

Structure of atoms, molecules and chemical bonds, stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction). Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties)**.**

**UNIT II: CARBOHYDRATES: STRUCTURE AND FUNCTION**

General structure, classification, and chemical properties of carbohydrates. Isomerism in glucose **(**Optical isomerism**,** Ring structure**,** Anomers & Epimers**,** Aldose & Ketose Isomerism) Bioenergetics - glycolysis, TCA cycle and oxidative phosphorylation.

**UNIT III: AMINO ACIDS AND PROTEINS**

Structure and classification of amino acids, Protein structure and function (Ramachandran plot, secondary structure, domains, motif and folds, Myoglobin, haemoglobin, etc.). Enzymes (Principles of catalysis, kinetic and regulation, isozymes) feedback inhibition, Ribozyme and Abzyme, protein hormones and Conjugated proteins: Lipoproteins, glycoproteins, nucleo proteins, allosteric enzyme.

**SEMESTER - II**

**UNIT- IV: LIPIDS: STRUCTURE & FUNCTION**

Definition and Nomenclature of fatty acids Classification of fatty acids and lipids. Saturated & Unsaturated fatty acids Simple lipids: Triacylglycerols, waxes

Complex Lipids: Phospholipids, Glycolipids Derived Lipids: Steroids, Lipoprotein, Prostaglandins, Oxidation of fatty acids; biosynthesis of saturated and unsaturated fatty acids.

**UNIT- V: NUCLEOTIDES AND NUCLEIC ACIDS**

Nucleotides; building blocks of nucleic Acid. Conformation of nucleic acids (DNA, RNA, helix (A, B, Z), t-RNA,). Proteins-nucleic acid interaction and post-transcriptional modification, Biosynthesis of purines and pyrimidines.

**Suggested books**:

1. Zubay, G. 1988, biochemistry (2nd ed), Macmillan Publ. House N.Y.
2. Mahler, H.R. and codes F.H. 1971. Biological chemistry, Harper International.
3. Lehinger. A.L. 1978, Biochemistry Kalyani Publishers, Ludhiana
4. Goodwin T.W.a dn Meriar L.E.I. 1989 Introductory plant Biochemistry pergamon Press VY.
5. Conn, E.E. and Shimpap, P.K. 1976. Outlines of Biochemistry Wiley Eastern
6. Styer, Biochemistry.
7. Freifelder Molecular Biochemistry.

**SEMESTER - II**

**COURSE NAME: ANIMAL BEHAVIOUR**

**Course Code: ZOO 473** **Credit: 02**

**Course Learning Objectives:**

- To understand the historical foundations of the field, as well as current theories and evidence for a broad range of behavioural topics.
- Behavioural ecology and the evolution of behaviours as adaptations will be recurring themes interwoven through all topics discussed. The purpose of the animal Behaviour Laboratory is for students to have hands-on experiences designing and implementing experiments that concern a variety of behaviour.

**Course Learning Outcomes**: At the completion of their Animal Behavior course, students will be able to:

- Exhibit critical and integrative thinking skills
- Demonstrate ability to communicate scientific information in both oral and written formats
- Demonstrate knowledge of key concepts in animal behaviour
- Exhibit quantitative research skills (or demonstrate ability to perform all parts of the scientific method).

**Course Contents:**

**UNIT I: INTRODUCTION**

Introduction, definition, Ethology, history of the study of animal behavior and contribution of scientists; significance of animal behaviors, objectives of behaviors; approaches and methods in study of behaviors.

**UNIT II: PATTERNS OF BEHAVIOUR**

Reflexes- reflex action, types of reflexes, reflex arch, characteristics of reflexes; orientation and navigation, migration in fishes and birds; individual behavioral patterns; fixed action pattern, instinct and learnt behaviors; associative learning, classical and operant conditioning, habituation, imprinting; learning and memory.

**UNIT III: ROLE OF BRAIN, HORMONES AND PHEREMONES**

Hormones and pheromones in regulation of behaviors; motivation; mimicry, mimetic releaser and code breakers; biological rhythms- types and characteristics.

**SEMESTER - II**

**UNIT IV: SOCIAL BEHAVIOR**

An over view of sociality in animal systems, aggregations- schooling in fishes, flocking in birds, herding in mammals, social organization in honey bee, various type of communications, altruism: reciprocal altruism, group selection, kin selection and inclusive fitness, cooperation, alarm call and parental care.

**UNIT V: ECOLOGICAL ASPECTS OF BEHAVIOUR**

Habitat selection, homing, territoriality, dispersal, foraging; reproductive behaviors: asymmetry and sexual dimorphism, mate choice, sexual selection, and sexual conflicts.

**Suggested books:**

1. Peter Marler and J. Hamilton, Mechanism of Animal Behavior, John Wiley & Sons, USA
2. David McFarland, Animal Behavior, Pitman Publishing Limited, London, UK
3. John Alcock, Animal Behavior, Sinauer Associate Inc., USA
4. Goodenough, McGuire and Wallace, Perspective on Animal Behavior, John Wiley & Sons, USA
5. Sherman P. W. and John Alcock, Exploring Animal Behavior, Sinauer Associate Inc., Massachusetts, USA
6. Manning A. and Dawkins M.S., An Introduction to Animal Behavior, Cambridge University Press, UK
7. Richard Dawkins, The Selfish Gene, Oxford University Press, 2016.

**SEMESTER - II**

**COURSE NAME: APPLIED ZOOLOGY**

**Course Code: ZOO 474** **Credit: 02**

**Course Learning Objectives**:

- To make the students aware of various pests of food crops and food products and various insect control methods.
- To educate the students about economic importance and techniques of Apiculture and sericulture

**Course Learning Outcomes**:

- Understand pests of food crops and food products and various insect control methods.
- Understand different honey bee species, bee products, silk worm species and sericulture.
- Understand different species of culturable fishes, ornamental fishes, fish culture practices, management of fish culture, fish processing and preservation.

**Course Contents**

**UNIT I: SERICULTURE AND PISCICULTURE**

Sericulture Silkworm and its strains, rearing of silkworms, sericulture and its components, silk reeling Pests, and diseases of silkmoth. Pisciculture, monoculture and composite culture Fresh water, & marine fisheries, induced breeding & its technique in pisciculture; Haps & ponds for fish culture and their management. Fish diseases and their control.

**UNIT II: INTEGRATED PEST MANAGEMENT**

IPM and Different methods: Pest Control Principles and practices of pest control. Methods of pest control- Chemical Biological, Microbial, Integrated control. organochlorine, Insecticides, Organisphosophorus insecticides, Carbamates, Acaricides, Nematicides, Rodenticides, Molluscicides and Botanical pesticides. Pheromonal and Hormonal control. Chemosterilants and genetic control.

**UNIT III: MEDICAL ZOOLOGY**

Medical Zoology Systematics, biology, and control of following medically important organisms. trichomonas, onchocerca, cyclops, sarcoptes, dermacentor, phlebotmus, and glossina. Mode of transmission and of some important diseases. Cholera, Typhus, small pox, plague, Malaria, Dengue fever, Filariasis & AIDS.

**SEMESTER - II**

**UNIT IV: PARASITOLOGY**

Parasitic platyhelminthes and nematodes- Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Fasciola hepatica, Schistosoma haematobium, Taenia solium, Ascaris lumbricoides*, and *Wuchereria bancrofti*.

**UNIT V: WILDLIFE CONSERVATION**

Wild Life conservation and conservation strategies; Extinction of wild species meaning and cause; Wild life protection in India and classification of threatened species, protected wild animals, protected areas and their management in India Endangered fauna and special projects for endangered species.

**Suggested books:**

1. Park, K. (2007). Preventive and Social Medicine. XVI Edition. B.B Publishers.
2. Arora, D. R and Arora, B. (2001). Medical Parasitology. II Edition. CBS Publications and Distributors.
3. Kumar and Corton. Pathological Basis of Diseases.
4. Atwal, A.S. (1986). Agricultural Pests of India and South East Asia, Kalyani Publishers.
5. Dennis, H. (2009). Agricultural Entomology. Timber Press (OR).
6. Hafez, E. S. E. (1962). Reproduction in Farm Animals. Lea & Fabiger Publisher
7. Dunham R.A. (2004). Aquaculture and Fisheries Biotechnology Genetic Approaches.
8. CABI publications, U.K.
9. Pedigo, L.P. (2002). Entomology and Pest Management, Prentice Hall.
10. Text Book of Applied Entomology Vol. I & II by K. P. Srivastava

**SEMESTER - II**

**COURSE NAME: HISTOLOGY AND HISTOCHEMISTRY**

**Course Code: ZOO 475** **Credit: 02**

**Course Learning Objectives:**

- To acquaint the students with various techniques to study histology and histochemistry of various animal tissues and to know about fixation and staining techniques.
- To enable the students, understand the molecular basis of cell-cell signalling, cell division and transport of ions across cell membranes.

**Course Learning Outcomes**:

- To identify the basic structure of cells, tissues and organs and describe their contribution to normal function.
- To interpret light- and electron-microscopic histologic images and identify the tissue source and structures.

**Course Contents:**

**UNIT I: TISSUE FIXATION**

Fixation and fixatives, types of fixatives used in tissue fixation. Chemistry of fixation, choice of fixatives in histology.

**UNIT II: TISSUE PROCESSING**

Tissue processing, dehydration, clearing and embedding, microtomy of tissue sections, types of microtomes. sectioning paraffin blocks. staining of paraffin sections.

**UNIT III: PRINCIPLES AND METHODS OF STAINING**

Principle and methods of staining. Histological stains. Haematoxylin and Eosin. Principles and methods of histochemical localization and identification of the following: Carbohydrate moieties, Glycogen and glycoproteins with oxidizable vicinal diols by Periodic acid Schiff method. Glycoproteins with carboxyl groups and/or O-sulphate esters by Alcian blue methods.

**UNIT IV: PROTEIN ANALYSIS**

Protein end groups, General proteins by Bromophenol blue method, –NH2 groups by Nihydrin-Schiff method, - SS groups by Performic acid –Schiff and performic acid- alcian blue methods. Lipid moieties. General lipids by Sudan black B method. Neutral lipids by total Sudan III and Sudan IV methods.

**SEMESTER - II**

**UNIT V: NUCLEIC ACIDS ANALYSIS AND IHC**

Nucleic acids, Methyl green pyronin for DNA and RNA. Feulgen reaction for DNA. Enzymes: Acid and alkaline phosphatases by Metal precipitation and Azo dye methods. Immunocytochemistry: Basic principles of IHC staining. Fluorescence histochemistry: Basic principles in Fluorescence histochemistry.

**Suggested books:**

1. Boyd, W. (1976): A text book of Pathology. Structure and function in disease, 4th edition. Lea and Fibiger, Philadephia.
2. Pearse, A.G.E. (1980): Histochemistry, theoretical and Applied, J & A, Churchill Ltd., London.
3. Rogers, A.W. (1983): Cells and Tissues, An introduction to Histology and Cell Biology, Academic Press, NY.
4. Telford, I.R. and Bridgman,C.F.(1990). Introduction to Functional Histology, Harper and Row, NY.
5. Histochemistry in focus: A source book of techniques and research needs. (2007), K. Shyamasundari and K. Hanumantha Rao. Publisher - M. J. Publishers Chennai, India.
6. Histological and Histochemical methods: Theory and Practice. 4th edition (2008), J. A. Kiernan Publisher – Scion Publishing Ltd. Oxford shire. • Colour Atlas of Histology. 3rd edition (2000). L. P. Gartner and J. L. Hiat Publisher – Lippincott- Williams & Wilkins, Baltimore.
7. Histology: A text book and Atlas. 2nd edition (1989). M. H. Ross, E. J. Reith and L. J. Romrell Publisher - Williams & Wilkins, Baltimore.
8. Bailey's text book of Histology. 15th edition (1964). W. M. Copenhaver. Publisher – The Williams & Wilkins Company, Baltimore.
9. Histochemistry (Vol I –III). 4th Edition (1991), Stoward, P. J. & Pearse, A. G. E. Publisher – Churchill Livingstone Edinburgh, London.

**SEMESTER - II**

**COURSE NAME: TRADITIONAL USES OF ANIMALS FOR SUSTAINABLE SOCIAL AND HEALTH WELFARE**

**Course Code: ZOO 476** **Credit: 02**

**Course Learning Objectives:**

- To comprehend the knowledge of traditional Indian system.
- To provide knowledge of traditional medicine and intellectual property issues, legal framework of traditional knowledge

**Course Learning Outcomes**:

- Discuss the concept of traditional knowledge
- Have a deeper understanding of Traditional Knowledge in Medicine
- Gain knowledge of Intellectual Property Issues in traditional knowledge

**Course contents:**

**UNIT I: INTRODUCTION TO TRADITIONAL KNOWLEDGE**

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, indigenous knowledge, characteristics. protection of traditional knowledge. traditional knowledge in different sectors (overview).

**UNIT II: THE MEDICAL TRADITION IN ANCIENT INDIA**

Specialization into eight branches, The tradition of surgery, medical genetics in Ayurveda, inoculation for smallpox, microbiology and parasitology, communicable diseases, and epidemics.

**UNIT III: USE OF ANIMALS FOR TREATING HUMAN AILMENTS**

Use of crustacean, insects, reptiles, birds, mammals, fishes etc. and their by-product in traditional human healthcare system.

**UNIT IV: USE OF ANIMALS BI-PRODUCT IN AGRICULTURE AND FOR VETERINARY DISEASES**

Use of crustacean, insects, reptiles, birds, mammals, fishes etc. and their bi-product in agriculture and veterinary system.

**UNIT V: TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY**

Systems of traditional knowledge protection, legal concepts for the protection of traditional knowledge, patents and traditional knowledge, strategies to increase protection of traditional knowledge.

**SEMESTER - II**

**Suggested books:**

1. Traditional Knowledge System in India, by Amit Jha, 2009.
2. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
3. Knowledge Traditions and Practices of India; Kapil Kapoor and Michel Danino.
4. Traditional Knowledge System and Technology in India (English, Hardcover)
5. Basanta Kumar Mohanta, Vipin Kumar Singh) Edition: 2012 Language English

**SEMESTER - II**

# INTERDISCIPLINARY COURSE

## COURSE NAME: PERSPECTIVES ON ANIMAL BEHAVIOUR

**Course Code: ZOO 477** **Credit: 02**

**Course Learning Objectives:**

- To understand the historical foundations of the field, as well as current theories and evidence for a broad range of behavioural topics.
- Behavioural ecology and the evolution of behaviours as adaptations will be recurring themes interwoven through all topics discussed. The purpose of the animal Behaviour Laboratory is for students to have hands-on experiences designing and implementing experiments that concern a variety of behaviour.

**Course Learning Outcomes**: At the completion of their Animal Behaviour course, students will be able to:

- Exhibit critical and integrative thinking skills
- Demonstrate ability to communicate scientific information in both oral and written formats
- Demonstrate knowledge of key concepts in animal behaviour
- Exhibit quantitative research skills (or demonstrate ability to perform all parts of the scientific method).

**Course Contents:**

**UNIT I: INTRODUCTION TO ANIMAL BEHAVIOUR**

Origin and history of Ethology, pioneers of modern ethology: Karl von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Proximate and ultimate causes of behavior, tools, techniques, and methods used in studying animal behavior.

**UNIT II: MECHANISM OF ORIENTATION**

Primary and secondary orientation, kinesis, and taxis. learning and cognition: habituation, classical conditioning, operant conditioning, latent learning, social learning, homeostasis and behavior: motivational system and their physiological basis, motivational conflict and decision making, displacement activity, hormonal regulation of behaviors.

**UNIT III: ROLE OF BRAIN, HORMONES AND PHEREMONES**

ROLE of brain, hormones, and pheromones in regulation of behaviors; motivation; mimicry, mimetic releaser, and code breakers.

**SEMESTER - II**

**UNIT IV: SOCIAL AND SEXUAL BEHAVIOUR**

Social behavior, concept of society, communication, and the senses (chemical, tactile, auditory, visual), altruism, inclusive fitness, Hamilton's rule, insects' society (example: honey bee), foraging in honey bee and advantages of the waggle dance. sexual behavior: asymmetry of sex, sexual dimorphism, mate choice, intra-sexual selection (male rivalry), inter-sexual selection (female choice), courtship behavior, parental care, sexual conflict in parental care.

**UNIT V: BIOLOGICAL RHYTHM**

Characteristics of biological rhythms, short-and long-term rhythms, circadian rhythms, tidal rhythms and lunar rhythms, concept of synchronization and masking, photic and nonphotic zeitgebers, circannual rhythms, photoperiod, and regulation of seasonal reproduction of vertebrates, and role of melatonin.

**Suggested books:**

8. Peter Marler and J. Hamilton, Mechanism of Animal Behavior, John Wiley & Sons, USA
9. David McFarland, Animal Behavior, Pitman Publishing Limited, London, UK
10. John Alcock, Animal Behavior, Sinauer Associate Inc., USA
11. Goodenough, McGuire and Wallace, Perspective on Animal Behavior, John Wiley & Sons, USA
12. Sherman P. W. and John Alcock, Exploring Animal Behavior, Sinauer Associate Inc., Massachusetts, USA
13. Manning A. and Dawkins M.S., An Introduction to Animal Behavior, Cambridge University Press, UK
14. Richard Dawkins, The Selfish Gene, Oxford University Press, 2016.

**SEMESTER - II**

**COURSE NAME: PRINCIPLES OF AQUACULTURE**

**Course Code: ZOO 478** **Credit: 04**

**Course Learning Objectives:**

Understand the nature, status and scope of aquaculture to acquire knowledge on the importance of aquaculture. Identify significant types of aquaculture systems with particular emphasis on its operation and management options. Develop a comprehensive knowledge of major steps involved in aquaculture. Critically evaluate the problems faced in aquaculture and its possible solutions and to inculcate thorough knowledge on the prospects and importance of aquaculture

**Course Learning Outcomes:**

- Explain and understand the international and national status of aquaculture
- State and remember the history of aquaculture
- Evaluate and analyse various scientific methods of aquaculture

**UNIT I: INTRODUCTION TO AQUACULTURE**

Definition, basics, scope, and history of aquaculture; Present global and national scenario. Lakes, their origin, Physical and chemical conditions, and related phenomena; Biological relations: Influence of physical and chemical conditions on living organisms in inland waters.

**UNIT II: AQUACULTURE SYSTEMS**

Systems of aquaculture: pond culture, pen culture, cage culture, running water culture and zero water exchange system. Extensive, semi-intensive, intensive, and super-intensive aquaculture in different types of water bodies viz., freshwater, brackish water and marine water.

**UNIT III: MAJOR SPECIES IN AQUACULTURE**

Fish species in freshwater, brackish and marine water; in monoculture, polyculture, and integrated culture systems. Ornamental Fish Farming: Introduction to Aquarium Fish Keeping, Exotic and Endemic Ornamental Fish species for Aquarium.

**UNIT IV: WATER QUALITY MANAGEMENT**

Water quality in relation to fish production: Physical, chemical, and biological factors affecting productivity of ponds.

**SEMESTER - II**

**UNIT III: DESIGN OF HATCHERIES & FISH FARM**

Brood stock ponds, water supply system, main hatchery complex, spawning tanks, incubation/hatching tanks, artemia hatching unit, live feed unit, water storage tanks. Tide fed/pump fed farms, creeks, estuarine and marine water source utilization.

**Books Recommended:**

1. Ayyappan, S., 2011.Handbook of Fisheries and Aquaculture, ICAR Publications, New Delhi.
2. Rath, R.K., 2011. Fresh water Aquaculture, Scientific publications.
3. Khanna, S. S. and Singh, H. R. (2014). A textbook of Fish Biology and Fisheries, Narendra Publishing House. New Delhi.

**SEMESTER - III**

**COURSE NAME: AGRICULTURAL ENTOMOLOGY**

**Course Code: ZOO 515** **Credit: 02**

**Course Learning Objectives:**

- The course describes adverse effects of pesticides and management of crop pests by an Integrated Pest Management (IPM) approach.
- The course offers information on transmission of diseases, methods of surveillance for diseases, effective Integrated Management of Vector control and other methods of prevention of arthropod borne diseases

**Course Learning Outcomes:**

- The course study makes the students capable to learn ill effects of pesticides and management of crop pests by bio-rational methods in an integrated approach (IPM) and impart concerned knowledge to the farmers and get involved in various pest management organizations.

**Course Contents:**

**UNIT I: INTRODUCTION TO PEST AND PEST SURVEILLANCE**

Definition of pest, pest status, factors responsible for achieving the status of pest, General equilibrium position (GEP), Economic injury level (EIL), economic threshold level (ETL), action threshold, Damage boundary (DB), pest spectrum, pest complex, carrying capacity, causes of pest outbreak, secondary pest outbreak, pest surveillance and sampling.

**UNIT II: INSECT PESTS OF CEREAL CROPS**

Systematic position, host range, nature of damage, bioecology and integrated management of the important insect pests of Paddy (*Nilaparvata lugens, Scirpophaga incertulas, Nymphula depunctalis, Orseolio oryzae, Diclasdispa armigera*), Wheat (*Sitobion miscanthi, Mythimna separata, Tanymecus indicus, Heterodera avenae, Anguina tricici*) and Maize(*Chlio partellus, Sesamia inferns, Helicoverpa armigera, Mythimna separata, Holotrichia serrata*).

**UNIT III: INSECT PESTS OF PULSES AND ORNAMENTAL CROPS**

Systematic position, host range, nature of damage, bioecology and integrated management of the important insect pests of Sugarcane, Pulses (*Helicoverpa armigera, Maruca testualis, Lampides boeticus, Exelasis atomosa, Etiella zinckenella*) and Ornamental crops.

**SEMESTER - III**

**UNIT IV: INSECT PESTS OF FRUITS AND VEGETABLES**

Systematic position, host range, nature of damage, bioecology and integrated management of the important pests of fruits (mango, apple, citrus, banana, guava, and papaya) and vegetables (tomato, potato, cucurbits, brinjal and Cole crops).

**UNIT V: STORED AND POLYPHAGOUS INSECT PESTS**

Systematic position, host range, nature of damage, bioecology and integrated management of the important stored and polyphagous pests -locust, termites, and white grubs.

**Suggested Books:**

1. Matthews, R.W., Matthews**,** J. R., Insect Behaviour, Springer, Dordrecht
2. Pedigo, L.P., Entomology & Pest Management, Prentice Hall, New Jersey, USA
3. Norris, Caswell-Chen and Kogan, Concepts of IPM, Prentice-Hall, USA
4. Hill, D. S., Agricultural insects pests of the tropics and their control, Cambridge University Press, UK
5. S. Pradhan, Agriculture Entomology and Pest Control, Indian Council of Agriculture Research.

**SEMESTER - III**

**COURSE NAME: ENTOMOLOGY LAB**

**Course Code: ZOO 516** **Credit: 02**

**Course Learning Objectives:**

- The course describes adverse effects of pesticides and management of crop pests by an Integrated Pest Management (IPM) approach.
- The course offers information on transmission of diseases, methods of surveillance for diseases, effective Integrated Management of Vector control and other methods of prevention of arthropod borne diseases

**Course Learning Outcomes:**

- The course study makes the students capable to learn ill effects of pesticides and management of crop pests by bio-rational methods in an integrated approach (IPM) and impart concerned knowledge to the farmers and get involved in various pest management organizations.

**Course contents:**

1. Morphology: Study of head and its sclerites.
2. Study of wings and their venation
3. Study of different types of mouth parts of Insects
4. Study of different types of antennae and legs of insects.
5. Taxonomy: Identification of insects belonging to different groups up to orders and sub orders.
6. Study of various types of social insects and their nests.
7. Dissection/Demonstration of Alimentary canal, Reproductive system, Circulatory system, Excretory system and Nervous system of insects
8. Estimation of LD50 and LC 50 through data provided.
9. Agricultural Entomology: Collection and identification of economically important insects and various stages of their life history.
10. Identification of important insect pests of different crop plants and stored products.
11. Visits to agricultural fields and forests for on spot study of pests and damage caused by them.
12. Study of life history stages of medically important insects.
13. Identification and anatomical studies of major vector species of Anopheles, Culex and Aedes.

**SEMESTER - III**

**Suggested Books:**

1. Pedigo, L. P., Entomology & Pest Management, Prentice Hall, New Jersey, USA
2. Norris, Caswell-Chen and Kogan, Concepts of IPM, Prentice-Hall, USA
3. Hill, D. S., Agricultural insects pests of the tropics and their control, Cambridge University Press, UK
4. S. Pradhan, Agriculture Entomology and Pest Control, Indian Council of Agriculture Research.

**SEMESTER - III**

**COURSE NAME: FISH BIOLOGY**

**Course Code: ZOO 517** **Credit: 02**

**Course learning Objectives:**

This course has been designed to equip the student with a balanced and complete scientific understanding of fish biology concepts. Understand the diversity and classification of fish: Students should be able to identify and describe the major groups of fish, including their anatomical and physiological characteristics, as well as their evolutionary relationships. To impart knowledge about fish nutrition, methods of determining the food of fishes.

**Course Learning Outcomes:** After completion of the course the students will be able to:

- Students will be able to identify and classify various fish species based on their anatomical features, external characteristics, and taxonomic classification.
- Students will demonstrate an understanding of fish behavior and their ecological adaptations, including feeding habits, reproductive strategies, migration patterns, and interactions with their environment.
- Students will be able to analyze the reproductive strategies employed by fish, understand the stages of fish development, and explain the various modes of parental care.

**Course Contents:**

**UNIT I: EVOLUTION AND PHYLOGENY OF FISHES**

Introduction and classification (Berg; Romar; Bertin and Arambourg; Pough et al. 1989). Origin and evolution of major groups of fishes, zoo-geographical distribution of fishes. Principles and different methods employed in fish identification (morphological, biometric analysis and at molecular level). Classification and identifying characters upto order level of major freshwater fish species. Formulation of taxonomic key.

**UNIT II: EPIDERMIS AND EXOSKELETON**

Histology and function of integument. Colouration and its significance, mechanism of colour change. Exoskeleton, placoid scale, cycloid scale, ctenoid scale, cosmoid scale, ganoid scale and importance of scales. Structure of fin, Origin of paired fins. Skeletal system of fishes. Adaption in the hill stream fishes.

**UNIT III: AIR BREATHING ORGANS AND SWIM BLADDER**

Gill structure and accessory respiratory organ (like, skin, alimentary canal, air bladder, buccopharynx, opercular cavity). Blood supply of a gill. Significance of the air breathing organs.

**SEMESTER - III**

Structural modifications of swim bladder in Dipnoi and Teleostei, Blood supply of the air bladder, Gas secreting complex and function of swim bladder.

**UNIT IV: DIGESTION AND FOOD, FEEDING HABITS**

Alimentary canal of a Teleost and its modification, feeding habits of herbivorous, Carnivorous and omnivorous fishes. Types of feeders (like, Surface, column and bottom feeder fishes). Seasonal variation of food, feeding intensity, Gastrosomatic index (GaSI) and methods of food analysis.

**UNIT V: REPRODUCTION, MATURATION AND SPAWNING**

Male reproductive organs, copulatory organ and histology of the testis, Female reproductive organs, maturation, spawning, seasonal changes and Gonadosomatic index (GSI). Regulation of oocytes maturation by hormones, fecundity. Reproductive behavior (Sexual dimorphism, courtship, building of a nest and parental care).

**Suggested books:**

1) Gene Helfman, Bruce B. Collette, Douglas E. Facey, Brian W. Bowen. The Diversity of Fishes: Biology, Evolution, and Ecology, 2nd Edition. April 2009, Wiley-Blackwell. ISBN: 978-1-4051-2494-2.
2) Handbook of Fish Biology and Fisheries, Volume 1 October 2002, Wiley-Blackwell. ISBN: 978-0-632-05412-1.
3) Hoar, W.S. and D.J. Randall (eds). Fish Physiology Vol. 1 to 9. From 1968 onwards, Academic Press, New York.
4) Jayram, K.C. (1999): The Freshwater Fisheries of Indian Region, 2nd Editon Narendra Publishing House Delhi.
5) Jhingran, V.G. Fish and Fisheries of India. 3rd ed. Hindustan Publishing Corporation New Delhi, 727 Pp.
6) Khanna, S.S. An Introduction to Fishes. S. Chand & Co., New Delhi. Latest ed. Matty, A.J. 1985.
7) Khanna, S.S. and Singh H. R. (2014). A Text Book of Fish Biology and Fisheries. Narendra Publishing House. New Delhi. ISBN: 13: 9789384337124.

**SEMESTER - III**

**COURSE NAME: FISH BIOLOGY LAB.**

**Course Code: ZOO 518** **Credit: 02**

**Course learning Objectives:**

This course has been designed to equip the student with a balanced and complete scientific understanding of fish biology concepts. Develop practical skills in fish handling and observation: Students will gain proficiency in safely handling live fish specimens, including proper techniques for immobilization, measuring, and examining their external features. Students will design and conduct experiments or investigations related to fish biology, such as studying feeding behavior, reproductive strategies, or the effects of environmental factors on fish physiology or behavior.

**Course Learning Outcomes:** After completion of the course the students will be able to:

- Students will acquire practical skills in fish handling, observation, and measurement techniques, demonstrating competence in safely and effectively handling live fish specimens.
- Students will develop proficiency in identifying different fish species using taxonomic keys, field guides, and morphological characteristics, accurately distinguishing between closely related species.
- Students will collect and analyze data obtained from experiments or field observations, utilizing appropriate statistical methods and data analysis techniques specific to fish biology.

**Course Contents:**

1) Morphometric and meristic studies of freshwater fish species:
   *a) Tor putitora* *b) Schizothorax richardsonii* *c) Garra gotyla*
   *d) Labeo rohita* *e) Catla catla* *f) Channa marulius*
   *g) Sperata seenghala* *h) Barilius bendelisis* *I) Glyptothorax pectinopterus*
   *j) Crossocheilus latius*
2) Morphological analysis of fish scales: investigating the range of shapes, sizes, and surface patterns.
3) To study the length weight relationship of freshwater fish species.
4) To study the morphological adaption in the hill stream fishes.
5) To study the comparative anatomy of swim bladder in different fish species.
6) To study the food and feeding habits of freshwater fish species
   *a) Tor putitora* *b) Schizothorax richardsonii* *c) Garra gotyla*
   *d) Labeo rohita* *e) Sperata seenghala* *f) Glyptothorax pectinopterus*

**SEMESTER - III**

7) To calculate the Gastrosomatic index (GaSI) and (RLG) in different fish species.

8) To study the different maturity stages of gonads in male and female fish.
9) Study of gonadosomatic index and fecundity of freshwater fish species.
10) To determine the sexual dimorphism using morphometric techniques in freshwater fish species.

**Suggested Books:**

1. Day, (1888). Fishes of India. Supplement, October, 1888. William Dawson, London: 779-816.
2. Day, F. (1875- 1878). The Fishes of India: being a natural history of the fishes known to inhabit the seas and fresh waters of India, Burma and Ceylon. Text and Atlas in 4 parts. London, XX +778 pp., 195 pls.
3. Hora, (1938). The game fishes of India. V The Pangas catfish. J. Bombay Nat. Hist. Soc., 40(3): 355-366.
4. Jayaram, K.C. (1999). The Freshwater Fishes of the Indian Region. Narendra Publication, New Delhi.
5. Jayaram, K.C. (2010). The Freshwater Fishes of the Indian Region (Revised second edition). Delhi, Narendra Publishing House, New Delhi, India.

**SEMESTER - III**

**COURSE NAME: ADVANCES IN MOLECULAR BIOLOGY**

**Course Code: ZOO 519** **Credit: 02**

**Course Learning Objectives:** The course aims to provide students with an introduction of the underlying molecular mechanisms of various biological processes in cells and organisms.

**Course Learning Outcomes**: Upon completion of the course, students will be able to:

- Describe the basic structure and chemistry of nucleic acids, DNA and RNA;
- Compare and contrast DNA replication machinery and mechanisms in prokaryotes and eukaryotes.
- Elucidate the molecular machinery and mechanism of information transfer processes– transcription and translation-in prokaryotes and eukaryotes

**Course Content:**

**UNIT I: MOLECULAR MECHANISM IN CELL DIVISION**

Mitosis and meiosis: molecular regulations, steps in cell cycle, and control of cell cycle. Cell cycle progression: Maturation promoting factors (MPF), Cyclins and Cyclins dependent kinases, growth factors and growth inhibitory factors. Cell death and apoptosis.

**UNIT II: MECHANISM OF DNA REPLICATION AND REPAIR**

DNA replication, repair and recombination. Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination.

**UNIT III: MECHANISM OF TRANSCRIPTION AND TRANSLATION**

RNA synthesis and processing: transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, and RNA transport.

**UNIT IV: CONTROL OF GENE EXPRESSION IN PROKARYOTES**

Constitutive, Inducible and Repressible gene expression, Positive and Negative control of gene expression, Lac, Tryptophan, arabinose operons; and lysogenic repression in lambda bacteriophage.

**SEMESTER - III**

**UNIT V: CONTROL OF GENE EXPRESSION IN EUKARYOTES**

Eukaryotic genome organization, Proteins involved in the control of transcription, Protein, protein interactions, Post-translational control, DNA methylation, Ligand binding to membrane receptors and its role in regulating transcription, phosphorylation cascade and amplification of signal.

**Recommended Books**:

1. Freifelder D (2012). Molecular Biology, 5th edition. Narosa Publishing House, India
2. Allison A. Lizabeth (2012) Fundamental Molecular Biology, 2nd Edition. J Willey and Sons, Hoboken,New Jersey.
3. Freifelder D and Malacinski GM (2005) Essentials of Molecular Biology, 4th Edition, John and Bartlett Publishing, UK
4. Raghavarao, D.: Statistical Techniques in Agricultural and Biological research (1983), Oxford and IBH Publishing Co.
5. Karp, G. 2010 Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc.
6. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MAiley & Sons. Inc.
7. Allison A. Elizabeth (2012) Fundamental Molecular Biology, 2nd Edition. J Willey and Sons, Hoboken, New Jersey.
8. De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology. 8$^{th}$ edition. Lippincott Williams and Wilkins, Philadelphia.
9. Cooper, G.M. and Hausman, R. E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
10. Lodish, H., Berk, A. and 6 more. (2007) Molecular Cell Biology 6th edition. W. H. Freeman.

**SEMESTER - III**

**COURSE NAME: ADVANCES IN MOLECULAR BIOLOGY LAB.**

**Course Code: ZOO 520** **Credit: 02**

**Course Learning Objectives:** The course aims to provide students with an introduction of the underlying molecular mechanisms of various biological processes in cells and organisms.

**Course Learning Outcomes**: Upon completion of the course, students will be able to:

- Describe the basic structure and chemistry of nucleic acids, DNA and RNA;
- Compare and contrast DNA replication machinery and mechanisms in prokaryotes and eukaryotes.
- Elucidate the molecular machinery and mechanism of information transfer processes– transcription and translation-in prokaryotes and eukaryotes

**Course Contents:**

1. DNA Isolation Techniques for both Prokaryote and Eukaryote
2. RNA Isolation Techniques for both Prokaryote and Eukaryote
3. Chromosome Isolation Techniques
4. FISH (Fluroscence Insitu Hybridization Technique.
5. DNA and RNA Staining Techniques.
6. Plasmid DNA Isolation and Genomic DNA Isolation.
7. PCR and its application
8. Electrophorosis Techniques in Genetics.
9. Protein Isolation techniques.
10. Cell Culture Techniques.

**Suggested Books**:

1. Lewin, B. 2000. Genes VIII Oxford University, Press, New York
2. Alberts, B. Bray, D., Lewis, J. Raff, M., Roberts, K. and Watson, J.D. 1999, Molecular biology of the cell. Garland Publishing, Inc. New York.
3. Wolfe, S.L. 1993, Gruissem, W. and Jones, R.L. 2000, Biochemistry and molecular biology of plants, American society of plant physiologists, Maryland, USA
4. Frifelder, D. Molecular Biology. John and Bartlett Publishers, inc., Boston, USA

**SEMESTER - III**

**COURSE NAME: RESEARCH METHODOLOGY**

**Course Code: ZOO 521** **Credit: 04**

**Course Learning Objectives:** To introduce the students to research methods applicable in biological studies.

- To acquaint the students to different types of scientific writing.
- to provide hands-on experience with collection, analysis and interpretation of data and also writing a report/thesis.
- to motivate students to learn scientific investigation to solve problems, test hypothesis, develop or invent new products for the benefit of society.

**Course Learning Outcome:** After completing this course, the students should be able to:

- Describe basic concepts of research and its methodologies ·
- Identify appropriate research topics and set up hypothesis ·
- Perform literature review using library (print) and internet (online) resources ·
- Design experiments/surveys, collect data and represent data in tables/figures · Analyze data with appropriate software tools, interpret results and draw conclusion

**Course contents:**

**UNIT I: INTRODUCTION TO RESEARCH METHODOLOGY**

Meaning of Research, Objectives of Research, Motivations in Research, Types of Research, Research Approaches, Significance of Research, Research Methods v/s Methodology, Research and Scientific Methods, Research Process, Criteria of Good Research.

**UNIT II: PROBLEM IDENTIFICATION AND FORMULATION**

Identification of Research problem, Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.

**UNIT III: RESEARCH DESIGN**

Meaning, Need, Features of Good Design, Concept and Importance in Research, Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

**SEMESTER - III**

**UNIT IV: SAMPLING**

Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non-Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling.

**UNIT V: TOOLS OF DATA COLLECTION**

Collections of Primary Data, Collection of Data through questionnaire and Schedules, other Observation Interview Methods, Collection of Secondary Data, Selection of appropriate method for data collection, Case Study, Focus Group Discussion, Techniques of developing research tools, viz. Questionnaire and rating scales etc. Reliability and validity of Research tools.

**Suggested Books:**

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
4. Singh, Y. K. (2006). Fundamental of Research Methodology and Statistics. New Delhi. New International (P) Limited, Publishers.
5. Kumar, R. (2011). Research Methodology: a step-by-step guide for beginners (3rd edition). London, UK: TJ International Ltd, Padstow, Corwall.

**SEMESTER - III**

**COURSE NAME: APPLICATION OF COMPUTER, GPS, IMAGE ANALYSIS AND PAST IN RESEARCH**

**Course Code: ZOO 522** **Credit: 02**

**Course Learning Objectives:**

- To introduce students to Fundamentals of Computer - introduction to the internet and the world wide web (WWW) Information technology - an overview of what it is and what are its applications.
- To acquaint the students to Microsoft Word, Excel, Powerpoint, GPS, PAST.

**Course Learning Outcomes:**

- The course enables the students to understand the IT applications in the area of biology
- Use of GPS, Image analysis and PAST etc.
- On completion of the course, students should have acquired essential knowledge to meet their computational requirements as a life sciences aspirant

**Course Contents:**

**UNIT I: INTRODUCTION TO MICROSOFT WORD**

Typing text in MS Word, manipulating text, formatting the text & using different font sizes, bold, italics. Using bullets and numbering, insertion of pictures, & file insertion, aligning of the text and justify.

**UNIT II: MICROSOFT POWERPOINT**

Preparing new slides using MS-Power-point, Inserting slides, Slides transition and animation. Using templates, different text and font sizes. Inserting slides with sounds, inserting clip arts, pictures, tables and graphs, Presentation using wizards.

**UNIT III: SPREADSHEET TOOL**

Introduction to spread-sheet applications, features & functions, using formulae & functions, data storing, features for statistical data analysis, generating charts/graphs & other features (Microsoft Excel, Open office and similar or other advanced tools)

**SEMESTER - III**

**UNIT IV: INTRODUCTION TO INTERNET**

Definition about the World Wide Web & brief history. Using search engine and beginning Google search- Exploring the next using Internet explorer and Navigator- Uploading and Download of files and images- E-mail ID creation- Sending messages- attaching files in E-mail.

**UNIT V: OTHER SOFTWARES**

GPS (applications and example of GPS), Image analysis Software, Use of PAST for scientific data analysis, Use of BLAST in research programmers.

**Suggested Books**

1. Jensen, J.R.,. Remote sensing of the environment: An earth resource perspective, Prentice Hall, Upper saddle river, NJ 2000
2. Joseph, George, , Fundamental of Remote Sensing, University Press (India) Pvt. Ltd, Orient Longman Pte. Ltd., Hyderabad, India 2003
3. Lillesand, T.M. and Kieffer, R.W.,. Remote Sensing and Image Interpretation, 5th Edition., Wiley, New York 2003
4. Panda, B. C., 8. Remote Sensing: Principles and Applications, Viva Books Private Limited, India 2008
5. Avery,T.E.,and G.L.Berlin, Fundamental of remote sensing and airphoto interpretation,5th ed, Macmillan, New York,1992
6. Barrett,E.C., and L.F.Curtis, Introduction to environmental remote sensing, 3rd ed, Chapman and Hall, New York,1992
7. Barrett,E.C., and L.F.Curtis, Introduction to environmental remote sensing, 3rd ed, Chapman and Hall, New York,1992

**SEMESTER - III**

**COURSE NAME: ROLE OF BIOSTATISTICS IN RESEARCH**

**Course Code: ZOO 523** **Credit: 02**

**Course Learning Objectives:**

- To introduce the students to research methods applicable in biological studies.
- To acquaint the students to different types of scientific writing

**Course Learning Outcomes:** After completing this course, the students should be able to: ·

- Identify research tools and their use in research
- Formulate and test hypothesis based on the nature of the research problem
- Apply different statistical methods for analysis

**Course Content:**

**UNIT I: BIOSTATISTICS**

Definition and relevance of Biostatistics in biological research. Descriptive Statistics: definition, objectives, organization of data, population, sample, variable, parameter, primary and secondary data, screening and representation of data, frequency distribution, tabulation, bar diagram, histograms, pie diagram, Measures of Central Tendency: arithmetic mean, median and mode. Measures of dispersion: Range, variance, standard deviation, coefficient of variation, skewness and kurtosis.

**UNIT II: INFERENTIAL STATISTICS**

Inferential Statistics: Hypothesis testing, errors in hypothesis testing, null hypothesis, alternative hypothesis, type i and type ii errors, confidence limits. Setting up of level of significance. Introduction of one tailed and two tailed tests and its applications.

**UNIT III: PROBABILITY AND DISTRIBUTION**

Definition of probability (frequency approach), independent events. Addition and multiplication rules, conditional probability, examples- Bernoulli, binomial, poisson and normal distribution.

**UNIT IV: CORRELATION AND REGRESSION**

Correlation and Regression: Correlation coefficient (r), properties, interpretation of r, partial and multiple correlations, linear regression: Fitting of lines of regression, regression coefficient. Introduction to Parametric and Non-Parametric Statistics.

**SEMESTER - III**

**UNIT V: STATISTICAL SOFTWARE**

Overview of SPSS (Statistical Package for the Social Sciences), MATLAB, RStudio, Python with libraries, Prism and Origin.

**Suggested Books:**

1. 1 Biometry. 3rd edition (2001). R. R. Sokal and F. J. Rohlf. W. H. Publisher-Freeman and Company.
2. Biostatistical analysis. 5th edition (2008). J. H. Zar. Publisher-Pearson Education Inc. and Dorling Kindersley Publishing Inc.
3. Biostatistics: A foundation for analysis in Health Sciences. 5th edition (1991). W. W. Daniel. Publisher-John Wiley & Sons
4. Elementary Bayesian Biostatistics. (2008) L. E. Moye. Publisher - Chapman and Hall/CRC, Boca Raton.
5. Introduction to Biostatistics. (1973) R. R. Sokal and F. J. Rohlf. Publisher-W. H. Freeman & Company.
6. Introductory Statistics for Biology. 3rd edition (1979) R. E. Parker, Publisher-Edward Arnold Ltd. • Statistics and Experimental Design 2nd edition (1980). G. M. Clarke. Publisher-Edward Arnold Ltd.
7. Statistical Methods in Biology 3rd edition (1994). N.T. J. Bailey. Publisher-Cambridge University Press
8. Statistical methods. 6th edition (1967). G. W. Snedecor and W. G. Cochran. Publisher-Oxford and IBH Publishing Co.
9. Statistics: Concepts and Applications. (1995), H. Frank and S. C. Althoen. Publisher-Cambridge University Press.
10. Understanding Medical Statistics. (1983) L. A. Goldstone and William Heinemann. Publisher Medical Books LTD.

**SEMESTER - III**

**COURSE NAME: REVIEW OF LITERATURE**

**Course Code: ZOO 524** **Credit: 04**

**Course Learning Objectives:** To acquaint the students to different types of scientific writing.

**Course Learning Outcomes:**
Through this paper students should be able to write effective research paper, review article, research proposal and thesis.

**Course Contents:**

**UNIT I**: **BASIC INTRODUCTION TO LITERATURE REVIEW**
Introduction and the role of the literature review in scientific research- Definition, Need and Significance of Literature review in Research.

**UNIT II: TYPES OF LITERATURE REVIEW**
Types of Literature review- Evaluative, Explorative and Instrumental. Different elements of Literature review.

**UNIT III: LITERATURE SEARCH**
Literature search for review: Sources of Literature Review-; Primary, Secondary and Tertiary. Use of Search Engines in Literature Review: PubMed, Google Scholar, Science direct.

**UNIT IV: STEPS OF LITERATURE REVIEW**
Different steps of Literature review: Guidelines to follow during the writing stage of Literature review, Bibliography, Citations, Types of Citation-MLA, APA, Harvard.

**UNIT V: WRITING OF LITERATURE REVIEW**
Structure of Literature Review- Introduction, Body and Conclusion; Organisation of Literature review; Characteristics of a good literature review,

**Suggested Book:**
Jose. L. Galvan. (2014). Writing Literature Reviews, 6th edition. Routledge publisher.
Jose. L. Galvan and Melise C. Calvan (2017). Writing Literature Reviews, 7th edition. Routledge publisher.
M. Ling. Pan. (2008). Preparing Literature Reviews, 3rd edition. Routledge publisher.

**SEMESTER - III**

**COURSE NAME: RESEARCH PROPOSAL WRITING SKILL**

**Course Code: ZOO 525** **Credit: 04**

**Course Learning Objectives**:
To acquaint the students to different types of scientific writing.
To help students to understand the methods of citation and referencing styles, check plagiarism and get insight of intellectual property right

**Course Learning Outcomes:** Through this course students should be able to:

- Identify ethics of research in writing research proposal, thesis and research paper.
- Represent the research proposal, thesis and research paper effectively.

**Course Contents:**

**UNIT I: LITERATURE SURVEY**
Literature survey, developing hypothesis, writing research objectives and origin of proposal for particular research problem.

**UNIT II: METHODOLOGY DEVELOPMENT**
Methodology development, expected outcomes writing and finding gap in research. Ethics of writing paper, Guidelines for preparation of research proposals, Budget preparation, Style of writing: MLA, APA, SHS, Origin of Research proposals

**UNIT III: STARTING OF PROPOSAL PROCESS**
Starting of Proposal Process: Introduction, background and significance, Review of prior studies and literature, aim of research, research design and methods, implication and contribution of knowledge, compliance and ethical principles

**UNIT IV: RESEARCH BUDGET**
Writing research budget and its justification. Need of overhead charges for supporting Institute and need of Supplementary document like endorsement letter from institute to funding agency.

**UNIT V: FUNDING IN RESEARCH**
Introduction to different National and International funding agency and fellowship support.

**SEMESTER - III**

**Suggested Books:**


- Chapin Paul G. (2004). Research Projects and Research Proposals, 1st edition. Cambridge University Press.
- Soraya M. Coley and Cynthia A, Scheinberg. (2018). Proposal writing, 5th edition. Sage Publication.
- Jay D. Gatrell., Gregory D. Bierly and Ryan R. Jensen (2014). Research Design and Proposal Writing in spatial Science, 2nd edition. Springer publication

**SEMESTER - IV**

**COURSE NAME: MEDICAL ENTOMOLOGY**

**Course Code: ZOO 565** **Credit: 02**

**Courses Learning Objectives**:
The rate of pathogen transmission by insects is increasing at an alarming rate posing a growing threat to the human population. Disease transmission by these insects can be prevented only by studying their biology, modes of transmission of pathogens by them, evaluation of associated risk factors, devise effective methods to control these insects and resolve the challenges posed.

**Course Learning Outcomes:** Upon completion of the course, the students will be able to:

- Describe the host-pathogen relationships and the role of the host reservoir on transmission of parasite
- Recognize various possible modern tools and methodologies for laboratory diagnosis, surveillance, and treatment of diseases
- Explain control methods of insect vector diseases including spreading awareness on public health programs and mitigating insect borne diseases · Employ the use of advanced management strategies in disease control with respect to parasite evolution

**Course Contents:**

**UNIT I: INTRODUCTION AND CLASSIFICATION**
Classification of medically important Insects and other arthropods, characteristic, features of insect orders categorised as vectors (*Diptera, Siphonaptera, Siphunculata, Hemiptera*) and their evolutionary, anatomical, physiological, cellular and molecular adaptations as vectors.

**UNIT II: INSECT BORNE DISEASES AND EPIDEMIOLOGY**
Medical important insect vectors of order Diptera- their life cycle, epidemiology and management: Mosquitoes, Sand flies, Tsetse flies, Houseflies, study of transmission, epidemiology; occurrence, causative agents and control of mosquito borne diseases, Malaria, Dengue, Yellow fever, Chikungunya, Viral encephalitis, Filariasis, control of mosquitoes, Sand-fly borne diseases-Leishmaniasis, Phlebotomus fever, control of sand flies; Tsetse fly-borne disease- sleeping sickness.

**UNIT III: VECTOR BORNE DISEASES**
Vector borne diseases spread through: Siphonapterans- Fleas-Host-specificity, study of flea borne diseases- plague, typhus fever, control of sand flies, Siphunculata- human louse (head, body, and pubic louse) as disease vectors; study of louse borne diseases-Typhus fever, relapsing fever, trench fever, vagabond's disease, phthiriasis; control of human louse; Hemipterans-Bugs as insect

vectors; blood sucking bugs; chagas disease, bed bugs as mechanical vectors, control and prevention methods. Vectors and diseases spread through class arachnida, crustacean ticks, mites, cyclops, their life cycle, and control measures.

**UNIT IV: VECTOR MANAGEMENT**

Vector management strategies, chemical and non-chemical methods of control i.e., quarantine, cultural, mechanical, chemical, biological, behavioural, and integrated vector management.

**UNIT V: FORENSIC ENTOMOLOGY**

Forensic entomology: important insects as forensic tools, role of insects/arthropods in criminal investigation, by predicting time and cause of death.

**Suggested Books:**

1. Medical and Veterinary Entomology Mullen, G., Durden, L., Academic Press, USA
2. Medical Entomology for students, Service, M. Cambridge University Press, UK
3. The Insects, An outline of Entomology, Gullan, P. J., and Cranston, P. S., Wiley Blackwell, UK
4. Park K. (2007) Preventive and social medicine XVI edition, B.B. Publisher
5. Arora DR and Arora B (2001). Medical Parasitology, II Edition. CBS Publications and Distributors
6. Roy D.N. and Brown A.W.A. 1970. Entomology (Medical and Veterinary) including insecticides & insects & Rat control; The Bangalore Printing & Publishing Co. Ltd., Bangalore
7. Mullen, G. and Durden L. 2009. Medical and veterinary entomology, Academic press, London
8. Service M.W. 1996. Medical Entomology for students. Chapman & Hall, London.
9. World Health Organization. 1975. Manual on practical entomology in malaria. Part II. Methods and Techniques., Geneva.
10. Kettle, D.S. 1995. Medical and Veterinary Entomology. 2nd edition. CAB International. New York, NY.

**SEMESTER - IV**

**COURSE NAME: MEDICAL ENTOMOLOGY LAB.**

**Course Code: ZOO 566** **Credit: 02**

**Courses Learning Objectives**:

Disease transmission by these insects can be prevented only by studying their biology, modes of transmission of pathogens by them, evaluation of associated risk factors, devise effective methods to control these insects and resolve the challenges posed.

**Course Learning Outcomes:**

- Recognize various possible modern tools and methodologies for laboratory diagnosis, surveillance, and treatment of diseases
- Explain control methods of insect vector diseases including spreading awareness on public health programs and mitigating insect borne diseases · Employ the use of advanced management strategies in disease control with respect to parasite evolution

**Course Contents:**

1. Study of mouthparts and their modification in medically important insects
2. Study of life history stages of medically important insect vectors through permanent slides or photographs: *Aedes, Culex, Anopheles*, lice (head, body, pubic), bed bug, *Phlebotomus* (sand fly), and *Musca domestica* (house fly).
3. Study of different stages of life cycles of medically important ticks and mites.
4. Study of different diseases transmitted by above insect vectors.
5. Field visit/Project report on any one disease transmitted by insect vector/important forensic insects

**Suggested Books:**

1. Medical and Veterinary Entomology Mullen, G., Durden, L., Academic Press, USA
2. Medical and Veterinary Entomology, Kettle, D. S., Cabi Press, USA
3. Medical Entomology for students, Service, M. Cambridge University Press, UK
4. The Insects, An outline of Entomology, Gullan, P. J., and Cranston, P. S., Wiley Blackwell, UK
5. Park K. (2007) Preventive and social medicine XVI edition, B.B. Publisher
6. Arora DR and Arora B (2001). Medical Parasitology, II Edition. CBS Publications and Distributors
7. Imms A.D. (1977) A General Text Book of Entomology. Chapman and Hall UK.

**SEMESTER - IV**

**COURSE NAME: ADVANCES IN FISHERIES AND AQUACULTURE**

**Course Code: ZOO 567** **Credit: 02**

**Courses Learning Objectives:**

This course has been designed to equip the student to understand the nature, status and scope of aquaculture and its importance. Identify significant types of aquaculture systems with particular emphasis on its operation and management options. Develop a comprehensive knowledge of major steps involved in aquaculture. Critically evaluate the problems faced in aquaculture and its possible solutions.

**Course Learning Outcomes:**

After completion of the course the students will be able to:

- Students will be able to explain and understand the international and national status of aquaculture.
- Students will evaluate and analyze various scientific methods of aquaculture.
- Comprehensive awareness on aquaculture engineering, proficiency in pond designing and preparation, detailed knowledge on water quality monitoring systems'
- Identify stress in aquaculture and manage the causative reasons**.** Differentiate between bacterial, viral and fungal diseases of fish species. Make management decisions on the event of a disease outbreak to minimize economic loss.

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**Course Contents:**

**UNIT I: AQUACULTURE, PRINCIPLES AND PRACTICES**

Introduction, history, and scope of aquaculture. Present scenario in aquaculture. Aquaculture systems (pond culture, pen culture, cage culture, running water culture and zero water exchange system). Extensive, semi-intensive, intensive, and super-intensive aquaculture types. Principles of pond culture (Pre-stocking and post-stocking pond management, carrying capacity of pond, Factors influencing carrying capacity; major fish species in aquaculture. Water quality management (Physical, chemical, and biological factors affecting productivity of ponds).

**UNIT II: AQUACULTURE ENGINEERING**

Application of molecular biology techniques: Cell culture and cell lines, development of vaccines against fish. Hybridoma technology: production of monoclonal antibodies; Diagnostic kits: development of gene probes, PCR techniques. Probiotics: Growth promoters. Bioremediation, waste water treatment, biofilters in aquaculture, biofertilizers, biosensors, bioindicators. Concept of Bioinformatics, NCBI, gene bank sequence database (Primary and Secondary database).

**SEMESTER - IV**

**UNIT III: ADVANCED TECHNOLOGY IN AQUACULTURE**

Biofloc technology (BFT): Introduction, principle and design, components of Biofloc technology system. Recirculating aquaculture system (RAS), concept of water reuse and recirculation, principle, components of RAS, solid removal, biological filtration, aeration and oxygenation, disinfection and sterilization, water quality management, species selection advantages and disadvantages. Remote sensing: Principles of remote sensing in aquaculture. Induced breeding, technique of induced breeding, factors affecting induced breeding. Advantages of induced breeding.

**UNIT IV: STRESS IN AQUACULTURE**

Stress in aquaculture and its role in disease development. Infectious, nutritional and environmental disease (Causative agent, symptoms and Control). Bacterial diseases (Dropsy, Furunculosis and tail rot). Fungal diseases (*Saprolegniasis* and *Branchiomycosis*). Viral diseases (IPN, IHN, VH, CCVD), Protozoan diseases (*Costiasis* and *Ichthyophthiriasis*). Preventive measures of infectious diseases and management tools.

**UNIT V: FISH TOXICOLOGY**

General toxicity, definitions and branches, toxicity testing, Toxicity caused by metal and non-metals, phytotoxins (toxic principles of various alkaloids and toxic plants), drug toxicity and toxicity caused by agrochemicals. Mycotoxins and bacterial toxins. Collections and dispatch of specimens in toxicological cases, toxicity of drugs in aquaculture: Maximum residual limits (MRL) of various drugs and chemicals in fish, metabolism of toxic substances by aquatic organisms. Factors modifying toxicity in aquaculture, toxicokinetic and toxicodynamic.

**Suggested books:**

1. Boyd, C.E. (1982). Water quality management for pond fish culture. Elsevier Sci. Publ. Co.
2. Coche, A. G. and J. F. Muir. (1996). Pond Construction and Fresh Water Fish Culture – Pond Farm Structures and Layouts – Simple Methods for Aquaculture. FAO. Daya Publishing House, New Delhi.
3. Upadhyay, A. S. (1995). A hand book on design, construction and equipment's in coastal aquaculture (Shrimp Farming). Daya publishing house, New Delhi
4. Halver and Hardy. Acad. Press. 2002: Ash Nutrition. An Imprint
5. ICAR. (2006). Hand Book of Fisheries and Aquaculture. ICAR.
6. Milden & Redding TA. (1998). Environmental Management for Aquaculture. Kluwer.
7. MPEDA (1990). Aquaculture Engineering and Water Quality Management. Cochin, India.
8. Pillay TVR & Kutty MN. (2005). Aquaculture- Principles and Practices. 2nd Ed. Blackwell

**SEMESTER - IV**

9. Pillay TVR & M.A. Dill (1979). Advances in Aquaculture. Fishing News Books Ltd., London
10. Pillay TVR, (1996). Aquaculture Principles and Practices, Fishing News Books Ltd., London
11. Talwar, P.K. and Jhingran, A.G. (1991). Inland Fishes of India and Adjacent Countries. Oxford-IBH Publishing Co. Pvt. Ltd., New Delhi, 1158pp.

**SEMESTER - IV**

**COURSE NAME: ADVANCES IN FISHERIES AND AQUACULTURE LAB**

**Course Code: ZOO 568** **Credit: 02**

**Courses Learning Objectives:**

This course has been designed to equip the student with a balanced and complete scientific understanding of aquaculture concepts. Develop practical skills in fish handling and observation: Students will gain proficiency in safely handling live fish specimens, including proper techniques for immobilization, measuring, and examining their external features. Students will design and conduct experiments or investigations related to fish biology, such as studying feeding behavior, reproductive strategies, or the effects of environmental factors on fish physiology or behavior.

**Course Learning Outcomes:**

After completion of the course the students will be able to:

- Students will gain practical experience in utilizing advanced techniques and tools commonly used in the field of fisheries and aquaculture. They will develop skills in various areas such as fish sampling, data collection, water quality analysis, fish health assessment, and genetic analysis.
- Students will learn about common diseases that affect fish in aquaculture settings and how to identify and manage them effectively. They will gain knowledge of disease prevention strategies, biosecurity measures, and treatment options. Students will also explore emerging diseases and the latest advancements in disease management.

**Course Contents:**

1. 1. To estimate the pH of water.
2. To estimate the dissolved oxygen in water sample.
3. To determine the BOD in water sample.
4. Estimation of total hardness in a given water sample.
5. Collection and identification of different types of plankton.
6. Collection and identification of macrobenthos.
7. Collection and identification of major culturable fish species
8. To study the different common diseases of fishes caused by virus, bacteria and protozoan.
9. To study the different types of fishing gears.
10. Isolation of DNA from blood and tissue.
11. Estimation of heavy metals in

    a) Water b) Sediment c) fish muscles d) Gills

**SEMESTER - IV**

12. Estimation of $LC_{5O}$ and $LD_{5O}$
13. Demonstration of drug toxicity.
14. Preparation and maintenance of aquarium.
15. Report of field visit to farms and aquaculture institutes.
16. Field visit to freshwater fish farms.

**Suggested Books:**

1. Ward, H. B. & Whipple, G. Ch. (1957). Fresh Water Biology. 2 ed. London & New York: edited by W. T. Edmondson: John Wiley & Sons. 1248 p.
2. APHA, AWWA, & WEF (2005). Standard methods for the examination of water and waste water (21st ed.). New York, Washington, DC: Jointly prepared and published by the American Public Health Association, American Water Works Association, and Water Environment Federation.
3. Jayaram, K.C. (1999). The Freshwater Fishes of the Indian Region. Narendra Publication, New Delhi
4. Pillay TVR, (1996). Aquaculture Principles and Practices, Fishing News Books Ltd., London
5. Pillay, TVR. & Dill, M.A. (1979). Advances in aquaculture. Fishing News Books Ltd., London
6. Stickney, RR. (1979). Principles of warm water aquaculture. John Wiley & Sons Inc.
7. Boyd, CE. (1982). Water quality management for pond fish culture. Elsivier Scientific Publishing.
8. Bose AN et.al. (1991). Costal aquaculture engineering. Oxford & IBH Publishing Company

**SEMESTER - IV**

**COURSE NAME: MOLECULAR GENETICS**

**Course Code: ZOO 569** **Credit: 02**

**Course learning Objectives:**

The course will help in building sound fundamental knowledge of molecular genetics, to be used as a stepping stone for higher studies and research in this field.

**Course Learning Outcomes:** Upon completion of the course, students will be able to:

- Have a deeper understanding of the varied branches of the biological sciences like microbiology, evolutionary biology, genomics and metagenomics.
- After successful completion of the course the student should be able to design and comprehend experimental strategies for whole genome, transcriptome and proteome analysis.

**Course Contents:**

**UNIT I: STRUCTURE AND FUNCTION OF THE GENETIC MATERIAL**

The genetic material - Structure of nucleic acids - folding motifs, conformation flexibilities, super-coiling of DNA; Packaging of DNA in the nucleus- structure of chromatin, function of the genetic material; and evolution of genetic material.

**UNIT II: COMMON DEFECTS IN GENE ACTIONS**

Gene actions: Tracing Defects in Gene Function: (a) haemoglobinopathies-, beta-thalassemia and sickle cell anemia (b)fragile X syndrome (c) hearing impairment (d) epilepsy (e) Gauchers Disease and Glycogen Storage disorders (f) Noonan syndrome and Rasopathies.

**UNIT III: VARIATION IN GENETIC MATERIAL**

Stability and variation in the genetic material. Mechanism of DNA repair; Genome instability; Homologous and site-specific recombination. Mechanism of homologous recombination in prokaryotes and eukaryotes.

**UNIT IV: FATE OF RNA IN TRANSCRIPTION AND TRANSLATION**

Fate of RNAs exported from the nucleus- Stability of different types of RNA; Translational machinery and translational control- Energetics of amino acid polymerization, tRNAs and their modifications; Amino-acyl t-RNA synthetases; and regulation of translation.

**UNIT V: HEREDITARY GENETIC DISORDERS**

Sex linked disorders, sex limited, sex influenced traits, and genomic imprinting

**SEMESTER - IV**

**Suggested books:**

1. Molecular Biology of the Gene, Watson et al. (7th Ed. 2017), Pearson Education, Delhi, INDIA
2. Lewin's Genes XI (2014), Jones and Bartlett Publishers, Boston, USA
3. Molecular Cell Biology, Lodishet al., W.H. Freeman and Company (8th Ed. 2016)
4. Accuracy in Molecular Processes: Its Control and Relevance to Living System, TBL Kirkwood, RF Rosenberger, and DJ Gala (1989), Chapman and Hall, NY, USA.

**SEMESTER - IV**

**COURSE NAME: MOLECULAR GENETICS LAB.**

**Course Code: ZOO 570** **Credit: 02**

**Course learning Objectives:**

The course will help in building sound fundamental knowledge of molecular genetics, to be used as a stepping stone for higher studies and research in this field.

**Course Learning Outcomes:** Upon completion of the course, students will be able to:

- Have a deeper understanding of the varied branches of the biological sciences like microbiology, evolutionary biology, genomics and metagenomics.
- After successful completion of the course the student should be able to design and comprehend experimental strategies for genome, transcriptome and proteome analysis.

**Course Contents:**

1. DNA isolation protocol for bacteria and yeast
2. DNA isolation protocol from mammals
3. RNA Isolation Protocol
4. UV Spectrophotometry- best for quantifying oligos, single stranded RNA and DNA.
5. Representative DNA Size Markers for Agarose Gels
6. Ethidium fluorescence- best if you have small quantities and no fluorometer
7. Simplified preparation of DNA from blood
8. Restriction digestion of DNA
9. Determination of cellular DNA and Protein concentrations
10. Role of PCR in DNA amplification
11. Staining method to determine nucleic acid
12. Role of Gel Doc in genetic study.

**Suggested Books:**

1. Molecular Biology of the Gene, Watson et al. (7th Ed. 2017), Pearson Education, Delhi, India.
2. Lewin's Genes XI (2014), Jones and Bartlett Publishers, Boston, USA
3. Molecular Cell Biology, Lodishet al., W.H. Freeman and Company (8th Ed. 2016)
4. Accuracy in Molecular Processes: Its Control and Relevance to Living System, TBL Kirkwood, RF Rosenberger, and DJ Gala (1989), Chapman and Hall, NY, USA.

**SEMESTER - IV**

**COURSE NAME: ACADEMIC WRITINGS**

**Course Code: ZOO 571** **Credit: 02**

**Course learning Objectives**:

- To acquaint the students to different types of scientific writing.
- To help students to understand the methods of citation and referencing styles, check plagiarism and get insight of intellectual property right

**Course Learning Outcomes:** Through this course students should be able to:

- Identify ethics of research in writing research proposal, thesis and research paper.
- Represent the research proposal, thesis and research paper effectively.

**Course content:**

**Unit I: INTRODUCTION OF ACADEMIC RESEARCH WRITING**

Introduction of academic and research writing, importance of academic writing and basics of academic writing. English in academic writing and styles of research writing.

**Unit II: PLAGIARISM**

UGC guidelines on Plagiarism, tools of detection of plagiarism and avoiding plagiarism. Journal metrices, author metrices.

**Unit III: LITERATURE MANAGEMENT TOOL**

Literature review, process of literature review, online literature databases. Literature management tools. Referencing and citation, submission, and post submission.

**Unit IV: WRITING RESEARCH ARTICLE AND PROPOSAL**

Introduction and tips for writing the Popular article, research proposal, Research article, review articles, book and thesis. Empirical study.

**Unit V: ETHICS IN ACADEMIC WRITING**

Challenges in Indian research and writing, team management, time management, Open education resources, Ethics in academic writing.

**Suggested Books:**

1. Stephen B. Heard. The Scientist's Guide to Writing: How to Write More Easily and Effectively throughout Your Scientific Career, Princeton University Press (2016)
2. John M. Swales, Christine B. Feak. Academic Writing for Graduate Students: Essential Tasks and Skills, University of Michigan Press (2012).

**SEMESTER - IV**

**COURSE NAME: PAPER PUBLICATIONS/SEMINAR, CONFERENCES PRESENTATION AT NATIONAL LEVEL**

**Course Code: ZOO 572** **Credit: 02**

**Course learning Objectives**:
To acquaint the students to different types of scientific writing and presenting their work.

**Course Learning Outcomes:** Through this course students should be able to:

- write effective research paper, research proposal and thesis.
- identify ethics of research in writing research proposal, thesis and research paper.
- represent the research proposal, thesis and research paper effectively.

**Course Content:**

1. Publish at least one research article/ review article in UGC approved research journal/Journal of Himalayan Life Sciences/Peer reviewed.
2. Participate in an oral presentation/ talk in refereed conference/ Seminar. Additionally, student must submit a write up at CUHP before the end of this course.
3. Participate in poster/Oral presentation in a referred conference / Seminar. Additionally, student must submit a write up at CUHP before the end of this course.

**SEMESTER - IV**

**COURSE NAME: ROLE OF ARTIFICIAL INTELLIGENCE IN ANIMAL SCIENCE RESEARCH**

**Course Code: ZOO 573** **Credit: 02**

**Course learning Objectives**:
This course offers an overview of fundamental concepts of Bioinformatics and Biostatistics. An interdisciplinary program, it emphasizes integration of Computer Science with Biology and introduces the students to various computational methods and software tools for understanding biological databases, gene sequence alignments, gene annotation, protein structure predictions, drug discovery, molecular phylogeny, metagenomics, etc.

**Course Learning Outcomes:** After completion of the course the students will be able to:

- Explain the basic concepts of Bioinformatics and its various applications in different fields of biological sciences
- Describe theoretically sources of biological data, and list various biological databases – nucleic acids, protein sequence, metabolic pathways and small molecule
- Identify various file formats of sequence data and tools for submission of data in databases as well as retrieval of gene and protein data from databases

**Course Contents:**

**UNIT I: INTRODUCTION TO BIOINFORMATICS**

Definition and scope of computational biology and bioinformatics, national centre for biotechnology information (NCBI), basic local alignment search tool (BLAST), flavors of BLAST (BlastP, BlastN, BlastX, tBlastN), different file formats, bioinformatics in India- current status and future implications.

**UNIT II: BIOLOGICAL DATABASE: AN INTRODUCTION**

General introduction of biological databases, primary biological databases, secondary biological databases, specialized databases, GenBank, DDBJ, EMBL, PDB, Uniprot (SwissProt/TrEMBL), PIR, Pfam, PROSITE, CATH, KEGG, SCOP.

**UNIT III: SEQUENCE ALIGNMENTS AND PHYLOGENETICS**

Introduction to Sequences alignments, local alignment and global alignment, pairwise sequence alignment and multiple sequence alignment, ClustalX, Muscle, T-Coffee, Phylogenetics (Overview), phylogenetic tree, Bootstraping, MEGAX.

**SEMESTER - IV**

**UNIT IV: AN INTRODUCTION TO ARTIFICIAL INTELLIGENCE (AI)**

Artificial intelligence (basics), machine learning (Basics), neural networks (overview), support vector machine (overview), hidden markov model (overview).

**UNIT V: APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN ANIMAL HUSBANDRY**

AI in automated milking, animal health monitoring, precision livestock farming, optimizing farm animal growth, tackling parasites, improving feed quality, seminar, project work.

**Suggested Books:**

1. Essential Bioinformatics, First Edition. Author: Jin Xiong, published by Cambridge University Press, United Kingdom, ISBN 13 978-0-511-16815-4.
2. Bioinformatics: Sequence and Genome Analysis, Second Edition. Author: David Mount, Published by Cold Spring Harbor Laboratory Press, United States, ISBN 978-087969712-9.
3. Machine Learning for Dummies, First Edition. Author: John Paul Muller and Luca Massaron, Published by Wiley, ISBN-13: 978-1119245513.
4. Deep Learning for the Life Sciences. Author: Bharath Ramsundar, Peter Eastman, Patrick Walters, Vijay Pande, Publisher(s): O'Reilly Media, Inc. ISBN: 9781492039839.
5. Lednicer, D. “Strategies for Organic Drug Discovery Synthesis and Design”; (1998) Wiley International Publishers.

**SEMESTER - IV**

**COURSE NAME: USE OF ADVANCED SOFTWARE LIKE: BIORENDER, GIS, MENDELEY AND TURNITIN ETC. IN RESEARCH**

**Course Code: ZOO 574** **Credit: 02**

**Course learning Objectives**:

- To introduce students to Fundamentals of Biorender, GIS, Mendeley and Turnitin and its applications in research.

**Course Learning Outcomes:**

- After successful completion of the course the student should be able to use mentioned software's and apply them in their research process.

**Course Contents:**

**UNIT I: SCIENTIFIC DIAGRAM MAKING**

Introduction to scientific drawing software and websites. Features of biorender, figure drawing, graphical representation of paper, and pre-drawn icons.

**UNIT II: REFERENCE MANAGEMENT**

References manager, academic social network, storage organization and searching of references, insertion of citation and bibliography into Microsoft word through Mendeley, Zotero and Endnote.

**UNIT III: GEOGRAPHICAL INFORMATION SYSTEMS**

Introduction to GIS: definition, concept, and history of developments in the field of information systems, Hardware and software requirements for GIS, Coordinate system and projections in GIS, Spatial data models – raster and vector, Digital elevation model, Supervised and unsupervised classification. Overview of image processing & amp; and GIS Packages- ArcGIS, ERDAS, and QGIS.

**UNIT IV: ANTI- PLAGIARISM SOFTWARE**

Plagiarism and introduction to usage of Turnitin, iThenticate and URKUND to check plagiarism and creation of similarity index and originality report.

**UNIT V: ACADEMIC WRITING SOFTWARE**

Advances in academic writing through software - Grammarly and QuillBot. Use of Latex.

**Suggested Books:**

Geographic Information Systems and Science" by Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind (2015).

**SEMESTER - IV**

**COURSE NAME: DISSERTATION**

**Course Code: ZOO 595** **Credit: 08**
**Dissertation (50%):** **4 Credits**
**Presentation and Viva voce (50%):** **4 Credits**

The course of dissertation is based on their specialization field to get more learning in particular field with Practical knowledge.

**COURSE NAME: RESEARCH AND PUBLICATION ETHICS**

**Course Code: CPE-RPE** **Credits: 2**

**Course Contents:**

**THEORY**

**UNIT I: PHILOSOPHY AND ETHICS**

Introduction to philosophy: definition, nature and scope, concept, branches.

Ethics: definition, moral philosophy, nature of moral judgements and reactions

**UNIT II: SCIENTIFICCONDUCT**

Ethics with respect to science and research

Intellectual honesty and research integrity

Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)

Redundant publications: duplicate and overlapping publications, salami slicing

Selective reporting and misrepresentation of data

**UNIT III: PUBLICATION ETHICS**

Publication ethics: definition, introduction and importance

Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.

Conflicts of interest

Publication misconduct**:** definition, concept, problems that lead to unethical behavior and vice versa, types

Violation of publication ethics, authorship and contributorship

Identification of publication misconduct, complaints and appeals

Predatory publishers and journals

**PRACTICE**

**UNIT IV: OPEN ACCESS PUBLISHING**

- Open access publications and initiatives
- SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
- Software tool to identify predatory publications developed by SPPU
- Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

**UNIT V: PUBLICATION MISCONDUCT**

**Group Discussions**

- Subject specific ethical issues, FFP, authorship
- Conflicts of interest
- Complaints and appeals: examples and fraud from India and abroad

**Software tools**

Use of plagiarism software like Tumitin, Urkund and other open source software tools

**UNIT VI: DATABASES AND RESEARCH METRICS**

**Databases (4 hrs.)**

- Indexing databases
- Citation databases: Web of Science, Scopus, etc.

**Research Metrics (3 hrs.)**

- Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score
- Metrics: h-index, g index, i10 index, altmetrics

**Suggested books:**


1. Bird, A. (2006). Philosophy ofscience. Routledge.
2. MacIntyre, Alasdair (1967) A Short History ofEthics. London.
3. P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978- 9387480865
4. National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being
5. a Scientist.' A Guide to Responsible Conduct in Research: Third EditfOn. National Academies Press.
6. Resnik, D. B. (2011). What is ethics in research & why is it important. National Institute ofEnvironmental Health Sciences, 1-10. Retrieved from httos://www.nieiys.nih. ov/research/resources/bioethics/whatis/index.cfm Beall, J. (2012). Predatory publishers are comipting open access. Nature, 489(7415), 179—179. https://doi.org/10.1038/489179a
7. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance(2019**), ISBN:978-81-939482-1-7. http://www.insaindia res.in/pdf/Ethics Book.pdf**

**COURSE NAME: PEDAGOGY OF TEACHING LEARNING PROCESS**

**Course Code: PTLP-01** **Credit: 02**

**Course Learning Objectives:**

The course will enable the student teachers to -

- Develop an understanding about differential learning needs of the learners with regard to abilities, learning styles, socio-cultural differences, language, and learning difficulties.
- Develop awareness of the different contexts of learning.
- Reflect on their own implicit understanding of the nature and kinds of learning.
- Gain an understanding of different theoretical perspectives of learning including the constructivist perspective.
- Develop understanding about the concept of teaching from various perspectives.
- Explore teaching strategies to address diversity of students is a classroom.
- Analyse 'teaching' as a profession.

**Course Contents:**

**UNIT I: DEVELOPMENT AND LEARNING**

Learning and Teaching Nature, Relevance and Relationship. Nature and Nurture, Growth and Maturation: Relationship between Development and Learning. Developmental Influences: Development as a resultant of interactions between individual and the external environment (physical, Socio-cultural, Economic, Ecological and Technological).

**UNIT II: DIMENSIONS OF INDIVIDUAL DEVELOPMENT**

Physical, Cognitive, Affective, Social and Moral their interrelationships and implications for teachers (Drawing from relevant ideas of Piaget, Erikson and Kohlberg). Key Cognitive Processes: Perception, Attention, Memory, Language, Thinking, Problem Solving, Emotions and Motivation. **Cognition and Learning:** Approaches to Learning. Understanding processes that facilitate Construction of Knowledge.

**UNIT III: ROLE OF A TEACHER IN A TEACHING-LEARNING CONTEXT**

(a) Transmitter of knowledge (b) Model (c) Facilitator (d) Negotiator (e) Learner.

**Intelligence and Motivation:** Intelligence. Nature of Intelligence and the role of Heredity and Environment. Theories of Intelligence (a) Spearmanís Two Factor theory (b) Guilfordís Factor Analytical Theory (c) Cattell and Hornís Theory of Intelligence (d) Sternbergís Information Processing Theory (e) Howard Gardnerís Theory of Multiple Intelligence.

**UNIT IV: LEARNING AND ITS ASSESSMENT**

Learning: Concept, meaning, types of learning and process of learning, Concept of assessment: Measurement and evaluation, NRT and CRT Tools of assessment: tests, observation-participatory, non – participatory and controlled, interviews, discussion, etc.

**UNIT V: CLASSROOM RESEARCH METHODOLOGY**

Research and its Classification, Classroom Research: Concept, need and importance. Advantages and limitations of classroom research. Variables in the classroom: Independent Variables. Teaching Style or Strategy, Learning Environment, Learning Activity Moderator Variables: Student Characteristics, Teacher Characteristics, Learning Material Characteristics Dependent Variables: Specific knowledge and comprehension, General knowledge and comprehension, Thinking and Problem Solving, Attitudes and Values, Learning related Behaviour. Designs for the classroom research.

**Suggested books:**


1. Piaget, J. (**1997**). ―Development and Learning, In M. Gauvain & M. Cole (Eds.), Reading on the Development of Children. New York: WH Freeman & Company.
2. Kauchak, D. P and Eggen, P. D (**1998**). Learning and Teaching: Research based Methods, Boston: Allyn and Bocan.
3. Mangal, S. K. and Mangal, S. (**2019**). Learning and Teaching. PHI Learning Pvt. Ltd.,
4. Bhatia, S.K. Jindal S. (**2016**). A Textbook of Curriculum, Pedagogy and Evaluation.

**COURSE NAME: INDIAN TRADITIONAL KNOWLEDGE AND PRACTICES**

**Course Code: ITKP - 01** **Credit 02**

**Course Learning Objectives:** Students will be able to:

- Familiar with Indian thought in different disciplines.
- Get familiar with major Indian thinkers in different disciplines.
- Familiar with the primary texts of Indian thought through an organized study of short
- extracts in translation of those texts.
- Develop a better appreciation and understanding of not only the Knowledge Traditions and Practices of India but also of many contemporary questions and issues that they handle in their course work in related disciplines.
- Enhance self-awareness and self-esteem.
- To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
- To make the students understand the traditional knowledge and analyses it and apply it to their day to day life

**Course Contents:**

**UNIT I: INTRODUCTION TO TRADITIONAL KNOWLEDGE**

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics. Protection of traditional knowledge. **Traditional Knowledge in Different Sectors:** Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK. **Agriculture in Prehistory and Proto history**: Irrigated Crops/ Implements/ Seed and Sowing/ Manures/ Pests and Their Management/ Cattle Management/ Horticulture and Arboriculture/ Fishing/ Agriculture and Society.

**UNIT II: THE MEDICAL TRADITION IN ANCIENT INDIA**

Specialization into eight branches, The tradition of surgery, medical genetics in Ayurveda, inoculation for smallpox, microbiology and parasitology, communicable diseases and epidemics, An evolving pharmacopoeia, pluralistic approach to healthcare, cross-cultural interactions, A dynamic literary tradition, global resurgence of Ayurveda, contemporary status **Primary Texts**: Dead body dissection, Rhinoplasty, Genetic basis of diseases, Communicable Diseases.

**UNIT III: TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY**

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge.

**UNIT IV: LEGAL FRAMEWORK AND TK**

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.

**UNIT V: OTHER TECHNOLOGIES**

A Survey Harappan Technologies/ Later pottery/ Glass/Water Management/ Textile Technology/ Writing Technologies: A Selection from Primary Texts Gemmology/ Water Management/ Textiles and Garments/ Perfumes and Cosmetics. **Early and Classical Architecture:** Temple Architecture/ Rock-Cut Structures/ Monolithic Temples/ Constructed Temples/ Public and Private Architecture

**Suggested books:**


1. Traditional Knowledge System in India, by **Amit Jha, 2009.**
2. Traditional Knowledge System in India by Amit Jha Atlantic publishers, **2002.**
3. "Knowledge Traditions and Practices of India" Kapil Kapoor and Michel Danino.
4. Traditional Knowledge System and Technology in India (English, Hardcover,
5. Basanta Kumar Mohanta, Vipin Kumar Singh) Edition: **2012** Language English

**COURSE NAME: BASIC RESEARCH METHODOLOGY**

**Course Code: ZOO 601** **Credits: 4**

**Course Contents:**

**UNIT I: INTRODUCTION TO RESEARCH DESIGN**

Definition of the Problem: Identifying and formulating the problem. Developing a research plan: Research objective: information required for solving the problem: defining each major concept in operational terms: an overall description of approach, clearly stating any assumptions.

**UNIT II: SCIENTIFIC LITERATURE REVIEW**

Reading and critical analysis of scientific literature/ research paper/case reports etc. Drafting and communicating research results in peer-reviewed journals. Acknowledgement of contributions, authorship issues; Intellectual Property Rights (IPR), scientific ethics, rules of plagiarism.

**UNIT III: WRITING AND PRESENTATION SKILLS**

Communication skills of research work through Poster and oral presentation Writing review paper on a relevant research topic and presentation of the same in a seminar /conferences / workshop / symposium.

**UNIT IV: EXPERIMENTAL DESIGN AND ANALYSIS**

Define sensitivity, accuracy, precision, and specificity. The limits and range of measurement in different systems Experimental design; single and double blind studies, use of placebo in experiment

Maintenance and storage of data, Concept of sampling, Positive and negative controls groups, biological and technical replicates in experiments.

**UNIT V: BIOSTATISTICS AND DATA ANALYSIS**

Biostatistics: Correlation and Regression, Probability and Distributions, Principles of Hypothesis Testing, Significance, One Sample z-test, One Sample t-test, Two Sample z-test, Two Sample t-test, Chi-Square test, ANOVA. Factorial and transformation.

**Suggested books:**


1. Blum, Deborah and Mary Knudson, eds. A field guide for science writers: the official guide of the National Association of Science Writers, New York: Oxford University Press, 1997.
2. Booth, Wayne, Gregory G Colomb, Joseph M. Williams. The craft of Research Chicago University of Chicago Press, 1995.
3. Davis, Martha. Scientific Papers and Presentations. San Diego: Academic Press, 1997.
4. Fuscaldo, AA, Erlick, BI, Hindman, B. Laboratory Safety: Theory and Practice. New York: Academic Press, 1980.
5. Bajpai, PK. Biological Instrumentation and Methodology. New Delhi: S. Chand & Co. Ltd. 2006.,
6. Kothari, C. R. (2004). 2/e, Research Methodology- Methods and Technique.(New Age International, New Delhi)
7. Montgomery, Douglas C. and Runger, George C. (2007), 3/e. applied statistics and probability for Engineers. (Willey, India)

**COURSE NAME: ADVANCED RESEARCH TOOLS AND TECHNIQUES**

**Course Code: ZOO 602** **Credits: 4**

**Course Contents:**

**UNIT I: MICROSCOPY AND IMAGE ANALYSIS**

Significance of microscopy, stereoscopic zoom microscope, compound microscope, Bright field microscope; fluorescence microscope; confocal microscope, Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM). Image acquisition and data analysis.

**UNIT II: BACTERIAL AND ANIMAL CELL CULTURE**

Aseptic technique and preparation of media. Types of cell culture. Applications of cell culture. Animal handling and ethics on animal trials. Maintenance of animals and acclimatization of experimental animals. Various routes of injections of drugs and sample collection for study. CPCSEA guidelines; Institutional ethics committees and its role. Ethical consideration in research on human beings/clinical trials

**UNIT III: ANALYTICAL TECHNIQUES AND INSTRUMENTATION**

Colorimetry; Spectrophotometry, Electrophoresis and PCR, Immunological techniques like ELISA and RIA, Chromatography – HPLC/GCMS, Atomic Absorption Spectrophotometry (AAS), ICPMS.

**UNIT IV: MODEL SYSTEMS AND MODEL ORGANISMS**

Pre-requisites of a model system; in vitro systems; Prokaryotic model organisms. Eukaryotic model organisms for conducting research.

**UNIT V: BIOINFORMATICS AND ITS APPLICATION**

Databases, sequences, sequence alignment- pairwise/ multiple, global/ local protein family, domain, sequence conservation Introduction to software used for proteomics data analysis.

**Suggested books:**


1. Introduction to instrumental analysis-Robert Braun-McGraw Hill.
2. A biologist Guide to principles and Techniques of Practical Biochemistry-K, Wilson and K.H. GouldingElBSEdn.
3. Essentials of Biophysics, P Narayanan, New Age Int. Pub. New Delhi. 2000.
4. Principles and Practice of Bioanalysis, R F Venn, Taylor and Francis, 2003.
5. John R.W. Masters. Animal Cell culture- A practical approach. IRL Press.

**COURSE NAME: CELL AND MOLECULAR BIOLOGY**

**Course Code: ZOO 603** **Credits: 4**

**Course contents:**

**UNIT I: CELL CULTURE TECHNIQUES**

Cell culture: Introduction to sterile cell culture technique. Counting viable cells and subculture into multiwell plates. Cell attachment (adhesion) and growth. Cell attachment (adhesion) and growth. Cell staining techniques: Culturing of primary cells, Application of primary cell culture techniques. Isolation of chromosomal DNA, Preparation of cellular extract, isolation of nuclear and cytoplasmic extract.

**UNIT II: CYTOGENETICS**

FISH techniques and cytogenetics. Role of chromosome labeling in neonatal disorders. Chromosomal disorders. Cancer cytogenetic and role of cytogenetics in research.

**UNIT III: PRINCIPLES AND TECHNIQUES OF MOLECULAR BIOLOGY**

Introduction to basic and advanced information on DNA, RNA and proteins. Potential applications of molecular biology techniques in drug discovery and development will also reviewed.

**UNIT IV: GENOME ANALYSIS TECHNIQUES**

Isolation and purification of plasmic and genomic DNA samples from different cell types and tissues, DNA concentration techniques, restriction digestion and analysis. Agarose gel electrophoresis, DNA transfer techniques, isotopic and non-isotopic probe labeling methods, DNA fingerprinting.

**UNIT V: DNA SEQUENCING**

Basics and applied methods of DNA sequencing, modern day tools and instruments for sequencing, dideoxy sequencing, applications of sequencing in drug discovery and development, single nucleotide polymorphism (SNP)s identification and characterization techniques, SNPs applications in modern day drug discovery, CNV identification, identification of gross chromosomal deletions. Application of high throughput sequencing in genome wide association study.

**Suggested books:**


1. Wang, K., Gan, L., Boysen, C., and Hood, L. (1995) A microtiter plate-based high-throughput DNA purification method. *Analyt. Biochem.* **226,** 85–90.
2. Mardis, E. R. and Roe, B. A. (1989) Automated methods for single-stranded DNA isolation and dideoxynucleotide DNA sequencing reactions on a robotic workstation. *Biotechniques* **7,** 840–850.
3. Smith, V., Brown, C. M., Bankier, A. T., and Barrell, B. G. (1990) Semiautomated preparation of DNA templates for large-scale sequencing projects. *DNA Seq.* **1,** 73–78.
4. Cao, X., and Brosius, F. C. (1993) Direct sequencing of double-stranded PCR products isolated from conventional agarose gels. *Biotechniques* **15,** 384–386.

**COURSE NAME: ADVANCES IN ENTOMOLOGY AND MANAGEMENT OF INSECT PEST**

**Course Code: ZOO 604** **Credits: 4**

**Course contents:**

**UNIT I: TAXONOMY AND CLASSIFICATION OF CLASS INSECTA**

Taxonomy and Classification of beneficial and harmful insects. Phylogenetic relationship of class insect, modern method of classification. Inpact of climatic change on insects.

**UNIT II: BODY ORGANIZATION AND MORPHOLOGY OF INSECT**

Structure, modification, and physiology of different systems- digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands. Insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra-cellular microorganisms and their role in physiology; artificial diets.

**UNIT III: APPLIED ASPECT OF ENTOMOLOGY**

Scope, development and further prospective of medical entomology. Forensic entomology and insects as biological control agent in agriculture pest management. Ecological importance of Insects. EPM, mechanism of host plant establishment and host plant resistance.

**UNIT IV: PEST MANAGEMENT**

Tools of pest management and their integration- legislative, cultural, physical and mechanical methods; pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis.

**UNIT V: GENETIC ENGINEERING IN ENTOMOLOGY**

Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in biocontrol agents for introgressing and for progeny selections, breeding techniques of biocontrol agents. DNA-based diagnostics; insect immune systems in comparison to vertebrates; molecular basis of metamorphosis; Sf transgenic technology and implications; molecular biology of baculoviruses; insecticide resistance. Resistance management strategies in transgenic crops.

**Suggested books:**


1. H.H. Ross, C.A. Ross & J.R.P. Ross, 1982. A textbook of entomology. (John Wiley & Sons).
2. R.A. Arnett & R.L. Jacques, 1985. Insect life: A field entomological manual for the amateur naturalist (Prentice-Hall, Inc.)
3. P.J. Gullan & P.S. Cranston, 2000. The insects: An outline of Entomology. (Blackwell Science, USA).
4. O.W. Richard & R.G. Davies, 1977. IMMS' General textbook of Entomology. Part I & II. (Chapman & Hall, London)
5. D.B. Tembhare, 1997. Modern entomology. (Himalaya Publ. House).

**COURSE NAME: ADVANCES IN FISH AND FISHERY**

**Course Code: ZOO 605** **Credits: 4**

**Course Contents:**

**UNIT I: AQUATIC ECOSYSTEM**

Present scenario and problems of inland fisheries. Trends in Indian aquaculture. Inland fisheries resources, major river systems of India and their fisheries. Origin, distribution, classification and ecology of lakes and their fisheries Problems and prospects. Origin, distribution, classification and fishery potentialities of Indian reservoirs. Ecology and sustainable management of reservoirs. Important cold water fishes and inland freshwater fishes.

**UNIT II: TAXONOMY AND CLASSIFICATION OF FISHES**

Definition of taxonomy, types and molecular approaches of taxonomy, Taxonomic key, Classification of freshwater and (Vertebrate-Sub-order; Invertebrate-Sub-class). Phylogeny: Scope and definition. Method employed in phylogenic studies. Phylogenic tree. Fish identification and fish bar-coding.

**UNIT III: NUTRITIONAL REQUIREMENTS AND FEEDING MANAGEMENT STUDY**

Body composition of fish and shellfish; the nutritional requirement. Designing of nutritional experiments; experimental culture systems; Methods for study the nutritional requirements in finfish and shellfish; Nutrient requirements (proteins, carbohydrates, lipids vitamins, and minerals) of warm water and cold water fish and shellfish, and their different life stages with respect to commercial important. Factors affecting nutritional requirements of fish and shellfish.

**UNIT IV: FEED FORMULATION AND FEED TECHNOLOGY**

Principles and methods of feed formulation, feed ingredients, international coding of feed ingredients, evaluation of ingredient quality, conventional unconventional and novel ingredients, feed additives and feed binders, antinutritional factors and their prevention; and Low cost feed development.

**UNIT V: AQUAFARM ENGINEERING** AND **CONCEPT AND APPLICATION**

Design, layout and construction of different aqua farms and aqua houses. Construction and design of pond dyke and sluice gate. Water supply and drainage system. Instruments (Kits) for measuring water quality.

**Suggested books:**


1. Dr. Sven Erik Jorgensen , Jose Galizia Tundisi and Takako Matsumura Tundisi (2012). Handbook of Inland Aquatic Ecosystem Management, Taylor and Francis, CRC press pp-452.
2. R. S. K. Barnes (1994). Fundamentals of Aquatic Ecology, 2nd Edition, published by Wiley. Kenneth H. Mann received the first Lifetime Achievement Award of the American Society of Limnology and Oceanography .
3. Stuart Findlay and Robert Sinsabaugh (2002). Aquatic Ecosystems: Interactivity of Dissolved Organic Matter Academic press
4. J.W., **Hertrampf** and F **Piedad-Pascual** Handbook on Ingredients for Aquaculture Feeds
5. S. Athithan, N.Flex and N. Venkatasamy (2013) Fish Nutrition and Feed Technology: A Teaching Manual ebook Daya publishing House New Delhi.