# ANDHRAKESARI UNIVERSITY: ONGOLE
## (A State University, Recognised by UGC)
## M.Sc ZOOLOGY SYLLABUS
## Course Structure as per National Educational Policy-2020 under CBCS
*(For the students admitted from the academic year 2026-2027 onwards)*



## COURSE STRUCTURE & SCHEME OF MARKS

| Semester | Components of Study | Course Code | Title of the Course | No. of Credits | Hr/Week | Internal Assessment | Semester End Exams | Total |
|---|---|---|---|---|---|---|---|---|
| SEMESTER - I | Mandatory Core | R26-ZOO 1.1 | Structure and Function of Invertebrates and Vertebrates | 4 | 4 | 30 | 70 | 100 |
| | | R26-ZOO 1.2 | Principles of Ecology and Biodiversity | 4 | 4 | 30 | 70 | 100 |
| | Foundation Course | R26-ZOO 1.3 | Developmental Biology | 4 | 4 | 30 | 70 | 100 |
| | Foundation Elective (Opt' 1) | R26-ZOO 1.4 (A) | Molecular Cell Biology | 4 | 4 | 30 | 70 | 100 |
| | | R26-ZOO 1.4 (B) | Endocrinology | | | | | |
| | | R26-ZOO 1.4 (C) | Marine and Brackish water ecology | | | | | |
| | Core Practical-I (Skill) | R26-ZOO 1.5P | Structure and Function of Invertebrates and Vertebrates & Principles of Ecology and Biodiversity | 4 | 6 | 30 | 70 | 100 |
| | Core Practical-II (Skill) | R26-ZOO 1.6P | Developmental Biology and Molecular Cell Biology | 4 | 6 | 30 | 70 | 100 |
| | *Audit course* | R26-ZOO 1.7 | Human Values and Professional Ethics | *2* | *2* | *50* | - | - |
| | | | **Sub-Total** | **24** | | | | **600** |
| SEMESTER - II | Mandatory Core | R26-ZOO 2.1 | Genetics and Evolution | 4 | 4 | 30 | 70 | 100 |
| | | R26-ZOO2.2 | Comparative Animal Physiology | 4 | 4 | 30 | 70 | 100 |
| | Research Foundation | R26-ZOO2.3 | Research Methodology | 4 | 4 | 30 | 70 | 100 |
| | Foundation Elective (Opt' 1) | R26-ZOO2.4 (A) | Tools and Techniques in Biology | 4 | 4 | 30 | 70 | 100 |
| | | R26-ZOO2.4 (B) | Fish Physiology | | | | | |
| | | R26-ZOO 2.4 (C) | Aquatic microbiology | | | | | |
| | Core Practical-I (Skill) | R26-ZOO2.5P | Genetics and Evolution and Comparative Animal Physiology | 4 | 6 | 30 | 70 | 100 |
| | Core Practical-II (Skill) | R26-ZOO2.6P | Research Methodology & Tools and Techniques in Biology | 4 | 6 | 30 | 70 | 100 |
| | *Skill Development* | R26-ZOO 2.7 | Skill Development MOOCs/SDC | *2* | *2* | *50* | – | – |
| | | | **Sub-Total** | **24** | | | | **600** |
| SEMESTER - III | Mandatory Core | R26-ZOO 3.1 | Animal Biotechnology and Microbiology | 4 | 4 | 30 | 70 | 100 |
| | | R26-ZOO 3.2 | Ichthyology | 4 | 4 | 30 | 70 | 100 |
| | Generic Elective-I (Opt' 1) | R26-ZOO 3.3 (A) | Limnology | 4 | 4 | 30 | 70 | 100 |
| | | R26-ZOO 3.3 (B) | Water quality management | | | | | |
| | | R26-ZOO 3.3 (C) | Environmental Biology | | | | | |
| | Open Elective-II (Opt' 1) | R26-ZOO 3.4 (A) | Aquatic Toxicology | 4 | 4 | 30 | 70 | 100 |
| | | R26-ZOO 3.4 (B) | Aquaculture Engineering | | | | | |
| | | R26-ZOO 3.4 (C) | Taxonomy and Functional Anatomy of Shellfish | | | | | |
| | Core Practical-I (Skill) | R26-ZOO 3.5P | Animal Biotechnology, Microbiology and Ichthyology & Limnology and Aquatic Toxicology | 4 | 6 | 30 | 70 | 100 |
| | Core Practical-II (Skill) | R26-ZOO 3.6P | Industry Internship / Mini Research project | 4 | 6 | 30 | 70 | 100 |
| | *Skill Enhancement* | R26-ZOO 3.7 | Skill Development MOOCs/SDC | *2* | *2* | *50* | – | – |
| | | | **Sub-Total** | **24** | | | | **600** |
| SEMESTER - IV | Mandatory Core | R26-ZOO 4.1 | Fish Pathology | 4 | 4 | 30 | 70 | 100 |
| | | R26-ZOO 4.2 | Immunology | 4 | 4 | 30 | 70 | 100 |
| | Core Elective-I (Opt' 1) | R26-ZOO 4.3 (A) | Aquaculture | 4 | 4 | 30 | 70 | 100 |
| | | R26-ZOO 4.3 (B) | Taxonomy and Anatomy of Finfish | | | | | |
| | | R26-ZOO 4.3 (C) | Fish Nutrition | | | | | |
| | Open Elective-II (Opt' 1) | R26-ZOO 4.4 (A) | Aquaculture Management | 4 | 4 | 30 | 70 | 100 |
| | | R26-ZOO 4.4 (B) | Fish processing technology | | | | | |
| | | R26-ZOO 4.4 (C) | Economic Zoology | | | | | |
| | Core Practical-I (Skill) | R26-ZOO 4.5P | Fish Pathology and Immunology & Aquaculture and Aquaculture Management | 4 | 6 | 30 | 70 | 100 |
| | Core Practical-II (Skill) | R26-ZOO 4.6 | Project Work **(Dissertation + Seminar + Viva-voce)** | 4 | 6 | - | 100 (50+20+30) | 100 |
| | | | **Sub-Total** | **24** | | | | **600** |
| | | | **Grand Total** | **96** | | | | **2400** |

***Note: Pass in Audit course, skill development and skill enhancement courses are mandatory***

# First Semester



# DEPARTMENT OF ZOOLOGY & AQUACULTURE
# M.Sc. ZOOLOGY
# SEMESTER-I

## ZOO 1.1. Structure and Function of Invertebrates and Vertebrates

Course Type: Theory

Course Category: Mandatory core

Credits: 4

**Course Objectives/Course outcomes:**

This course is designed to

**CO:1** Understand the general characteristics of all invertebrates of coelom and about the nutrition, digestion, respiration.

**CO:2** To discuss about Larval forms of free-living invertebrates and Minor phyla general characters.

**CO:3** Remembering the biology and life cycles of Parasites and insects and its importance in environment.

**CO:4** Elucidate the comparative accounts of respiratory and circulatory systems of vertebrates.

**CO:5** Comparative anatomy and function of Nervous, sensory and urinogenital systems among different vertebrates.

**UNIT – I**

Invertebrates: General characters of invertebrates; Coelom - Origin and functions, acoelomates, pseudocoelomates and coelomates (Protostomia andDeuterostomia).

Nutrition and Digestion: Patterns of feeding and digestion in Cnidarians; filter feeding in Polychaeta, Mollusca and Echinodermata.

Respiration: Structure and function of respiratory organs in Annelida, Arthropoda and Mollusca - gills, lungs and tracheae.

**Learning Outcome:**

Students will understand the General characteristics of all invertebrates, and origin, functions and types of Coeloms, Patterns of feeding and digestion, and structure and function of respiratory organs in invertebrates.

**UNIT – II**

Invertebrate Larvae: Larval forms of free-living invertebrates; Larval forms of parasites.
Minor Phyla: Organization and general characters of Rotifera, Phoronida and Chetognatha.

**Learning Outcome:**

Students will be familiar with the Larval forms of free-living and parasitic invertebrates, Organization and general characters of minor phyla like Rotifera, Phoronida and Chaetognatha



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**UNIT – III**

Parasites: Life cycle and biology of *Trypanosoma gambiense*, *Leishmania donovani*, *Wuchereria bancrofti* and *Schistosoma haematobium*.

Insects: Insects and diseases;

Economic importance of insects.

**Learning Outcome:**

Students will be familiar with the

Life cycle, biology and diseases caused by protozoan and helminthic parasites.

Diseases caused by harmful insects and economic importance of beneficial insects.

**UNIT – IV**

Vertebrates: Important characters, nature of vertebrate morphology.

Respiratory system: Comparative account of respiratory organs invertebrates.

Circulatory system: Evolution of heart among vertebrates; Evolution of aortic arches

and portal systems among vertebrates.

**Learning Outcome:**

Students should be able to describe the

- Salient features and morphology of vertebrates
- Comparative account of respiratory organs; evolution of heart, aortic archesand portal systems among vertebrates.

**UNIT – V**

Nervous system: Comparative anatomy and function of brain and cranial nerves in vertebrates. Comparative anatomy of spinal cord, spinal nerves and autonomous nervous system invertebrates.

Urinogenital system: Evolution of urinogenital systems among vertebrates.

Sensory organs: Olfactory and taste organs in vertebrate series; Lateral line system in fishes.

**Learning Outcome:**

Students will have a knowledge on the

Anatomy and function of nervous system, evolution of urinogenital system and sensory organs among vertebrates.

**REFERENCE BOOKS:**


1) Barrington EJW. Invertebrate Structure and Function.1976.Thomas Nelson and Sons Ltd. London.
2) Hyman LH. The Invertebrates. 1955. Vol.1 to 8, McGraw Hill Co., NewYork.
3) Parker TJ and Haswell WA. 1972. Text Book of Zoology. Vol. 2, Vertebrates (Eds.), AJ. Marshall, ELPS and Mac Millan.
4) Read CP. 1972. Animal Parasitism. Prentice Hall, Inc. New Jersey.
5) Ruppert EE, Fox RS & Barnes RD. 2004. Invertebrates Zoology, 7thedition, Thomson, Brooks/Cole.
6) Young JZ. The Life of Vertebrates.1962. Marion Nixon fromAmazon.com
7) Young JZ.1966. The Life of Mammals, Clarendon Press.




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| CO-PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 3 | 2 | 1 | 2 | 2 | 1 | 2 | 3 |
| **CO2** | 2 | 1 | 3 | 1 | 1 | 2 | 2 | 1 | 3 | 1 |
| **CO3** | 2 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 |
| **CO4** | 1 | 2 | 2 | 1 | 2 | 3 | 2 | 1 | 2 | 2 |
| **CO5** | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 3 | 2 | 2 |



# ZOO 1.2.: Principles of Ecology and Biodiversity

Course Type: Theory

Course Category: Elective foundation

Credits: 4

**Course Objectives/ Course outcomes:**

**CO-5:** Applied biotechnology in biodiversity including molecular taxonomy, GIS.

**CO-1:** To introduce the scope, structure, function of composition of ecosystems.

**CO-2:** Understanding population ecology through applying mathematical methods.

**CO-3:** To introduce basic concepts and significance of biodiversity and distribution of world.

**CO-4:** Create knowledge about biodiversity management; *in-situ* and *ex-situ* conservation through technical aspects.

**CO-5:** Applied biotechnology in biodiversity including molecular taxonomy, GIS.

**UNIT – I**

1. **Ecology:** Nature and scope of ecology; ecosystem structure and function.
2. **Composition:** Abiotic and biotic components; classification of ecosystem with examples; feedback loop.
3. **Major terrestrial biomes;** ecotone, edge effect and advantages and disadvantages.

   **Learning outcome:** Acquire fundamental knowledge and understanding the important ecological components and their function, recognize terrestrial biomes.

**UNIT – II**

1. **Population ecology:** Population characteristics—density, natality, mortality, immigration and emigration; life tables generation.
2. **Population growth:** Population growth of organisms with non-overlapping generations; Verhulst-Pearl logistic growth models; stochastic and time lag models of population growth; net reproductive rate and reproductive value.
3. **Stable distribution,** population growth projection using Leslie Matrix method.
4. **Life history strategies:** *r-k* selection; survivorship curves.

   **Learning outcome:** Students shall acquire knowledge about population dynamics through mathematical, statistical analysis and understanding the critical stages of organisms in population growth.

**UNIT – III**

1. **Biodiversity:** Definition and significance; biodiversity at global, national and local levels; magnitude and distribution of biodiversity.
2. **Patterns of biodiversity:** Latitudinal and altitudinal gradients; species area relationship.



3. **Biogeographic realms** of the world.
4. **Biogeographic zones** of India and faunal diversity; Hotspots in the world and in India.

**Learning outcome:** Being aware of the significance and faunal diversity, distribution of hotspots in biogeographic realms at international, national, local levels and their patterns in respect of their latitude and altitudinal gradients. Analysis species area relationship.

**UNIT – IV**

**Biodiversity management and conservation**

1. **IUCN classification** of wildlife.
2. **Biodiversity threats;** *In-situ* conservation and *Ex-situ* conservation.
3. **Gene banks;** conservation of genetic resource; cryopreservation.
4. **Wildlife protection acts;** organizations involved in protection of Biodiversity. Deployment of AI in conservation engineering: Automated camera-trap image processing (e.g., AI species detection), autonomous bioacoustic monitoring networks for vocal animals, and smart anti-poaching surveillance.

**Learning outcome:** Student will learn about status of biodiversity through IUCN classification and implementation of various wildlife protection acts for conservation and management.

**UNIT – V**

1. **Biodiversity and biotechnology:** DNA based wildlife forensics; genetically modified organisms (GMOs) and Bioremediation.
2. **Molecular taxonomy:** DNA fingerprinting.
3. **Satellite Remote Sensing and GIS programs;** Environmental Impact Assessment (EIA). Integration of automated AI vision models to process satellite imagery for real-time habitat loss detection and predictive EIA simulations.

**Learning outcome:** Knowledge applied through biotechnology helps the DNA based wildlife forensics, GMOs, molecular taxonomy and also GIS programmes help in the observation of movement of wild animals and evaluate environmental problems through EIA.

**REFERENCE BOOKS:**


1. Agarwal KC. 1998. *Biodiversity*. India.
2. *International Code of Zoological Nomenclature*. 1985. Third edition adopted by XX General assembly of the International Union of Biological Sciences, University of California Press, Berkeley and Los Angeles Edition.
3. Kormondy EJ. 1996. *Concepts of Ecology*. Eastern Economy Edition.
4. Oliver S & Owen Mc. *Natural Resource Conservation: An Ecological Approach*. Macmillan Publ. Co. New York.

5. Peggy L. Fiedler and Perer M. Kareiva. 1997. *Conservation Biology*.
6. Prabodh K. Maiti and Paulami Maiti. 2011. *Biodiversity: Perception, Peril and Preservation*.
7. Saharia VV. 1982. *Wildlife in India*. Natraco Publishers, Dehradun.
8. Tandon RK. 1999. *Biodiversity*



| CO-PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 3 | 2 | 1 | 2 | 2 | 1 | 2 | 3 |
| **CO2** | 2 | 1 | 3 | 1 | 1 | 2 | 2 | 1 | 3 | 1 |
| **CO3** | 2 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 |
| **CO4** | 1 | 2 | 2 | 1 | 2 | 3 | 2 | 1 | 2 | 2 |
| **CO5** | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 3 | 2 | 2 |



# ZOO1.3. (A): Developmental Biology

Course Type: Theory

Course Category: Compulsory foundation

Credits: 4

**Course Objectives/Course outcomes:**

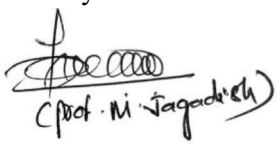
**CO 1**: The students can be able to remember the process of gametogenesis, including mitosis, meiosis and gamete formation in males and females.

**CO2:** Understanding the genetic and phenotypic variation that can arise from gamete formation, fertilization and the role of gametes in sexual reproduction and inheritance.

**CO 3**: By applying the differences between gametes and somatic cells in terms of chromosome number and DNA content.

**CO 4:** To analyze the evolutionary changes of gamete size , shape, factors that can influence gamete competition and mate choice .

**CO 5:** The reproductive strategies of different organisms including mogamy, promiscuity, asexuality and the ethical social implications of technologies related to gamete and embryo manipulations such as IVF, cloning and gene making.



**UNIT – I:**

Origin and migration of primordial germ cells (PGCs) to the genital ridges, differentiation of gonads in mammals.

Spermatogenesis: Sperm – formation, structure and types; Leydig cells – endocrine regulation of spermatogenesis.

Oogenesis: Formation and maturation of ovum, previtellogenesis, vitellogenesis, formation of yolk, functions of egg and types of eggs.

**Learning outcome:**

From the topic's gametogenesis the gonadial action with dual origin which helps in the maternal gene product with germ cell speciation in all invertebrates and vertebrates, which they confined with cytoplasmic bridges the during the yolk formation and function.

**UNIT – II:**

Fertilization: Cell surface molecules in sperm-egg recognition in animals, mechanism of fertilization, molecular events during fertilization and post fertilization.

Early Development: Zygote formation, cleavage, blastulation, gastrulation and formation of germ layers in animals; Fate maps and cell lineage.

**Learning outcome:**

By learning the process of fertilization, the gametes play an important role in different mammals and insects with the formation (or) development during fertilization process in mammals and basic approach to life of gametes is the outcome work during fertilization process in animals.

**UNIT – III:**

Cell aggregation and differentiation; axes and pattern formation in Drosophila, amphibian and chick. Differentiation of neurons, post embryonic development. Larval formation, metamorphosis in insects and amphibians.

**Learning outcome:**

In cell aggregation and differentiation, the development of nervous system, embryos, larval development metamorphosis and the role of endocrine system play an important role regulation system in formation of Drosophila, amphibians, chick and mammals in development biology.

**UNIT – IV:**

Programmed cell death: Incidence of apoptosis, apoptosis during animal development; apoptosis during limb development.

Aging and senescence; Dietary restriction and anti-aging action; Age related diseases.

**Learning outcome:**

The detailed out come in this chapter with apoptosis in animal development and apoptosis role in development process with special reference to aging and senescence's with life expectancy disorders and to know the diseases in human related factors.

**UNIT – V:**

Potency, commitment, Specification, Induction, Competence, Determination and differentiation.

Hormonal regulation of Meta morphosis in insects and amphibians.

**Learning outcome:**

The detailed out come in this unit with potency and specification and hormonal regulation in insects and amphibians.

**REFERENCE BOOKS:**


1) Austen CR and Short RV. 1980. Reproduction in Mammals. Cambridge University Press.
2) Gilbert SF. 2006. Developmental Biology, 8th Edition. Sinauer Associates Inc., Publishers, Sunderland, USA.
3) Longo FJ. 1987. Fertilization. Chapman & Hall, London.
4) Rastogi VB and Jayaraj MS. 1989. Developmental Biology. Kedara Nath Ram Nath Publishers, Meerut, Uttar Pradesh.
5) Schatten H and Schatten G. 1989. Molecular Biology of Fertilization. Academic Press, New York.
6) Sreekrishna V. 2005. Biotechnology –I, Cell Biology and Genetics. New Age International Publ. New Delhi, India.
7) Subramonian T. 2008. Molecular Developmental Biology. Narosa Publishing House.




| CO-PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 3 |
| **CO2** | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 3 | 1 |
| **CO3** | 2 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 |
| **CO4** | 1 | 2 | 2 | 1 | 2 | 3 | 2 | 1 | 2 | 2 |
| **CO5** | 2 | 1 | 2 | 1 | 2 | 3 | 2 | 2 | 2 | 2 |



# ZOO 1.4. (A): Molecular Cell Biology

Course Type: Theory

Course Category: Elective foundation

Credits: 4

**Course Objectives/Course outcomes:**

**CO1:** Understand the basic principles of molecular biology and how they apply to cellular processes.

**CO2:** Explain the molecular mechanisms of DNA replication, transcription and translation.

**CO3:** Analyze the structure and function of proteins, enzymes, and other macromolecules involved in cell signaling, metabolism, and regulation.

**CO4:** Understand the principles of genetic inheritance, including gene expression and regulation, and how these processes are involved in cellular differentiation and development.

**CO5:** Discuss current research in molecular cell biology and the applications of this knowledge to biotechnology, medicine, and other fields.

**UNIT– I**



Composition, Structure and Functions of Carbohydrates and Proteins.

Composition, Structure and Functions of Lipids and Nucleic Acids.

**Learning outcome:**

Students are able to understand the basic principles of molecular biology and cellular processes

**UNIT– II**

Membrane Structure and Function: Phospholipid Bilayer and Membrane Proteins, Diffusion, Osmosis, Active Transport, Ion channels, Ion pumps, Electrical Properties of Membrane.

Bioenergetics, Glycolysis, OxidativePhosphorylation.

**Learning outcome:**

Students are aware with molecular mechanisms of DNA replication, transcription and translation.

**UNIT– III**

**RNA Synthesis and Processing:** Transcription Factors and Machinery, Formation of Initiation Complex, Transcription Activators and Repressors, RNA Polymerases, Capping, Elongation and Termination (RNA Processing, RNA Editing, Splicing and Polyadenylation), RNA transport.

**Protein Synthesis and Processing:** Translation, Ribosome, Formation of Initiation Complex, Initiation Factors and their Regulation, Elongation and Elongation Factors, Termination, Aminoacylation of tRNA, Aminoacyl Trna Synthetase and Translational Proof reading, Translational Inhibitors: Antibiotics, Post-translational Modification of Proteins.

**Learning outcome:**

Students are able to understand the structure and function of proteins, enzymes, and other macromolecules involved in cell signaling, metabolism, and regulation.

**UNIT– IV**

Control of Gene Expression at Transcription and Translation Level: Prokaryotic and Eukaryotic Gene Expression.

Regulation of Expression of Viral and Phage Genes, Role of Chromatin in Gene Expression, Gene Silencing.

**Learning outcome:**

Students are aware with principles of genetic inheritance, including gene expression and regulation, and how these processes are involved in cellular differentiation and development.

**UNIT– V**

Organization of Gene and Chromosome: Structure of Gene and Chromosomes, Unique and Repetitive DNA, Heterochromatin vs. Euchromatin, Operon Concept, Interrupted Genes, Gene Families, Transposons.

Cell Cycle and Cell Division: Steps in Cell Cycle, Control of Cell Cycle, Mitosis and Meiosis.

**Learning outcome:**

Students are able to go for current research in molecular cell biology and the applications of this knowledge to biotechnology, medicine, and other fields.

**REFERENCEBOOKS:**


1) Bourne GH.1970.*Division of Labour in Cells* .Academic Press, NewYork.
2) DeRobertisRMFandSaezRDP.1970.*Cell Biology.* Academic Press, NewYork.
3) Gilman M, Witkowsk JA and WatsonMZJD.1992. *Recombinant DNA*.2nd Edition. Scientific American Books, W.H. Freeman and Company, NewYork.
4) LevineL.1973.*Biology of the Gene.* 2nd Editon.
5) Pragya Khanna.2008.*Cell and Molecular Biology.* I.K. International Publ. House Pvt. Ltd. New Delhi
6) WhiteMJD.1973.*Animal CytologyandEvolution.* Cambridge University Press.
7) Weaver.1999.*Molecular Biology.*WCB McGraw Hill.


| CO-PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 3 | 3 |
| CO2 | 1 | 2 | 2 | 2 | 3 | 1 | 1 | 2 | 2 | 2 |
| CO3 | 2 | 2 | 1 | 3 | 1 | 2 | 1 | 3 | 1 | 2 |
| CO4 | 1 | 2 | 2 | 1 | 2 | 3 | 2 | 1 | 2 | 2 |
| CO5 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 3 | 2 | 3 |



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# ZOO 1.4. (B): Endocrinology

Course Type: Theory

Course Category: Elective foundation

Credits: 4

**Course Objectives/Course outcomes:**

**CO1:** To introduce the basic concepts about biosynthesis of hormones and the factors influencing the secretions.

**CO2:** To understand the Hormones as messengers and the evolution of essential endocrine glands and their structure.

**CO3:** Analyzing the evolution of structural and functional organization of thyroid hormone action in different phylum.

**CO4:** To discuss about the Evolution, Synthesis and structural diversity of steroid hormones on human health.

**CO5:** To understand the growth, development and reproductive regulation of hormones.

**Unit 1:**

Classification of hormones. Brief account of structural features of endocrine glands. Hormonal effects and regulation – basic concepts and methods

Biosynthesis and secretion of pituitary. Factors influencing secretion.

Endocrine disorders - brief description

**Learning Outcome:** Students will get awareness about the origin of Endocrine glands, Biosynthesis and influencing factors of Pituitary.

**Unit 2:**

Biosynthesis and secretion of pancreas, adrenal hormones. Factors influencing secretion.

Peptide hormones, Steroid hormones. Hormones as messengers. Cell surface receptors. Cascade of reaction linked to signal transduction.

Evolution of pituitary gland; Physiological actions of pituitary hormones. Urophysis and action of its hormone(s). Pancreatic hormones and glucose homeostasis.

**Learning Outcome:** Upon completion of the above unit they are able to understand the role of hormones in human physiology.

**Unit 3:**

Evolution, Biosynthesis and Secretion of thyroid gland.

Thyroid hormone synthesis and its regulation, paradigms of thyroid hormone action in poikilotherms and homeotherms.

A comparative account of parathyroid gland and ultimobranchial body/C cells, synthesis of parathyroid hormone, calcitonin and of vitamin D3.

**Learning Outcome:** On completion of this unit students are able to differentiate the hormonal synthesis and their functions.



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**Unit 4:**

Evolution of discrete adrenal gland; Synthesis of corticosteroid

Structural diversity of glucocorticoids among vertebrates.

Hormones and human health

**Learning Outcome:** Students acquire knowledge about the evolution of adrenal gland, synthesis of different steroids and their regulation on human health.

**Unit 5**

Hormones growth and development.

Hormone's role in Reproduction.

Hormones regulating reproduction.

**Learning Outcome:** Significant role of hormones on growth, development and reproduction.

**SUGGESTED READING MATERIAL:**


1) Barrington. EJ.W. General and comparative Endocrinology Cambridge Press, Oxford.
2) Bentley, PJ. Comparative Vertebrate Endocrinology, Cambridge Press, Oxford.
3) Martin, C.R. Endocrine Physiology. Oxford Univ. Press, Oxford.
4) Prakash S. Lohar. Endocrionology-Hormones and human health-2005. MJP Publishers-Chennai.
5) Williams, R.H. Text Book of Endocrinology, W.B. Saunders Co., Philadelphia.


| CO-PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 3 | 1 | 2 | 3 | 2 | 2 | 1 |
| **CO2** | 2 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 1 |
| **CO3** | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 |
| **CO4** | 2 | 1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 1 |



## ZOO 1.4. (C): Marine and Brackish Water Ecology

Course Type: Theory

Course Category: Elective foundation

Credits: 4

**Course Objectives/Course outcomes:**

**CO1:** To study the classification and distribution of life and their adaptations in marine environment.

**CO2:** To know about the organic production and Human impact in coastal ecosystem.

**CO3:** To discuss about the classification and Ecology of some typical brackish water habitats of India.

**CO4:** To create awareness about structure, functions and adaptations of fauna in estuarine ecosystem.

**CO5:** To know about the Human impact on coastal and estuarine management in the 21st century.

**UNIT – I: Marine Ecology**

Classification of the marine environment and salient features of different zones.

Classification of marine organisms and their characteristic features.

Shore environment: Physico-chemical and biological factors of intertidal zone; distribution of life on rocky, sandy, mud shores and their characteristic features; fauna and their adaptations.

**Learning Outcome:** Students are able to learn about the classification of marine environment and characteristic features of shore environment.

**UNIT – II**

Organic production of the sea: Primary, secondary and tertiary production; factors affecting primary production; measurement of organic production.

Marine food chains and food webs.

Human impact and management of coastal ecosystems.

**Learning Outcome:** Upon completion of the above unit, they are able to understand the organic production and Human impact and management of coastal ecosystem.

**UNIT – III: Brackish water Ecology**

Classification of brackish water habitats and salient features of different zones: Estuaries, Mangroves, lakes, lagoons and marshes/ wetlands.

Ecology of some typical brackish water habitats of India: Estuaries – Hooghly-Matlah, Mahanadi, Godavari, Krishna, Cauvery and west coast estuaries; lakes- Chilka, Pulicat.

**Learning Outcome:** Students are able to know about the classification and ecology of some typical brackish water habitats of India.



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**UNIT – IV**

Structure and function of estuarine ecosystems: Physico-chemical features, mineral cycling (CNP), biotic communities, estuarine food webs and energy flow.

Estuarine fauna and their adaptations.

**Learning Outcome:** Students are able to understand the structure and function and faunal adaptations in estuarine ecosystem.

**UNIT – V**

Human impact and management of estuarine ecosystems.

Changes in Biotic structure due to harvest and introduction of new species.

Coastal and estuarine management in the 21st century.

**Learning Outcome:** Students are able to identify the human impact and significance of coastal and estuarine management in the 21st century.

**REFERENCE BOOKS:**


1) Balakrishnan Nair N and Thampi DM. 1980. *A Text Book of Marine Ecology*. Macmilaan Company of India Ltd. Delhi.
2) Clark JR. 1992. *Integrated Management of Coastal Zones*. FAO Fisheries Tech. No. 327, Rome.
3) Goudie A. 1993. *The Human Impact on the Natural Environment.* MIT Press.
4) Lewis JR. 1964. *The Ecology of Rocky Shores*. The English Universities Press Ltd. London.
5) Reid GK and Wood RD. 1976. *Ecology of Inland waters and Estuaries*. Van Nostrand Company.
6) Sverdrup HV, Johnson MW and Fleming RH.1942. *The Oceans: their physics, chemistry and general biology.* Prentice Hall, Inc. New York.
7) Santhanam R and Srinivasan A. 1994. *A Manual of Marine Zooplankton*. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.


| CO-PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
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| **CO2** | 1 | 2 | 1 | 2 | 1 | 2 | 3 | 1 | 2 | 1 |
| **CO3** | 1 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 3 | 2 |
| **CO4** | 2 | 1 | 2 | 3 | 3 | 2 | 1 | 2 | 1 | 1 |
| **CO5** | 1 | 2 | 1 | 2 | 3 | 2 | 1 | 1 | 2 | 1 |



## PRACTICAL – I:

## ZOO P 1.5: Structure and Function of Invertebrates & Vertebrates and Principles of Ecology and Biodiversity

**Invertebrates**

1) Nervous system of *Squilla/Sepia* and Prawn
2) Digestive system of *Squilla/Sepia* and Prawn
3) Appendages of Prawn.
4) Sting of Honey bee.
5) Gnathochilarium of Millipede.
6) Museum specimens and slides relevant to the type study in theory.

**Vertebrates**

1) *Trichiurus* – IX and X cranial nerves.
2) Catfish – Weberian ossicles.
3) *Anabas* – Accessory respiratory organs.
4) Museum specimens and slides relevant to the type study in theory.

**Principles of Ecology**

**Biodiversity**

1) List of local fauna (invertebrates and vertebrates) and Faunal diversity of man-made ecosystem.
2) Endangered species of Indian sub-continent (invertebrates and vertebrates).

## PRACTICAL - II:

## ZOO P 1.6.: Developmental Biology and Molecular Cell Biology

**Developmental Biology**

1) Identification of shrimp larvae.
2) Frog developmental stages – egg, 4 and 8 celled stage, blastula, gastrula and tadpole larva.
3) Chick embryonic stages – 18hour, 24hour, 36hour, 48 hour and 72-hour embryo.
4) Embryos of rat, rabbit and pig.
5) Estimation of calcium and phosphorus in egg shell.
6) Estimation of carbohydrates and proteins in egg.

**Molecular Cell Biology**

1) Identification of different stages of Mitosis and Meiosis.
2) Observation of Mitosis in Onion root-tip cells.
3) Observation of Meiosis in Cricket/ Grasshopper testis.
4) Preparation and Staining of Blood Smear.
5) Buccal Smear preparation for identification of Barr body.
6) Observation of permanent slides of Cytology.



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## ZOO P 1.7Audit Course: Human Values and Professional Ethics

**Learning Objectives:**

- ✓ To know the nature of ethics and goals.
- ✓ To know the basic moral concepts.
- ✓ To know the non-violance of non possession.
- ✓ To know the crime and theories of punishment.
- ✓ To know the Bhagavd Gita, Buddhism, Jainism.

### Unit-I: 6H

Definition and Nature of Ethics – Is relation to Religion, Politics, Business, Law, Medicine and Environment. Need and Importance of Professional Ethics – Goals – Ethical Values in Various Professions.

### Unit-II: 6H

Nature of Values-Good and Bad, Ends and Means, Actual and Potential Values, Objective and Subjective Values, Analysis of Basic Moral Concepts-Right, Ought, Duty, Obligation, Justice, Responsibility and Freedom, Good Behavior and Respect for Elders, Character and Conduct.

### Unit-III: 6H

Individual and Society: Ahimsa (Non-Violence), Satya (Truth), Brahmacharya (Celibacy), Asteya (Non Possession) and Aparigraha (Non-stealing). Purusharthas (Cardinal virtues) - Dharma (Righteousness), Artha (Wealth), Kama (Fulfillment Bodily Desires), Moksha (Liberation).

### Unit-IV: 6H

Crime and Theories of Punishment – (a) Reformative, Retributive and Deterrent, (b) Views on Manu and Yajnavalkya.

### Unit-V: 6H

Bhagavd Gita – (a) Niskama Karma, (b) Buddhism – The Four Nobel Truths – Arya astangamarga, (c) Jainism - Mahavratas and Anuvratas. Values Embedded in Various Religions, Religious Tolerence, Gandhian Ethics.



## Reference Books:


1) Johns S Mackenjie: A Manual of ethics
2) "The Ethics of Management" by Larue Tone Hosmer, Richard D. Irwin Inc.
3) Management Ethics – Integrity at work by Joseph A. Petrick and John F. Quinn, Response Books, New Delhi.
4) "Ethics in Management" by S.A. Shelekar, Himalaya Publishing House.
5) Harold H. Titus: Ethics for Today
6) Maitra, S.K: Hindu Ethics
7) William Lilly: Introduction to Ethics
8) Sinha: A Manual of Ethics
9) Manu: Manava Dharma Sastra or the Institute of Manu: Comprising the Indian System of Duties: Religious and Civil (ed) G.C. Haughton.
10) Sasruta Samhita: Tr. KavirajKunjanlal, KunjanlalBrishagratha, Chowkamba Sanskrit Series, Vol I,II and III, Varanasi, Vol I PP, 16-20, 21-32 and 74-77 only.
11) Charaka Samhita: Tr. Dr. Ram Karan Sarma and Vaidya Bhagavan Dash, Chowkambha Sanskrit Series Office. Varanasi I, II, III Vol I PP 183-191.
12) Ethics, Theory and Contemporary Issues. Barbara Mackinnon, Wadsworth/Thomson Learning, 2001.
13) Analyzing Moral Issues, Judith A. Boss, Mayfield Publishing Company, 1999.
14) An Introduction to Applied Ethics (Ed.,) John H. Piet and Ayodya Prasad, Cosmo Publications.
15) Text Book for Intermediate First Year Ethics and Human Values, Board of Intermediate Eduction – Telugu Academy, Hyderabad.
16) I.C. Sharma Ethical Philosophy of India. Nagin& Co Julundhar.


## Learning Outcomes:

- ✓ Students are able to understand relation to religion & ethical values.
- ✓ Students are able to understand to character & conduct.
- ✓ Students are able to understand to crime & theories of punishment.
- ✓ Students are able to understand to Gand
- ✓ hian ethics & values embedded in various religions.
- ✓ Studetns are able to understand various individuals of society.



# Second Semester



# DEPARTMENT OF ZOOLOGY & AQUACULTURE

# M.Sc. ZOOLOGY

# Semester-II

## ZOO 2.1.: Genetics and Evolution

Course Type: Theory

Course Category: Mandatory core

Credits: 4

**Course Objectives/Course outcomes:**

**CO :1**. To provide fundamental knowledge in Mendelian principles.

**CO :2** To evaluate human genome project quantitative and qualitative traits of human beings.

**CO :3** Remembering the concepts of evolution, and hardy- Weinberg law of equilibrium.

**CO :4** Elucidate the mega evolution and models of speciation.

**CO :5** Analyse the convergent and divergent evolution and adaptive radiation in vertebrates.

**UNIT – I**

**Genetic Principles:** Mendelian principles; interaction of genes, linkage and crossing over, sex linkage and sex determination; Extrachromosomal inheritance.

Behavioral genetics in *Drosophila* and bees.

**Learning Outcome:** Students will be familiar with the Mendelian laws, other genetical processes common in animals and Behavioural genetics in insects.

**UNIT – II**

**Human Genetics:** Human Genome Project, Pedigree analysis, Quantitative and qualitative traits of human beings, blood group inheritance, concepts of eugenics.

Inborn errors of metabolism; Chromosomal abnormalities.

**Learning Outcome:** Students should be able to know the Human genetics including Human genome project and genetic disorders.

**UNIT – III**

**Concepts of Evolution:** Theories of organic evolution – Lamarckism, Darwinism, Modern synthetic theory, Mutations.

Hardy-Weinberg law of equilibrium; genetic drift – random genetic drift.

**Learning Outcome:** Students will understand the Theories of organic evolution, modern synthetic theory, mutations, Hardy-Weinberg law of equilibrium and genetic drift.



**UNIT – IV**

**Mega Evolution:** Isolation, pattern and mechanisms of reproductive isolation; Mechanism of speciation, phylogenetic and biological concepts of species; models of speciation – allopatric, parapatric and sympatric.

**Learning Outcome:** Students will learn the Isolation, pattern, mechanisms and models of speciation

**UNIT – V**

Convergent and divergent evolution;

Adaptive radiation in amphibians, reptiles and mammals.

**Learning Outcome:** Students will learn the Convergent & divergent evolution and adaptive radiation in animals.

**REFERENCE BOOKS:**


1) Burns GW. 1972. *The Science of Genetics. An Introduction to Heredity.* Mac Millan Publ.Co.Inc.
2) Gardner EF. 1975. *Principles of Genetics.* John Wiley & Sons, Inc. NewYork.
3) Harth and Jones EW. 1998. *Genetics – Principles and Analysis.* Jones and Bar Hett Publ.Boston.
4) Levine L. 1969. *Biology of the Gene.*Toppan.
5) Pedder IJ. 1972. *Genetics as a Basic Guide*. W. Norton & Company, Inc.
6) Rastogi VB. 1991. *A Text Book of Genetics.* Kedar Nath Ram Nath Publications, Meerut, Uttar Pradesh, India.
7) Rastogi VB. 1991. *Organic Evolution.* Kedar Nath Ram Nath Publications, Meerut, UttarPradesh, India.
8) Stahl FW. 1965. *Mechanics of Inheritance.* Prentice-Hall.
9) White MJD. 1973. *Animal Cytology and Evolution.* Cambridge Univ.Press.


| CO-PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
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| CO2 | 1 | 2 | 1 | 1 | 2 | 1 | 3 | 1 | 2 | 1 |
| CO3 | 2 | 1 | 2 | 1 | 2 | 2 | 3 | 1 | 2 | 2 |
| CO4 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 2 | 1 |
| CO5 | 1 | 2 | 2 | 3 | 2 | 1 | 2 | 1 | 1 | 2 |



# ZOO 2.2.: Comparative Animal Physiology

Course Type: Theory

Course Category: Mandatory core

Credits: 4

**Course Objectives/Course outcomes:**

**CO1:** Ability to compare and contrast the physiological adaptations of different animals in different environments

**CO2:** Understanding the challenges in animals face in maintaining homeo- stasis such as thermo regulatory and various physiological such as metabolism, respiration, circulation, Osmo regulation and excretory system

**CO 3:** To recognize and analyze the mechanisms in animals to regulate their internal; environment in response to external stimuli.

**CO 4:** To integrate knowledge of molecular, cellular and organosomal physiology to understand the animal function.

**CO 5:** Appreciation of diversity of life and the remarkable adaptations that allow animals to survive and thrive in different environments.

**UNIT – I**

Transformation of energy in animals: Bio-energetics; diversity in operations, Factors regulating enzyme activity, energy producing reactions, proteolytic enzymes, pathways of cellular metabolism. Nutrition impairment and stress.

**Learning outcome**

In the topic of transformation of energy in the environment and diversity in operations can be regulation and the energy reactions with the enzymes in the cellular metabolic can be estimated in their unit.

**UNIT – II**

Digestion: Process of digestion and absorption; energy balance; Basal Metabolic Rate. Respiration: Mechanism of gaseous exchange in animals; neural and chemical regulation. Blood: Composition and function of blood; respiratory pigments and their functions.

Circulation: Comparative account of circulatory system in animals.

**Learning outcome:**

In the process of digestion, we can learn regarding the food digested in body, respiration through different necessary organs the way of circulation in different living organisms can be identified.

**UNIT – III**

Thermoregulation in poikilotherms and homeotherms.

Muscles: Structure and function of muscles; Theories of muscle contraction.

Nervous system: Neurons, action potential, neural control of muscle tone and posture; propagation of nerve impulse and synaptic transmission in animals.



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**Learning outcome**

Thermoregulation is the process to different temperature adaptations in the environment that how living organisms can live in different environment conditions through movement and nervous system and propagation in different animals by the students can learn regarding the above said themes.

**UNIT – IV**

Excretion and Osmoregulation: Comparative account of structure and function of kidneys in animals; regulation of water and electrolyte balance.

Endocrinology and reproduction: Endocrine glands in animals, mechanism of hormonal action; Hormonal regulation in reproduction; growth and development – Regeneration, moulting and metamorphosis.

**Learning outcome**

The detailed out comes from this chapters in regarding sensory organs, excretory and osmoregulation and endocrinology and reproductive process in different living organisms which are confined to aquatic and terrestrial organisms

**UNIT – V**

Chromatophores a n d Significance of chromatophores and colour change in animals-- Photo-receptors, Phono- receptors, Tango receptors, and Chemoreceptor's occurrence and Functional significance of Bioluminescence.

**Learning outcome**

The detailed out comes from this chapters in regarding sensory organs, excretory and osmoregulation and endocrinology and reproductive process in different living organisms which are confined to aquatic and terrestrial organisms.

**REFERENCE BOOKS:**


1) Eckert H. Animal Physiology: Mechanisms and Adaptation. W.H. Freeman & Company.
2) Floray E. An Introduction to General and Comparative Animal Physiology. W.B. Saunders Co., Philadelphia.
3) Goel KA and Satish KV. 1989. A Text Book of Animal Physiology, Rastogi Publications, Meerut, U.P.
4) Hoar WS. General and Comparative Physiology. Prentice Hall of India, New Delhi.
5) Lehninger AL. Nelson and Cox. Principles of Biochemistry. Lange Medical Publications, New Delhi.
6) Prosser CL and Brown FA. Comparative Animal Physiology. W.B. Saunders Company, Philadelphia.
7) Schmidt-Nielson K. Animal Physiology. Cambridge University Press, Cambridge.




| CO-PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
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| CO2 | 1 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 1 | 2 |
| CO3 | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 3 | 2 | 1 |
| CO4 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 1 | 2 | 2 |
| CO5 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 3 |



# ZOO 2.3. Research Methodology

Course Type: Theory

Course Category: Compulsory foundation

Credits: 4

**Course Objectives/ Course outcomes:**

**CO1:** To introduce the concepts, theoretical aspects, and instrumentation of Colorimetry, Electrophoresis, Chromatography, and Centrifugation.

**CO2:** To understand the concepts of Immunological reactions and systematic Research Methodology for scientific literature review.

**CO3:** To discuss about the Biostatistics principles and computer applications in biological data analysis.

**CO4**: To study the concepts of Limnological parameters, nutrient dynamics, and Planktonology extraction and identification techniques.

**CO5:** To study about the Biochemical Methods for quantitative estimation of macromolecules and specialized tissue micro-techniques.

**UNIT – I**

1. Colorimetry and Electrophoresis: Theoretical aspects, visual colorimetry, photoelectric colorimeters, methods of measuring the emitted light. Principle, stabilizing media, homogenization, preparation of homogenate.
2. Chromatography and Centrifugation: Advanced chromatography separation techniques; Principles and applications of centrifugation in biological research.

**Learning Outcome**: Students are able to distinguish the principles, instrumentation, and operations of colorimetry, electrophoresis, chromatography, and centrifugation.

**UNIT – II**

1. Immunological Reactions: Precipitin reaction and its biochemical applications; Agglutination reaction and its diagnostic applications.
2. Research Methodology: Reviewing of scientific information relevant to the topic of the candidate's research, collection of literature, reviewing of scientific information and preparation of manuscripts.

**Learning Outcome:** Upon completion of the above unit, they are able to understand the concepts of Immunological reactions and systemic collection, evaluation, and documentation of scientific literature.

**UNIT – III**

1. Biostatistics Foundations: The arithmetic mean, median and quintiles, mode; Measures of



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dispersion and skewness-objectives, variation and standard deviation.

2. Computational Biology: Applications of computers in Biology-Collection of data bases and use of software in biological data analysis.

**Learning Outcome:** On completion of the unit, they are able to calculate statistical parameters and use data handling software tools for biological database analysis.

**UNIT – IV**

1. Limnological Methods: Water quality parameters, Dissolved Oxygen (DO), Alkalinity, Hardness. Micro nutrients such as carbon, phosphates, Nitrites & iron.

2. Planktonology: Plankton collection separation, preservation, identification, and mounting techniques.

**Learning Outcome**: To understand the assessment of water quality parameters, nutrient distributions, and identification techniques for plankton populations.

**UNIT – V**

1. Micro technique: Separation of organs, whole mounts, section cutting, dehydration and staining techniques.

2. Biochemicals Methods: Estimation of proteins (Lowry's method & Biuret method), carbohydrates (Kemp et al., method and Anthrone method), lipids (Vanillin method & chromic acid method), lactate (Barker & Summerson), pyruvate (Friedman & Haugen) amino acids (Ninhydrin method, Noor and Anatein, Colowick and Caplan) and Nucleic acids (Searchy and Macllinnis).

**Learning Outcome:** They are able to apply routine micro-techniques for organ processing and execute chemical tests for the accurate identification and estimation of biochemical compounds.

**REFERENCE BOOKS:**


1. Garvey JS, Gramer NR and Sussdorf DH. 1977. Methods in Immunology: A laboratory text for instruction and research, WA Benjamin, Inc. Advanced book programme, Massachusetts, 01867 USA.
2. Bharucha B. Hand book of medical laboratory technology, A.H. Press, Vellore, Tamil Nadu.
3. Williams BK and Willson K. A biological wide to principles and techniques of practical biochemistry, Butler and Tanner Ltd, London.
4. Bhat BR, Sri Venkataramana and Madhava Rao KS. Statistics (A beginner's text) volume I New Age International Publishers Ltd, New Delhi.
5. Joshi KR and Osamo NO. Immunology, Agro botanical publishers, Vyas Nagar, Bikaner 334 003.
6. Wetzel. 1972. Limnological methods, WB Saunders and co. Philadelphia.
7. Welch. 1962. Limnological methods, WB Saunders and co. Philadelphia.
8. Golterman and Clamo. 1969. Water analysis, Black well Scientific Publications Laboratory manual in Biochemical—New age International (Pvt) Ltd. Publishers.




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| CO-PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
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| **CO1** | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 2 |
| **CO2** | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 3 | 1 | 1 |
| **CO3** | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 3 | 2 | 1 |
| **CO4** | 1 | 1 | 2 | 3 | 2 | 1 | 2 | 1 | 1 | 2 |
| **CO5** | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 1 |



# ZOO 2.4. (A): Tools and Techniques in Biology

Course Type: Theory

Course Category: Elective foundation

Credits: 4

**Course Objectives/Course outcomes:**

**CO:1** To provide information regarding different types of Microscopies, principles involved and working conditions of Microscopes up to SEM TEM and STEM.

**CO:2** To make understand about different types of spectroscopies, and the related principles involved and working conditions and applications of these spectroscopies and the advantages in scientific investigations.

**CO:3** To learn about the importance of different types of chromatographic techniques and electrophoretic techniques the principle involved, applications as analytical tools and their uses in the biological sample analysis.

**CO:4** To impart knowledge on the nucleic acid blotting techniques, Sequences and nomenclature data information sources like NCBI, GDB, MGB, data retrieval tools in analyzing the biomolecules.

**CO:5** To provide about the statistical analysis processes involved in the data collection, Sampling

distribution, measures of central tendencies and probability distributions Standard deviation, standard error and confidence interval; Regression and Correlation. Different tests of significance and Usage of Statistical Package for Social Sciences (SPSS).

**UNIT – I**

Microscopies: Working principle and types of Optical Microscopy – dark-field, phase-contrast, interference, polarization and fluorescence microscopy; Working principle and types of Electron Microscopy – Transmission electron microscopy (TEM), Scanning electron microscopy (SEM) and Scanning-Transmission electron microscopy (STEM); Different fixation and staining techniques for electron microscopy.

**Learning outcome:**

Students will be familiar with

- Different types of Microscopies, their working principles and uses

**UNIT-II**

Spectroscopies: Working principle of UV-Visible spectrophotometry, IR spectroscopy, AtomicAbsorption Spectroscopy (AAS), Fluorescence and Phosphorescence spectroscopy, Electron Spin Resonance (ESR) spectroscopy, mass spectrometry, X-ray crystallography and Nuclear Magnetic Resonance (NMR) spectroscopy.

**Learning outcome:**

Students will be familiar with

- Different spectroscopic methods, working principles and applications



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- Recent advances in the existing instrumentation and their evolution

**UNIT – III**

Chromatography: Principles and applications of Gel filtration, Paper, Column, Ion-exchange, Affinity, Thin layer (TLC),Gas liquid (GLC) and High-Performance Liquid Chromatography (HPLC)

Electrophoresis: Agarose gel electrophoresis, Pulsed Field Gel Electrophoresis (PFGE), Polyacrylamide Gel Electrophoresis (PAGE), Sodium Dodecyl Sulphate Polyacrylamide Gel Electrophoresis (SDS-PAGE), Two-dimensional electrophoresis - Iso-electric focusing (IEF).

**Learning outcome:**

Students will be familiar with

- Chromatographic techniques, their working principles, applications and uses
- Different electrophoretic methods, working principles and applications
- Recent advances in the existing instrumentation and their evolution

**UNIT – IV**

Nucleic acid blotting techniques: Southern blotting, Northern blotting and Western blotting; Polymerase Chain Reaction (PCR); DNA fingerprinting; Genomics and Proteomics.

Sequences and nomenclature: IUPAC symbols, nomenclature of DNA sequences, nomenclature of protein sequences, directionality of sequences, types of sequences used in bioinformatics.

Information sources: NCBI, GDB, MGB, data retrieval tools, database similarity searching, resources for gene level sequences, use of bioinformatics tools in analysis.

**Learning outcome:**

Students will be familiar with

- Blotting techniques, their working principles, applications and uses in analysis of Nucleicacids
- Nomenclature of DNA sequences, nomenclature of protein sequences types of sequences used inbioinformatics.
- Data retrieval tools, database similarity searching, resources for gene level sequences, use of bioinformatics tools in analysis.

**UNIT – V**

Bio-statistics: Measures of central tendency and dispersal – mean, median and mode; Probability distributions - binomial, poisson and normal; Sampling distribution.

Standard deviation, standard error and confidence interval; Regression and Correlation.

Tests of significance: Levels of significance, X 2 test, t-test and Analysis of Variance (ANOVA).

Usage of Statistical Package for Social Sciences (SPSS).

**Learning outcome:**

Students will be familiar with

- Sampling distribution, measures of central tendencies and probability distributions

- Standard deviation, standard error and confidence interval; Regression and Correlation.
- Different tests of significance and Usage of Statistical Package for Social Sciences (SPSS).

**REFERENCES BOOKS:**


1) Brewer JM, Pesce AJ & Ashworth RB. 1974. Experimental Techniques inBiochemistry. Prentice-Hall.
2) Diamond PS & Denman RF. 1966. Laboratory Techniques in Chemistry andBiochemistry. Butterworths
3) Dubey, R.C., 2006. A Text Book of Biotechnology. S. Chand & Company Ltd., NewDelhi.
4) Eaton AD, Clesceri LS, Rice EW & Greenberg AE. 2005. Standard Methods for theExamination of Water and Wastewater. APHAAWWA-WEF, Washington DC.
5) Fishbein L. 1973. Chromatography of Environmental Hazards: Metals, Gaseous andIndustrial Pollutants. Elsevier.
6) 6 Jeffery GH, Basset J, Mendham J & Denney RC.(Eds.).1989. Vogel's Textbook ofQuantitative Chemical Analysis. Longman.
7) Nelson DL and Cox MM. 2005. Lehninger Principles of Biochemistry. WH Freeman.
8) Murray RK, Granner DK, Mayes PA & Rodwell VW. 2000. Harper's Biochemistry .Appleton & Lange.
9) Narayanan, P. 2005. Essentials of Biophysics, New Age International (P) Ltd., New Delhi, India.
10) Satyanarayana, U. 2005. Biotechnology. Books and Allied (P) Ltd., Kolkata, India.
11) Sparks DL, Page AL, Helmke PA, Loeppert RH, Soltanpour PN, Tabatabai MA,Johnston CT& Sumner ME.(Eds.). 1996. Methods of Soil Analysis: Part 3.Chemical Methods. SSSA-ASA, Madison.
12) Welch PS. 2003. Limnological Methods. Narendra Publ. House.
13) Wilson K & Walker J. 2002. Practical Biochemistry: Principles and Techniques.Cambridge University Press, Oxford.
14) Anderson TW.1984. An Introduction to Multivariate Statistical Analysis.WileySeries in Probability and Statistics, Singapore
15) Biradar RS. 2002. Course Manual on Fisheries Statistics. 2nd Ed. CIFE, Mumbai.
16) Ghosh S. 1999. Multivariate Analysis, Design of Experiments and Survey Sampling.Marcel Dekker.
17) Keller G. 2001. Applied Statistics with Microsoft Excel. Duxbury.
18) William RD & Matthew G. 1984. Multivariate Analysis, Methods and Applications.


| CO-PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
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| **CO2** | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 3 | 2 | 1 |
| **CO3** | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 3 | 2 |
| **CO4** | 1 | 2 | 2 | 3 | 2 | 1 | 2 | 2 | 1 | 1 |
| **CO5** | 1 | 2 | 1 | 3 | 2 | 1 | 1 | 2 | 1 | 3 |



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# ZOO 2.4. (B): Fish Physiology

Course Type: Theory

Course Category: Elective foundation

Credits: 4

**Course Objectives/Course outcomes:**

**CO1:** To introduce the basic concepts about Digestion, role of hormones in regulation of digestion and metabolism.

**CO2:** To study about the concepts of Respiration, Mechanism of gaseous exchange and Circulation.

**CO3:** To discuss about Sensory organs and Osmoregulation.

**CO4:** To study the concepts of Excretion, Reproduction and Development in Fishes.

**CO5:** To study about the Endocrine Organs in fishes and Neuro-Endocrine system in Crustaceans.

**UNIT – I**

Digestion: Digestion of carbohydrates, lipids and proteins; Digestive enzymes and regulation of their secretions; Absorption and assimilation of nutrients; Role of hormones in the regulation of digestion; Factors affecting digestion and transport of nutrients.

Metabolism: Pathways of cellular metabolism.

**Learning Outcome:** Students are able to learn about the concepts of Digestion and Pathways of cellular metabolism

**UNIT – II**

Respiration: Definition of respiration; external respiration and internal respiration.

Mechanism of gaseous exchange, $CO_2$ transport, countercurrent principle, water flow across the gills, respiratory pumps.

Circulation: Role of blood in transport of gases; composition and function of blood.

**Learning Outcome:** Upon completion of the above unit students get awareness about Respiration, Mechanism of Gaseous Exchange and Circulation.

**UNIT – III**

Sensory organs: Structure and function of chemo-, photo- and photoreceptor, lateral line sense organs.

Action potential, synapse, neurotransmitters, impulse transmission.

Osmoregulation: Mechanism of osmotic and ionic regulation; endocrine control of Osmoregulation

**Learning Outcome:** On completion of the unit students are able to identify the structure and function of Sensory Organs and the significance of Action potential and Osmoregulation.



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**UNIT – IV**

Excretion: Mechanism of excretion of nitrogenous waste, water and ionic balance.

Reproduction and Development: Reproductive structure in fishes, Development of gonad: oogenesis, spermatogenesis, metabolic changes during oogenesis and spermatogenesis

**Learning Outcome:** Upon completion of the above unit students are able to understand the concepts of Excretion, Reproduction and Development.

**UNIT –V**

Endocrine system in fishes: Endocrine organs in fishes; Regulation of hormonal control on Reproduction in fishes.

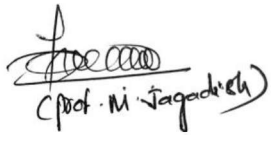
Neuro-endocrine system in crustacean and its role in the regulation of reproduction.

**Learning Outcome:** To understand the Endocrine system in fishes and Neuro-endocrine system in crustaceans.

**REFERENCE BOOKS:**


1) Adiyodi KG & Adiyodi RG. 1971. Endocrine Control of Reproduction in Decapod Crustacea. Biology Reviews.
2) Agarwal NK. 2008. Fish Reproduction. APH Publ.
3) Brown ME. 1966. Physiology of fishes. Vol. I and II Academic Press. New York.
4) Halver JE. 1972. Fish nutrition. Acaemic Press, New York.
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| CO-PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 2 |
| CO2 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 3 | 1 | 2 |
| CO3 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 3 | 1 |
| CO4 | 3 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 1 |
| CO5 | 3 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2 |



# ZOO 2.4. (C): Aquatic Microbiology

Course Type: Theory

Course Category: Elective foundation

Credits: 4

**Course Objectives/Course outcomes:**

**Course Objectives:**

**CO1:** To introduce the concept of cell structure.

**CO2:** To understand the concept of Microbial growth and Microbial Interaction in various Biogeochemical cycles.

**CO3:** To discuss about the Bioprocesses and Microbial Biomass Production.

**CO4:** To study the concepts of Nutritional requirements of Microorganisms and maintenance of cultures and population estimation techniques.

**CO5:** To study about the tests for identification of Bacteria and Basics of Mycological and Virological techniques.

**UNIT – I**

**Cell Structure:** Prokaryotic and eukaryotic cell structure; Cell membrane, cell wall, proteins, nucleic acids – structure, properties and interactions.

**Distribution and classification**: Microbial community in freshwater, estuary and marine environment - types and abundance.

**Learning Outcome:** Students are able to distinguish the cell structure, Microbial community in fresh water, estuary and marine environment.

**UNIT – II**

**Microbial Growth:** Factors influencing microbial growth - Physical, chemical and biological conditions of the environment.

**Microbial interaction:** Role of microbial population in biogeochemical cycles (C, N, P, S, Si and Fe), xenobiotic and in organic pollutants.

**Learning Outcome:** Upon completion of the above unit they are able to understand the concepts of Microbial growth and Role of microbial population in Biogeochemical cycles.

**UNIT – III**

**Bioprocesses:** Principles and applications of bioprocesses - Bioremediation, biofertilization, biofilms, bio-leaching, bio-corrosion, bio-fouling.

Microbial biomass production – single cell protein; Bioprospecting.

**Learning Outcome:** On completion of the unit they are able to differentiate Bioprocesses and Microbial Biomass Production.



**UNIT – IV**

Nutritional requirements of microorganisms – constituents of growth media.

Sterilization and media preparation; Isolation, enumeration, preservation; Maintenance of cultures – growth curve, different types of cultures, population estimation techniques.

**Learning Outcome:** To understand the Nutritional requirements of microorganisms and Maintenance of cultures.

**UNIT – V**

Routine tests for identification of bacteria – morphological, cultural, biochemical and serological.

Basics of mycological and virological techniques. Introduction to molecular techniques in microbiology.

**Learning Outcome:** They are able to apply routine tests for identification of bacteria and basics of mycological and virological techniques.

**REFERENCE BOOKS:**


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| CO-PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2 |
| CO2 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 3 | 1 |
| CO3 | 1 | 3 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 2 |
| CO4 | 1 | 2 | 1 | 3 | 2 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 1 | 2 |



## PRACTICAL – I:

## ZOO P 2.5.: Genetics and Evolution and Comparative Animal Physiology

**Genetics**

1) Genetic disorders – photographs.
2) Genetic exercises/problems based on:
   i) Dihybrid cross.
   ii) Law of independent assortment.
   iii) Multiple alleles.
   iv) Interaction of genes.

**Animal Physiology**

1) Estimation of glycogen.
2) Estimation of proteins.
3) Estimation of lipids.
4) Estimation of haemoglobin.
5) Qualitative identification and estimation of ammonia and urea.

## PRACTICAL – II:

## ZP 2.6.: Research Methodology and Tools and Techniques in Biology

**Research Methodology**

1) **Proteins:** Estimation using the standard Lowry's or Biuret colorimetric assay method.
2) **Carbohydrates:** Estimation using the Anthrone colorimetric method.
3) **Lipids:** Determination of biological lipid quantity via the Sulfophosphovanillin method.

**Tools and Techniques in Biology**

1) Microscopy - description and working methodology.
2) Spectrophotometry - principle and working methodology.
3) Paper chromatography - separation of molecules.
4) Thin layer chromatography - isolation of molecules.
5) Calculation of mean, median, mode, standard deviation and standard error.
6) Analysis of Variance (ANOVA).

