# M.Sc. Zoology

## Scheme and Syllabus


**School of Distance Education**
**Andhra University, Visakhapatnam, Andhra Pradesh**

| S.No. | Paper | M.Sc. Zoology (Previous) |
|---|---|---|
| 1 | Paper - I | Biosystematics, Taxonomy and Gamete Biology |
| 2 | Paper – II | Quantitative Biology, Population Genetics and Evolution |
| 3 | Paper – III | General Physiology and Comparative Endocrinology |
| 4 | Paper IV | Molecular Cell Biology and Tools and Techniques |

| S.No | Paper | M.Sc. Zoology (FInal) |
|---|---|---|
| 1 | Paper – I | Structure, Functions of Invertebrates and Comparative Anatomy of Vertebrates |
| 2 | Paper –II | Population Ecology and Animal Behaviour |
| 3 | Paper – III | Ichthyology and Aquaculture |
| 4 | Paper – IV | Medical Parasitology and Veterinary Parasitology |

## HOW IS M.Sc. ZOOLOGY COURSE BENEFICIAL?

- Candidates after completing the course can enter any field of biological and
- biomedical research.

- They can become researchers, teachers and can be trained in any fields of biology
- within a shortduration. If their past learning outcome in excellent they are fit for doing
- any job in biomedicalfield.
- They have also job scopes in the environmental and ecosystem management sector.
- They have also scopes of career in environmental consulting firms in private sector.

## EXAMS ONE CAN ATTEMPT AFTER COMPLETING M.SC ZOOLOGYCOURSE

- Indian Council of Agricultural Research (ICAR) - ARS- NET Exam
- CSIR/UGC – NET JRF exam in Life Sciences
- Indian Council of Medical Research (ICMR)
- GATE Life Sciences
- Entrance exams conducted by TIFR, NII, NIN, IISC. Etc.
- Indian Forest Service (IFS)
- Union public service commission and State public service commission

## M.Sc. ZOOLOGY EMPLOYMENT AREAS

- Colleges & Universities
- Zoos & National Parks
- Veterinary Sector
- Biotechnology Companies
- Clinical pathology labs
- National scientific institutions like ZSI, FSI etc

## JOB TYPES

- Zookeeper
- Wildlife Rehabilitator
- Zoology Teacher in colleges and Universities
- Wildlife Educator

- Biological Laboratory Technician
- Research Associate
- Research Scientist
- Wild life researcher

**AFTER COMPLETING M.SC ZOOLOGY YOU CAN BECOME**

- Zoology Faculty Member
- Zookeeper
- Animal rehabilitator
- Animal Caretakers
- Online tutor
- Zoo Curator
- Wildlife Biologists
- Research Associate
- Animal breeders
- Fishery consultant
- Aquaculture entrepreneur

**ADVANCED DEGREES – RESEARCH**

- **Ph.D**

**Program outcomes (POs):**

After successfully completing the M.Sc. Zoology program students will be able to:

PO1.
Zoology knowledge: Apply the knowledge of Zoology, Life Sciences and allied subjects to the understanding of complex life processes and phenomena and equip with recentadvances in Zoology from organismic to reductionist biology.

PO2.
Problem analysis: It also aims to empower students to understand the challenges of society and the country that falls into the realms of Zoology, such as Aquaculture,

Reproductive health, Parasitology, Cancer Biology, Microbiome and their ecology, Geneticsand Cytogenetics and their roles in health and diseases, etc.

PO3.
Design/development of solutions: Design processes/strategies that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.
Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, andsynthesis of the information to provide valid conclusions in real situations.

PO5.
Modern tool usage: Create, select, and apply appropriate techniques, resources, and ICT tools for understanding of the subject.

PO6.
The Postgraduate and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional practice.

PO7.
Environment and sustainability: Understand the impact of the natural and anthropogenic activities in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. Identify a range of invertebrates andvertebrates and justify their conservation.

PO8.
Communication: Communicate effectively on complex life activities with the scientific community and with society at large, such as, being able to comprehend and writeeffective reports and design documentation, make effective presentations, and give andreceive clear instructions.

PO9.
Project management and finance: Demonstrate knowledge and understanding of Zoology and management principles and apply these to one‟s own work, as a member andleader in a project team.

**Programme Specific Outcomes (PSOs):**

PSO 1.
It is expected that a student after successfully completing four semesters of M.Sc. in Zoology Programme would sufficiently be skilled andempowered to solve the problems in the realms of Zoology and its alliedareas.

PSO 2.
They would have plethora of job opportunities in the education,environment, Aquaculture, disease based, and health related sectors.

PSO 3.
The bright and ignited mind may enter into research in the contemporaryareas of Zoological/ Life Sciences.

PSO 4. The broad skills and the deeper knowledge in the field would make themhighly successful and excellent researcher in advanced areas of researchin the biological sciences.

**M.Sc ZOOLOGY 1 YEAR**
**ZOOLOGY-SYLLABUS (Previous)**

## PAPER-I: BIOSYSTEMATICS, TAXONOMY AND GAMETE BIOLOGY

### Course Specific Objectives

- The aim if the study is to discover and describe new biological diversity and equip the
- student in understanding evolutionary and biogeographic origins and relationships.
- Career options available as interns‟ natural science managers, park rangers, specimen
- collector, teachers research-based jobs both in private and public sector as JRF and SRF
- Aims to provide a thorough understanding on the fundamental concepts of developmentalbiology and introduce the students to the knowledge on early embryonic development.
- Provides variety of opportunities in career to work in various health care centers.etc.,

### Course Objectives:

CO 1. To obtain knowledge on basic concepts of biosystematics & taxonomy
CO 2. To learn about trends in biosystematics
CO 3. To know about species Concept
CO 4. To have knowledge on conservation of biodiversity
CO 5. To learn about taxonomic procedures, keys & ICZN
CO 6. To impart knowledge on basic concepts of development
CO 7. To learn about gametogenesis, fertilization & early development
CO 8. To have knowledge on morphogenesis and organogenesis
CO 9. To know about the advanced technologies
CO 10. To gain knowledge on assisted reproduction technologies & contraceptive measures

### PART-A

1.0 Definition and basic concepts of biosystematics and taxonomy: Historical resume of systematics; Importance and applications of biosystematics in biology; Material basis of biosystematics - different attributes.

2.0 Trends in biosystematics - concepts of different conventional and newer Aspects: Chemo taxonomy; Cytotaxonomy; Molecular taxonomy.

3 Molecular perspective on the conservation of diversity: Diversity and ecosystem process: theory, achievements site and future directions.

4.0 Dimensions of speciation and taxonomy characters: Dimensions of speciation - types of lineage changes, production of additional lineage; Mechanisms of speciation in panmictic and apomictic species; Species concepts - species category, different species concepts; sub species and other infra specific categories; Theories bem of biological classification, hierarchy of categories: Taxonomic characters - different kinds, origin of reproductive isolation - biological mechanism of genetic incompatibility.

5.0 Procedure keys in taxonomy: Taxonomic procedures - taxonomic collections, preservation, curetting process of identification; Taxonomic keys - different kinds of taxonomic keys, their merits and demerits; Systematic publications - different kinds of publications; Process of typification and different Zoological types, International code of Zoological Nomenclature (ICZN), its operative principles, interpretation and application of important rules, Zoological nomenclature; formation of scientific names of various taxa.

6.0 Evaluation of biodiversity indices: Shannon - Weiner index; Dominance index; Similarity and dissimilarity index; Association index.

**PART-B**

1.0 Heterogamy in eukaryotes.
2.0 Comparative account of differentiation of gonads in a mammal and an invertebrate.
3.0 Leydig cells: Morphology and Differentiation; Function and its regulation.
4.0 Spermatogenesis: Morphological basis in Rodents; Morphological basis in any invertebrates; Gamete specific gene expression and genomic.

5.0 Biochemistry of semen: Semen composition and formation; Assessment of sperm functions; Y-specific probes.
6.0 Fertilization: Pre-fertilization; Biochemistry of fertilization; Post-fertilization events.

7.0 Collection and cryopreservation of gametes and Tough embryos.

8.0 Ovarian follicular growth and differentiation: Morphology; Endocrinology; Molecular Biology; Oogenesis and Vitellogenesis; Ovulation and ovum transport in mammals.

9.0 Biology of sex-determination and sex-differentiation, a comparative account.

10.0 Multiple ovulation and embryo transfer technology (MOETT); In vitro oocyte maturation; Super ovulation; In vitro fertilization.

11.0 Transgenic animals and knock-outs: Production; Applications: Embryonic stem cells.

12.0 Assisted reproduction technologies: Embryo sexing and cloning; Screening for genetic disorders; ICSI, GIFT etc.; Cloning of animals by nuclear transfer.

13.0 Teratological effects of Xenobiotics.

14.0 Immunocontraception: Gamete specific antigens; Antibody mediated fertilization block and termination of gestation; other contraceptive technologies; Surgical Sus methods; Hormonal methods; Physical methods; IUCD.

**SUGGESTED READING MATERIAL:**


1. M. Kato. The Biology of Biodiversity, Springer.
2. J.C. Avice. Molecular Markers, Natural History and dition Evolution, Chapman & Hall, New York.
3. E.O. Wilson. Biodiversity, Academic Press, Washington.
4. GG Simpson. Principle of Animal Taxonomy; Oxford IBH Pub. Company.
5. E. Mayer. Elements of Taxonomy.
6. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northern & Co.
7. B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta.
8. Austen, C.R. and Short, R.V. Reproduction in animals.
9. Schatten and Schatten. Molecular biology of fertilization.
10. F.T. Longo. Fertilization, Chapman & Hall.
11. R.G. Edwards. Human Reproduction.


**Learning Outcomes:**

LO 1:
After completion of this course, students are able to LO1. Classify animals on the basis of their relation to other animals by body structure, external characters, development and DNA

LO2.
Apply the International rules of nomenclature to give a scientific name to animals which are found during research.

LO3.
Understand the gradual development and evolutionary history of different kinds of living organisms from earlier forms over several generations

LO4.
Understand and demonstrate various animals, biodiversity and related indices

LO 5: Will master the foundational knowledge that defines the field of developmental biology

LO 6: Will gain the knowledge of main anatomical changes that occur during development

LO7: Will acquire knowledge on advanced technologies in reproductive biology

**PAPER-II:QUANTITATIVEBIOLOGY,POPULATIONGENETICS ANDEVOLUTION**

**Course Specific Objectives**

- A skill-oriented course which will enable the students to arrange and analyze large data sets
- collected from various sources and infer results based on assumptions.
- The knowledge in bioinformatics helps the students to find employability in biological labs
- dealing with large biological data
- Helps in understanding how and why changes in gene frequencies and genotype
- frequencies lead to the sudden appearance of disease related recessive alleles in the
- population.
- To pursue career as geneticist in population study centres and various molecular labs.

**Course Objectives:**

CO 1:

This course is meant to impart knowledge to students on the most import skill which is required in this era for any scientific worker on statistical analysis.

CO 2:

The course is designed in such a way that the students get the confidence to use statistics for the daily design of experiments, data collection, and analysis of results.

CO 3:

To understand explosion, nature and types of biological data and its role in biological research to solve biological problems.

CO 4.

To learn basic concepts of representing biological data and analyzing the data using central tendency and deviation methods.

CO 5:
To understand the methodology for laying hypothesis and proving or disproving the hypothesis using different significance tests.

CO 6: In-depth knowledge into the area of Population genetics.

CO 7: let the students have an understanding of the implications and conditions under which gene and genotype frequencies change and/or remain the same

CO 8:
Help the students realize the principles underlying the Hardy-Weinberg law and its application

CO 9:
Understand the actual forces that drive evolution, sources of variation and the principle of natural selection.
CO 10:
Through understanding of Quantitative genetics and its applications and the idea of construction of Phylogenetic trees using molecular data.

**PART-A**

1.0 Basic Mathematics for Biologists: Matrices and vectors; Exponential functions; Periodic functions; Differential equations, integration.

2.0 Bio statistics: Introduction and scope of bio statistics, application of statistics in biology, concept of sampling, frequency distribution, sampling errors, sample size, probability, skew ness and kurtosis; Graphic presentation of data, measurement of central tendency, mean, mode and median, standard deviation and standard error; Distributions: binomial, poisson and normal; Test of significance, paired and unpaired t-test, chi-square analysis; Analysis of variance; Correlation and regression.

3.0 Mathematical Modelling: Types of models-statistical; mechanistic; stochastic; simulation etc.; Properties of models generality, precision, realism; Building a model- Inox planning (conceptualisation) implementation, evaluation, sensitivity analysis; Detailed treatment of selected specific models from different areas of Biology (examples) i.e. Ann Cycling of nutrients in an ecosystem/eutrophication model; Optimal clutch size in birds; Morphogenesis and Genetic drift.

**PART-B**

1.0 Concepts of evolution and theories of organic evolution with emphasis on Darwinism.
2.0 Neo-Darwinism: Hardy Weinberg law of genetic equilibrium; A detailed account of destabilizing forces (i) natural selection (ii) Mutation (iii) Migration.
3.0 Quantifying genetic variability: Genetic Structure of natural populations; Phenotypic variation; Models explaining changes in genetic structure of population; Factors affecting human diseases frequency.
4.0 Genetics of quantitative traits in populations: Analysis of quantitative traits; Quantitative traits and natural selection; Estimation or habitability; Genotype-environment interactions; Interbreeding depress and heterosis.
5.0 Genetics of speciation: Phylogenetic and biological concept of species; Patterns and mechanisms of reproductive isolation; Models of speciation (Allopatric, Sympatric, Parapatric).
6.0 Molecular evolution: Gene evolution; Evolution of gene families; Molecular drive.
7.0 Origin of higher categories: Phylogenetic gradualism and punctuated equilibrium; Micro- and macro-evolution.
8.0 Molecular Phylogenetic: How to construct Phylogenetic trees? Immunological techniques; Amino acid w phylogeny-DNA-DNA hybridizations, Restriction Enzyme sites, Nucleotide sequence comparisons and homologies; Molecular clocks,

**SUGGESTED READING MATERIAL:**


1. Batschelet, E., Introduction to Mathematics for Life Scientists. Springer Verlag, Berling.
2. Jorgensen, S.E., Fundamentals of Ecological Modelling. Elsevier, New York.
3. Swaritzman, GL. and S.P.O. Kaluzny. Ecological Simulation Primer. Macmillan, New York.
4. Lendren, D. Modelling in Behavioural Ecology. Chapman & Hal. London. U.K.
5. Sokal, R.R. & F.J. Rohlf. Biometry. Freeman, San Wobot Francisco.
6. Snedecor, G. W. and W.G. Cochran, Statistical methods for environmental biologists. John Wiley & Sons, New York.
7. Murray, J.D. Mathematical Biology. Springer-Verlag, In Berlin.
8. Pielou, E.C. The Interpretation of Ecological Data: A Primer on Classification and Ordination.
9. Dobzhansky, Th. Genetics and origin of Species. Colombia University press.
10. Dobzhansky, Th., F.J. Ayala. G.L. Stebbens and J.M. Valentine. Evolution. Surjeet Publication, Delhi.
11. Futuyama, D.J. Evolutionary Biology. Suinuaerbasma Associates, INS Publishers. Dunderland.
12. Hartl, D.L. A Primer of population Genetics. Sinauer Associates, INC. Massachusetts.

13. Jha, A.P. Genes and Evolution. John Publication, New Delhi
14. King, M. Species Evolution- the role of chromosomal change. The Cambridge University Press, Cambridge.
15. Merrel, D.J. Evolution and genetics. Oxford University Press, New York.
16. Strikberger, M.W. Evolution. Jones and Bartett Publishers, Boston London

Course Learning outcomes:

LO 1: Recognize importance and value of logical and statistical thinking, training, and approach to problem solving, in the discipline of biological sciences.

LO 2: Can condense the given raw data and present diagrammatically & graphically. Calculate the central tendency value of mean, median, mode for the given data.

LO 3: Estimate the deviation among the raw data from the central tendency value.

LO 3: Identify and choose correct statistical method to analyze the data

LO 4: Lay down the hypothesis and subject it to validation using significance tests.

LO 5: Correlate the two variables and able to make regression lines for prediction of correct observation in the data.

LO 6: This course will make them suitably knowledgeable to undertake biostatistical based jobs in the Scientific institutes, in addition to the teaching institutions

. LO 7: know how knowledge on Population genetics will help in understanding the disease frequency in the populations.

LO 8: analyze as well as assesses the implications of changes in gene and genotype frequencies.

LO 9: Know the significance of Quantitative traits, their quantification, and importance in applied aspects.

LO 10: Utilize the acquired knowledge for research and employability in academic institutions.

## PAPER-III: GENERAL PHYSIOLOGY AND COMPARATIVE ENDOCRINOLOGY

**Course Specific Objectives**

- Focuses on how organisms survive, work and function and help in understanding how
- interaction of biological, physical and chemical aspects are necessary for the survival of
- the organisms.
- Provides placements as a physiologist in fitness centres for health monitoring.

- Animal behaviour program – encompasses many areas of study including, physiology,
- anatomy, psychology, neuroscience and more.
- The student may have career opportunities in animal behaviour training and veterinary
- clinical settings as veterinary assistants, animal care takers at ex-suit conservation centres.

**Course Objectives:**

CO 1. To obtain knowledge on levels of adaptation
CO 2. To learn about extreme environment
CO 3. To gain knowledge on physiology of homeostasis & stress
CO 4. To impart knowledge on chemical and neural integration
CO5. To learn about physiology of endocrine glands in vertebrates
CO 6. To have knowledge on neuro-endocrine mechanisms in invertebrates
CO 7. To know about the comparative physiology of vertebrate hormones

**PART-A**

1.0 Adaptation: Levels of adaptation; Mechanisms of adaptation; Significance of body size;

2.0 Physiological adaptations to different environments: Marine Shores and Estuaries; Freshwater Extreme aquatic environments; Terrestrial Life-Extreme terrestrial environment; Parasitic habitats.

3.0 Stress Physiology: Basic concept of environmental stress brand strain; concepts of elastic and plastic train; stress abial resistance, stress avoidance and stress tolerance; Adaptation, acclimation and acclimatization; Concept of homeostasis; Endothermic and physiology mechanism of regulation of body temperature; Physiological adaptation to osmotic and ionic stress; mechanism of cell volume regulation; Osmoregulation in aqueous and terrestrial environments; Physiological response to oxygen deficient stress; Physiological response to body exercise; Meditation; Yoga and their effects.

**PART-B**

1.0 Aims and scope of endocrinology: hormones as messengers; hormones and eukaryotic metabolic gion regulation; Classification of hormones; Discovery of hormones; Experimental methods of hormone research; 8. Validity of comparative study of hormones.
2.0 Phylogeny of endocrine glands (Pituitary, pancreas, adrenals, thyroid. etc.)
3.0 Ontogeny of endocrine glands.
4.0 Neuroendocrine system Neurosecretion.
5.0 General principles of hormone action: Nature of hormone action; Concept of Hormone receptors; Hormones and homeostasis; Hormonal regulation of carbohydrates, nitrogen and lipid metabolism; Hormones and behavior, Termination of hormone action.
6.0 Hormone structure and evolution: Chemical nature and gross features of hormones; Evolution of protein hormones and their receptors.
7.0 Biosynthesis and secretion of hormones: Hormone lends in circulation and other body fluids; Biosynthesis of steroid hormones de novo; Biosynthesis and amino acid derived small size hormones (e.g. T4 epinephrine, etc.); Biosynthesis and simple peptide hormone Pre and Pro- hormones; Co-translation and post-translation modifications of hormone structure.
8.0 Metabolism of hormones.
9.0 Hormones, and behavior
10.0 Hormones and Growth and, Development.
11.0 Hormones and Reproduction: Seasonal breeders; Continuous breede

**SUGGESTED READING MATERIAL:**


1. E.J.W. Barrington, General and Comparative Endocrinology. Oxford, Clarendon Press.
2. P.J. Bentley, Comparative Vertebrate Endocrinology. Cambridge University Press.
3. R.H. Willims. Textbook of Endocrinology. W.B. Saunders.
4. C.R. Martin. Endocrine Physiology. Oxford Univ. Press.
5. A. Gorbman et. al. Comparative Endocrinology. John Wiley & Sons.
6. Eckert, R. Animal Physiology; Mechanisms and adaptation. W.H. Freeman and Company, New York.
7. Hochachka, P.W. and Somero, G.N. Biochemical adaptation. Princeton, N.J.
8. Hoar, W.S. General and comparative Animal Physiology, Prentice Hall of India.
9. Schiemdt Nielsen. Animal Physiology; Adaptation and Environment Cambridge.
10. Strand, F.L. Physiology. A regulatory systems approach. Macmillan Publishing Co. New York.
11. Punmer, L. Practical Biochemistry, Tata McGraw-Hill. 12. Prosser, C.L. Environmental and Metabolic Animal Physiology. Wiley-Liss Inc., New York.
13. Wilson, K. and Walker, J. Practical Biochemistry.

14. Willmer, P./G. Stone and I. Johnson. Environmental Physiology. Blackwell Sci. Oxford, UK. 944 pp.
15. Newell. R.C. (ed.) 1976. Adaptation to environment. Essays on the physiology of marine animals. Butterworths, London, UK. 539 pp.
16. Townsend, C.R. and P. Calow. Physiological Ecology. An evolutionary approach, To resource use, Blackwell Sci. Publ. Oxford. UK.
17. Dejours, P.L. Boils, C.R. Taylor and E.R. Weibel (eds.). Comparative physiology; Life in water and on Land, Liviana Press, Padova, Italy.
18. Johnston, I.A & A.F. Bennett (eds.) Animals and Temperature: Phenotypic and evolutionary adaptation. Cambridge Univ. Press, Cambridge, UK.
19. Louv, G.N. Physiological animal ecology. Longman Harloss, UK.

**Student Learning Outcomes:**

LO 1: Student will have an enhanced knowledge and appreciation of adaptation
LO 2: Understand the functions of important extreme habitats
LO 3: Understand how these separate systems interact to yield integrated physiological responses to different challenges
LO 4: Will be able to perform, analyze and report on experiments and observations in Physiology
LO 5. Will be familiar with the mechanism of hormone action
LO 6: Will have knowledge of physiology of vertebrates hormones
LO 7: Will learn about neuro-endocrine mechanisms in invertebrates
LO 8: Will get an understanding of comparative aspects of vertebrate hormones
LO 9: Will be familiar with approaches and methods in study of animal behavior

## PAPER-IV: MOLECULAR CELL BIOLOGY ANDTOOLS AND TECHNIQUES

**Course Specific Objectives**

- To gain a better picture of the cellular environment with greater understanding of how cellular processes are regulated at the molecular level
- This knowledge helps in finding placement opportunities in research labs, and also inR&D departments of various biological fields.
- A skill-oriented course where students equip themselves with new methods andtechniques for microscopy, chromatography, ultracentrifuge, SEM, TEM etc., which will help in studying fine structure and composition of various organisms
- The knowledge gained may help them to find a placement in some technological labs.

**Course Objectives:**

CO 1: Acquire the knowledge about the complex organization in the eukaryotic cell and themolecular mechanisms of cellular processesthat exist in all cell types.
CO 2: Design and develop models and Sketch for various types of cells and cell organelles.
CO 3: Illustrate the chemistry and organization of cytoskeleton.
CO 4: Explain the concepts of cell signaling
CO 5: Diagrammatically represent the cell cycle phases and its regulation. Can make models.
CO 6: Understand the fact that as we go down the scale of magnitude from cells to .organelles to molecules, the understanding of various biological processes becomes deeper and inclusive.
CO 7. To learn about microscopy
CO 8. To have knowledge on microbiological and cell culture techniques
CO 9. To learn about radiation techniques and electrophysiological methods

**PART-A**

1.0 Introduction: Experimental system in Cell Biology.
2.0 Biomembranes: Molecular composition and arrangement, functional consequences; Transport across cell membrane: diffusion, active transport and pumps, uniports, symports and antiports; Membrane potential; Co-transport bysymporters or antiports; transport across epithelia; Transport of macromolecules.
3.0 Cytoskeleton: Microfilaments and microtubulus-structure and dynamics; Microtubulus and mitosis; Cell movements-intracellular transport, role and kinesin and dyein, signal transduction mechanisms.
4.0 Cilia and flagella
5.0 Cell-Cell Signalling: Cell surface receptors; Second Intrance messenger system; MDP kinase pathways; Signallingalemin from plasma membrane to nucleus.
6.0 Cell-Cell adhension and communication: Ca++ golod dependent homophillic cell-cell adhesion; Ca++ independent homophillic cell-cell adhesion; Gap Junctions and connections.
7.0 Cell matrix adhesion: integrins; collagen; Non-collagen no components; Auxin & Cell expansion; Cellulose fibril synthesis and gradientation.
8.0 Cell cycle: Cyclines and cyclin dependent kinases; Regulation of CDK-cycline activity.
9.0 Genome organisation: Hierarchy in organization; Chromosomal organisation of genes and non-coding DNA; Mobile DNA; Morphological and functional elements of eukaryotic chromosomes.
10.0 Intracellular protein traffic: protein synthesis on free and bound polysomes; uptake into ER membrane proteins, Golgi sorting, post-translational modifications; Biogenesis of mitochondria and nuclei; Trafficking mechanisms.
11.0 Apoptosis-definition, mechanism and significance.

**PART-B**

1.0 Assay: Definition and criteria of reliability; Chemical assays; Biological assays - in vivo and in vitro assays.

2.0 Principle and uses of analytical instruments - balances, Ob pH meter, colorimeter, spectrophotometer, ultracentrifuge, densitometer scanner, spectrophotometer, chemiluminometers, radioactivity counter, differential De scanning calorimeter, ESR and NMR spectrometers.

3.0 Microscopy - Principles of light transmission, electron, ndal phase-contrast, fluorescence, electron cryo, confocal, scanning electron microscopes, Microphotography. Image analysers.

4.0 Microbiological techniques: Media preparation and sterilization; Inoculation and growth monitoring Use of pfomenters; Biochemical mutants and their use; Microbial blu assays.

5.0 Cell culture techniques: Laboratory facilities; Substrates on which cells grow; Treatment of substrate surfaces; Feeder layers; Culture media.

6.0 Separation techniques in biology: Molecular separations by chromatography, electrophoresis, precipitation etc.; Organelle separation by centrifugation etc.; Cell oil separation by density gradient centrifugation, unit gravity centrifugation, affinity adsorption, and anchorage-based techniques etc.

7.0 Computer aided techniques for data presentation, data analyses, statistical techniques.

8.0 Radioisotope and mass isotope for radioactive counting: Sample preparation for radioactive counting: Autoradiography; metabolic labelling.

9.0 Immunological techniques based on antigen-antibody interaction.

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**SUGGESTED READING MATERIAL:**


1 Molecular Cell Biology, J. Darnell H. Lodish and D. Baltimore Scientific American Book INC., USA.

2 Molecular biology of the cell, B. Alberts, D. Bray, J. Lewis, M. Raff. K. Roberts, and J.D. Watson Garland publishing Inc., New York.

3. Animal cell culture - A Practical approach, Ed. John.R.W. Masters, IRI Press.

4. Introduction to Instrumental Analysis. Robert Braun. McGraw Hill International Editions.

5 A Biologist Guide to Principles and Techniques of Practical Biochemistry, K. Wilson & K. H. Goulding, ELBS Edn.


**Course Learning outcomes:**

Lo1: `Understand how the cell functions as a unit of life and its organelles.

Lo2: Gain knowledge about the techniques and experiments that contributed to the understanding of molecular mechanisms of the cellular processes.

Lo3: Be able to draw parallels between the physiological processes at the cellular and organismic levels.
Lo4: Appreciate the importance of cell-cell adhesion and the extracellular matrix in the evolution of multicellular organisms.
Lo5: Acquire knowledge on cell cycle and cell signaling.
Lo6: Understand the mechanism of Cell Communication.
Lo7: Know about the complex organization of Chromosomes and Genes.
LO8. Student will learn about the basics of most often used tools, techniques, methodologies and methods of analysis used in biological research.
LO 9. Student will become comfortable and proficient, working in the lab and in the field

**PRACTICAL-I**

1. Examples representing the different taxa in the order of evolution; Methods of collection, preservation and identification of plankton and representative forms of terrestrial and aquatic fauna.
2. Types of eggs; 2. Clevage, Blastulation, Gastrulation Frog/Amphioxus/Chick; Testis section Human Ovary Section Human; Mounting spermatozoa - Grasshopper/ Frog/Chick/Rat.
3. Population genetics: Calculating gene frequencies and genotype frequencies for Autosomal dominant traits; Autosomal recessive traits. Using Binomial distribution; Quantitative Genetices, Mean, Standard Deviation, Chi- Square & Variance.

**PRACTICAL-II**

1. Oxygen consumption vs. temperature; Osmotic regulation; Ion Concentration measurements.
2. Cockroach - Carporacardiaca&Carporaallata; Prawn -Nervous system, y-organ & androgenic organ, ovaries; Crab- Nervous system, y-organ & androgenic organ, ovaries; Sepia - Optic glands; Fish - Endocrine glands: Pituitary gland, Pancreas, adrenals, testis and ovaries; Chick-Endocrine glands: Pituitary, Pancreas, adrenals, testis and ovaries.
3. Light microscopic examination of tissues; Preparation of different cell types Hepatic parenchyma cells, Madipocytes, macrophages, neuronal cells, epithelial cells; Stages of Mitosis and Meiosis; Squash preparation; Sub cellular fractionation-separation of macromolecules.

## M.Sc ZOOLOGY 2 YEAR

## ZOOLOGY-SYLLABUS (Final)

## PAPER-1: STRUCTURE AND FUNCTION IN INVERTEBRATESa

### PART-A

### Course Objectives

CO1 Describe general taxonomic rules on animal classification

CO2 Classify Protozoa to Coelenterata with taxonomic keys

CO3 Classify Phylum Platy helmninthes to Annelida phylum using examples from parasitic adaptation and vermin composting

CO4 Describe Phylum Arthropoda to Mollusca using examples and importance of insects and Molluscans

CO5 Describe Echinodermata to Hemi chordata with suitable examples and larval stages in relations to phylogeny

CO6 To instill knowledge across different Areas of chordates

CO7 To acquire knowledge on the life cycles and mode of reproduction in different vertebrates

CO8 To understand the systemic and functional morphology of various groups of chordates,

CO9 To study their economic importance, affinities and adaptations

### Learning objectives

1. To understand the taxonomic position of protozoa to helminthes.
2. To understand the general characteristics of animals belonging to protozoa to hemichordata.
3. To understand the structural organization of animals phylum from protozoa to hemichordate
4. To understand the origin and evolutionary relationship of different phyla from protozoa to hemichordata.
5. To understand the origin and evolutionary relationship of different phylum from annelids to hemichordates.relation to the phylogeny

1.0 Principles of animal taxonomy
- 1.1 Species concept: International code of Zoological nomenclature
- 1.2 Taxonomic procedures: New trends in taxonomy
- 1.3 Animal collection, handling and preservation

2.0 Organisation of coelom
- 2.1 Acoelomates, Pseudoelomates
- 2.2 Coelomates: Prostomidia and Deuterostomidia

3.0 Locomotion
- 3.1 Flagella and ciliary movement in Protozoa
- 3.2 Hydrostatic movement in Coelenterata, Annelida and do? Echinodermata

4.0 Nutrition and Digestion
- 4.1 Patterns of feeding and digestion in lower metazoan
- 4.2 Filter feeding in Polychaeta, Mollusca and Echinodermata.

5.0 Respiration
- 5.1 Organs of respiration: Gills, lungs and trachea
- 5.2 Respiratory pigments 5.3 Mechanism of respiration

6.0 Excretion
- 6.1 Mechanisms of excretion
- 6.2 Excretion and Osmoregulation

7.0 Nervous system
- 7.1 Primitive nervous system: Coelenterata and Echinodermata
- 7.2 Advanced nervous system: Annelida, Arthropods (Crustacea and insecta) and Mollusca (Cephalopoda)

8.0 Invertebrate larvae
- 8.1 Larval forms of free living invertebrates
- 8.2 Larval forms of parasites
- 8.3 Strategies and Evolutionary significance of larval alman forms

9.0 Minor phyla
- 9.1 Concept of significance
- 9.2 Organisation and general characters

PART-B

COMPARATIVE ANATOMY OF VERTEBRATES

1.0 Origin of Chordata
- 1.1 Concepts of Protochordata

2.0 The nature of vertebrate morphology
- 2.1 Definition, scope and relation to other disciplines
- 2.2 Importance of the study of vertebrate morphology

3.0 Origin and classification of vertebrates

4.0 Vertebrate Integument and its derivatives
- 4.1 Development, general structure and function of skin and its derivatives
- 4.2 Glands, scales, horns, claws, nails, hoofs, feathers and hairs

5.0 General plan of circulation in various groups
- 5.1 Blood
- 5.2 Evolution of heart
- 5.3 Evolution of aortic arches and portal systems

6.0 Respiratory system
- 6.1 Characters of respiratory tissue
- 6.2 Internal and external respiration
- 6.3 Comparative account of respiratory organs

7.0 Common Indian vertebrates: Fishes, amphibians, reptiles, birds & mammals

8.0 Evolution of urinogenital system in vertebrate series

9.0 Sense organs
- 9.1 Simple receptors
- 9.2 Organs of Olfaction and taste
- 9.3 Lateralline system
- 9.4 Electroreception

10.0 Nervous system
- 10.1 Comparative anatomy of the brain in relation to its functions
- 10.2 Comparative anatomy of spinal cord
- 10.3 Nerves-cranial, peripheral and autonomous nervous systems

**PRACTICAL-A:**

1. Nervous system: Crab; Sepia/Loligo
2. Mounting Nephridium and Spermatotheca in Earthworm
3. Respiratory system: Mounting of Gills, Trachea and Book lungs

| | | |
|---|---|---|
| Protozoa | : | Gregarines, Monocystis, Cerat/um, Euplotes, Didinium, Nocthuca, Adiolarin, Stentor, Opalina |
| Porifera | : | Sectonal view of Sycon (T.S., L.S) Grant/a (TS) |

Cridaria : Slides of Obelia polyp and medusa Pennaria, Aurelia -Tentacukxysts, Museum specimens of Virgularia, Spongodus, Zooanthus, Faviana

Helminths : Slides of Temnocephala Museum specimens of Ascaris fumbricoides, Teaneasolium, planaria

Annelids : Slides of Ozobranchus, Gtossiphonia

Museum specimens of Eunice, Chloieaftava, Potynoe, Terrebella, Eurythoe, Chaetrpterus

Arthropods : Slides of Balanus, Lepas, PaHnums, Uca, PyenaHippa, Gongy/us Beostoma, Limulus, Squilla, Eupagurus

Mollusca : Museum specimens of Dolbella, Pteria, Nerita, Blood no/aria Lambis, Tridanca, onchidium, Olivia, TuirriteHa, Buff/a, Card/urn, Area

Echinodermata: Museum specimens of Echinodiscus, HolothuriaAntedon Museum specimens of minor phyla Phorwis, Dendrostoma.

Fossil specimens: Aurelia, Planula, Redia, Cerearia, Filiform of strong yloides, Trochophore Nauplias, Zoea, Mysis, Phyilosoma, Trilobite larvae of Limulus, Antlion, Velliger, Bipinaria, Opbio and Echinopluteus, Auricularia, Tornaria

**PRACTICAL-B:**

1.Dissections : Trichiurus/ScoHodon - Digestion, Reproductive, Arterial, Venous systems. Neck nerves

2. Museum specimens and slides:

Protochordates - Salpa-sexual, Salpa-asexual, Bortyllus, Herdamania Fishes - Rhinobatus, amera, Acipenser, Amia, Periothalamus, Triacanthus; NotopterusScatophaousaraus, Trichluans, astacembalusarmatum, Exocoetus (flying fish), Diodonhysterix, Echenesneucrates

Amphibians - Icthyophls, Geganophis, Rhachophorus, Rana tigrina, Amblystoma

Reptiles - Sitana, Chameleon, Phynosoma, Chelone mydas

Birds - Indian Oriole, Indian Koel (male), Indian koel (female), Indian tailor bird,

kite, jungle fowl

Mammals - Indian otter. Marmoset, Loris Bat (Megaderma lyra), Pangolin Skull and lower jaw of Chelonia, Crocodile, Bird, Carnivore mammal (dog).

Herbivore mammal (horse)

Types of vertebratae of Procoelus. Opisthocoelus, Amphycoelus,

Amphiplatins, Heterocoelus, Axis and atlas vertebrate.

**SUGGESTED READING MATERIALS**

**Part-A:**


1. Hyman, L.H.theinverstbrates. Vol. Protozoa through etenophora, McGraw Hill Co. New York.
2. Barrington, E.J.W. Invertebrate structure and function. Thomas. Nelson and Sons Ltd. London.
3. Jagerstein, G Evolution of metazoan life cycle. Academic Press , New York .
4. Hyman, I.H. The invertebrates. Vol. 2 McGraw Hill Co., New York.
5. Hyman, I.H. The invertebrates. Vol. 8 McGraw Hill Co., New York.
6. Barnes, R.D. Invertebrate Zoology, III Edition W.B. Saunders Co. Philadelphia.
7. Russel-Hunter, W.D.A. Biology of higher invertebrates.TheMacmilian Col Ltd., London.
8. Hyman, I.H. The invertebrates smaller coelomate groups. Ters Vol. V. McGraw Hill Co., New York.
9. Read, C.P. Animal paratis'm. Prentice Hall Inc., New Jersey
10. Sedgwick, A.A. Student textbook of Zoology, Vol.II and III. Central Book Depot, Allahabad.
11. Parker, T.J., Haswell, W.A. Textbook of Zoology, Macmilian Co., London.


**Part B:**


1. Alexander, R.M. The Chordata. Cambridge University Press, London.
2. Barrington, E.J.W. The biology of Hemichordata and protochordata. Oliver and Boyd, Edinbourgh.
3. Bourne, GH. The structure and functions of nervous tissue, Academic Press, New York.
4. Carter, G.S. Structure and habit in vertebrate evolution. Sedwick and Jackson, London.

5. Eecles, J.C. The understanding of the brain. McGraw H Co. New York and London.
6. Kingsiey, J.S. Outlines of comparative autonomy of vertebrates. Central Book Depot, Allahabad.
7. Kent, C.G. Comparative anatomy of vertebrates.
8. Malcom Jollie. Chordate morphology. East-West Press Pvt. Ltd., London.
9. Milton Hilderbrand. Analysis of vertebrate structure. IV Ed. John Wiley and Sons Inc. New York.
10. Monielli A.R. The chordates. Cambridge University Press, London.
11. Smith, U.S. Evolution of chordate structure. Hold Rinehart and Winstoin Inc., New York.
12. Sedwick, A.A. Students textbook of Zoology, Vol. 11
13. Tensley, K Vision in vertebrate. Chapman and Hall Ltd., London.
14. Torrey, T.W. Morphogenesis of vertebrates, John Wiley and Sons Inc., New York.
15. Walters, H.E. and Syles, L.D. Biology of vertebrates Macmilian& Co., New York.

Learning Outcome

• To understand the importance of preservation of museum specimens

• To identify animals based on special identifying characters

• To understand different organ systems through demo or virtual dissections

• To maintain a neat, labeled record of identified museum specimens

## PAPER-II: POPULATION ECOLOGY

### Course Specific Objectives

- Helps in understanding how and why changes in gene frequencies and genotype frequencies lead to the sudden appearance of disease related recessive alleles in the population.
- To pursue career as geneticist in population study centres and various molecular labs.

**Course Objectives:** At the successful completion of the Course, the student gets

CO 1: In-depth knowledge into the area of Population genetics.

CO 3: introduce the principles underlying the genetics of populations

CO 4: let the students have an understanding of the implications and conditions under which gene and genotype frequencies change and/or remain the same

CO 6: Help the students realize the principles underlying the Hardy-Weinberg law and its application .

CO 7: The idea of construction of Phylogenetic trees using molecular data.

CO 8: The scope and areas of application of Population genetics Understand types of animal behaviour and their importance to the organisms.

CO 9: Enhance their observation, analysis, interpretation and documentation skills by taking short projects pertaining to Animal behaviour and chronobiology.

CO 10: Realize, appreciate and develop passion to biodiversity; andy will respect the nature and environment.

**PART-A:**

1. Origin of groups - Reproduction-Passive transport-Active locomotion-Common orientation-Mutual attraction.
2. Population Regulation - Effects of increased numbers - Harmful effects - Beneficial effects - Protection-Influence on reproduction - Division of labor.
3. Population growth - Natality and Mortality - Biotic potential and environmental resistance-Form of population growth-Logistic Curve - Stochastic and time lag models of population growth - Optimal yield.
4. Population - Inter-specific relationships - Positive interactions -Commensalism - Mutualism - Negative interactions - Predation -Parasitism - Antibiosis.
5. Population Antagonistic relationships - Antibiosis Exploitation -Parasitism - Predation-Competition.
6. Habitat and Ecological Niche-Ecological equivalents- Sympatry and Allopatry-Spatial relations of populations - Space requirements -Home range and territory - Homing and return migration-Emigration.
7. Demography - Life Tables - Net reproductive rate - Longevity and theories of ageing - Reproductive strategies.
8. Case studies in population dynamics - One or two examples from Fisheries, Wildlife and biological control of agricultural pests.
9. Ecological modeling - Fundamentals.

**PART-B: ANIMAL BEHAVIOUR**

1.0 Introduction
- 1.1 Ethology as a branch of biology
- 1.2 Animal psychology-Classification of behavioural patterns, analysis of behaviour (ethogram)

2.0 Innate behavior

3.0 Perception of the environment
- 3.1 Mechanical
- 3.2 Electrical
- 3.3 Chemical
- 3.4 Olfactory
- 3.5 Anditory
- 3.6 Visual

4.0 Neural and hormonal control of behavior

5.0 Genetic and environmental components in the development of behavior

6.0 Communication
- 6.1 Chemical
- 6.2 Visual
- 6.3 Light
- 6.4 Audio
- 6.5 Species specificity of songs
- 6.6 Evolution of language

7.0 Ecological aspects of behavior
- 7.1 Habitat selection, food selection. Optimal foraging theory, antipredator defenses
- 7.2 Aggression, homing, territoriality, dispersal
- 7.3 Host-parasite relations

8.0 Social behavior
- 8.1 Aggressions-schooling in fishes, flocking in birds, herding in mammals
- 8.2 Group selection, kin selection, altruism, reciprocal altruism, Inclusive fitness
- 8.3 Social organization in insects and primates

9.0 Reproductive behavior
- 9.1 Evolution of sex and reproductive strategies
- 9.2 Mating systems

9.3 Courtship

9.4 Sperm competition

9.5 Sexual selection

9.6 Parental care

10.0 Biological rhythms

10.1 Circadian and circannual rhythms

10.2 Orientation and navigation

10.3 Migrations of fish, turtle and bids

11.0 Learning and memory

11.1 Conditioning

11.2 Habituation

11.3 Insight learning

11.4 Association learning

11.5 Reasoning

11.6 Cognitive skills

**Practical-A:**

1. Population identification and enumeration

   Examples: Rocky shore. Interstitial, Weed inhabitants. Free floating and Estuarine fauna.

2. Growth patterns under hatchery - Laboratory conditions

   a) Hatchery- Using Phytoplankton cultures and estimating population densities

   b) Flagellates, ciliates through hay-culture and estimating rate and population crease/logistic curve

3. Natural population. Example: Fisheries- from fish landings (2-3 species to be given emphasis)

4. Statistical application In population biology.

**Practical-B:**

1. An introduction to animal behaviour - animal psychology- Classification of behavioural patterns.

2. Perception of the environment - Examples.

3. Communication - Examples from invertebrates and vertebrates (Terrestrial, Aerial, Aquatic habitats)

4. Ecological aspects-Food selection, optimal foraging, prey and predator, Host-Parasite relations.
5. Social behaviour-Aggregations - Examples from fishes, birds and mammals, social organization-insects.
6. Reproductive behaviour-mating systems, sexual selection, parental care.
7. Biological rhythms - Examples - migration of fish, turtle and bird.

SUGGESTED READING MATERIAL:

Part-A:


1. Begon, M., J.L. Harper and CR Townsend. Ecology, Individuals, Populations and Communities. Blackwell Science, Oxford, UK.
2. Koromondy, E.J. Concepts of ecology. Prentice and Hall, New Delhi.
3. Clarke, GL. Elements of Ecology, New York. John Wiley and Sons.
4. Odum, EP., Fundamental of Ecology, PhiladeJphja; WB Saunders
5. Krebs, CJ. Ecology. Harper & Row, New York
6. Jorgensen, S.E. Fundamentals of Ecological modeling. Elsevier, New York.


Part B:


1. Alocock, J. Animal behaviour. An evolutionary approach. Sinauer Assoc. Sunderland, Mass. USA.
2. Bradbury, J.W. and S.I. Vehrencamp, Principles of animal communication, Sinauer Assoc.
3. Clutton-Brock, T.H. The evolution of parental care. Princeton Univ. Press. Princeton, N.J., USA.
4. Eibl-Eibesfeldt, I. Ethology. The biology of behaviour. Holt, Rinehart & Winston, New York.
5. Gould, J.L The mechanisms and evolution of behavior
6. Hauser, M. The evolution of communication. MIT Press, Cambridge, Mass, USA.
7. Hinde, R.A. Animal behaviour: A synthesis of ethology and comparative psychology. MacGraw Hill, New York.
8. Krebs, J.R. and N.B. Davies: Behavioural ecology. Blackwell, Oxford, UK.
9. Wilson, E.O. Sociobiology. The new synthesis. Harvard Univ. Press, Cambridge, Mass. USA. .

**Student Learning outcomes:**

LO 1: know how knowledge on Population genetics will help in understanding the disease frequency in the populations.

LO 2: Develop an idea on application of knowledge of population genetics to the society.

LO 3: Analyze as well as assesses the implications of changes in gene and genotype frequencies.

LO 4: Understand the genetic structure of Populations and the influencing factors.

LO 6: Know the significance of Quantitative traits, their quantification, and importance in applied aspects.

LO7: Knowledge base in the field of Animal Behavior & Conservation: Students acquire knowledge of key concepts and principles and overarching themes in animal behavior, animal cognition, conservation psychology/biology, animal welfare science, comparative psychology and research methods. Students acquire credentials for employment in fields related to ABC.

LO8: Scientific inquiry and critical thinking: Students learn to reason scientifically, gain information literacy skills, interpret statistical information, and learn to interpret and design studies in animal behavior and cognition.

LO9: Ethical and Social Responsibility in a Diverse World: Students learn to apply ethical standards in conducting and evaluating psychological and behavioral research, build and enhance interpersonal relationships, adopt values that build community at local, national, and global levels.

LO10: Communication: Students learn communication skills to disseminate research findings, and to apply psychological content and skills to a range of career goals, exhibit self-efficacy and self-regulation, develop and refine project management skills, enhance their teamwork capacity, and develop meaningful professional direction for life after graduation.

## PAPER-III: ICHTHYOLOGY

**Course Specific Objectives :**

- To study culture of fish, aquatic plants and aquatic animals in three aquatic environments

  fresh water, brackish water and marine water.

- Provides job placements in central government agencies as technical officers, assistant directors, project officers and fishery officers. • Knowledge of the National Fisheries Development Board, department of Fisheries, Ministry of Fisheries, Govt. of India and their impact on GDP of the country.

**Course Objectives:**

CO 1. To impart knowledge on basis of aquaculture

CO 2. To learn about construction & management of aquaculture ponds

CO 3. To have knowledge on aquaculture of different shell fish & fin fish CO 4. To know about the water quality & feed management

CO 5. To gain knowledge on post harvest technology Competency developed

Co 6: Develop the ability to construct fish farm independently.

Co 7 : Develop the ability to research in the field of fish biology for more products in aquaculture and fisheries.

CO 8: Develop the ability to guide (consultancy) layman individual in his/her difficulties during the construction as well as to run a fish farm successfully.

**Student Learning Outcomes:**

LO1: Will be familiar with the methods of planning for aquaculture development

LO 2: Will have knowledge of construction & management of aquaculture ponds

LO 3: Will learn about aquaculture of different shell fish & fin fish of freshwater and brackish water

LO 4: Will get an understanding of water quality & feed management

LO 5: Will be familiar with post harvest technology

**PART-A:**

1. Systematics and nomenclature: Suitability of fishes: Historical background: Tasks of the systematics. Taxonomic concepts. Data of classification. Zoological nomenclature
2. Major groups of fishes: Scope of classification. Aims of classification. Methods of classification. Major groups of living fishes; major groups of extinct fishes: Phylogeny of fishes.

3. Basic fish anatomy: Digestive system, circulatory system, respiratory system-structure of gills, excretory system- structure of kidney, nervous system, sense organs and lateria system, reproductive system structure and development of reproductive organs.
4. Food and feeding habits: Food - Kinds and varieties, abundance of food and its availability, structural adaptation, search for food, classification based on food and feeding habits.
5. Body form and Locomotion: Locomotion body form and locomotion, fins and locomotion Age and growth. Growth, length frequency data variation in growth rate, age determination.
6. Genetics and Evolution: Inheritance in fishes, sex determination, hybridization, mechanism of evolution.
7. Ecology of fishes: Introduction: Water - Organic production in aquatic ecosystems: Bio-geo chemical cycles. Ecological classification of fishes, ecological factors.

**PART-B:AQUACULTURE:**

1.0 History, General principles and economics of different kinds of aquaculture and productivity of culture ponds.

2.0 Freshwater aquaculture

2.1 Construction of fish farm and reclamation of swamps

2.2 Selection of species for culture - Biological principles

2.3 Preparation and management of nursery ponds, rearing ponds and stocking ponds along with control of weeds, pests and predators

3.0 Fish seed resources

- 3.1 Procurement and transportation of seed from natural resources
- 3.2 Transportation of brood stock and induced breeding
- 3.3 Construction of hatcheries and their management

4.0 Freshwater fish culture

- 4.1 Common carp; Indian major crops; Air breathing fishes; Composite fish culture; Freshwater prawn culture.
- 42 Integrated Fish Farming - Paddy cum Fish Culture and Fish cum Livestock Culture

5.0. Fish nutrition

5.1 Nutritional requirements, energy metabolism, formulation and preparation of fish feeds

6.0 Brackishwater aquaculture

6.1 Selection of site, principles of pond design; traditional, extensive, modified extensive, semi- extensive, intensive and super Intensive culture of shrimps and their management and economics.

6.2 Crab culture - pond design, management of crab farm, fattening process of crab, economics – cage culture and pen culture.

6.3 Finfish culture-Mullets (Mugil), Milk fish (Chanos) and sea bass (Lates)

7.0 Hatchery management

7.1 Principles of shrimp hatchery establishment. Site selection, water source, water management, maturation section, larval and post-larval sections, feed management.

7.2 Principles of establishment of crab and lobster hatcheries; site selection, water source and management, larval and post-larval sections, feed management.

8.0 Brackish water farm management

8.1 Water quality management - pH, turbidity, dissolved oxygen, BOD, COD, Nitrates, Phosphates, Ammonia, etc.

8.2 Feed management Fish schedules, protein requirements at different ages of finfish and shellfish, feed formulations, wet and dry feeds.

9.0 Mariculture

9.1 Lobster culture

9.2 Mussel culture

9.3 Pearl oyster culture

9.4 Edible oyster culture and

9.5 Sea weed culture

**PRACTICAL-A:**

1. Identification of fishes with suitable examples from each class.
2. Dissection of fish for internal anatomy - External characters. Types of scales, fins, types of teeth, structure of alimentary canal, gill rockers.
3. Ecology of fishes-identification characters of pelagic, mid pelagic, benthic and migratory fishes.

**PRACTICAL-B:**

1. Analysis of water Turbidity, pH, Dissolved oxygen. Alkalinity etc.
2. Primary productivity. Estimation by Light and Dark Bottle method
3. Spotters: Cultivable species of finfish and shellfish based on the theory
4. Dissecting out the pituitary gland and preparing the extract
5. Visits to aquaculture farms, finfish and shellfish hatcheries

**SUGGESTED BOOKS:**

**PART-A:**


1. Lagler, K.F. Ichthyology, John wiley Publication, 1977
2. Norman, J.R. &P.H. Green Wood. A history of fishes.
3. Bond, E. Carl. Biology of fishes.
4. Nikolsky, GV. Ecology of fishes. Academic Press.
5. Love, M.S. &Cailiet, GM. reading in ichthyology. Prentice Hall Publications, 1979.


**PART-B:**


1. Pillay, T.V.R. 1990. Aquaculture - Principles and practices. Fishing News Books Survey. U.K.
2. Jhingran, V.G. 1993. Fish and fisheries of India. Hindustan Publishing Corporation (India). New Delhi.
3. Ravishankar Piska. 1999. Fisheries and Aquaculture. Lahari Publications, Hyderabad.
4. Santanam, R. Ramanathan, N. and Jegatheesan, G 1990. Coastal Aquaculture in India. CBS Publishers & Distributors, Delhi.
5. Bardach, J.E., Ryther, J.H. and McLarney, W.O. 1972. Aquaculture. John Wiley & Sons Inc. USA.
6. Ghosh, S.K., Palanisamy, K. and Pathak, S.C. 1994. Shrimp and freshwater Hatchery. Public Relations Division, National Bank for Agriculture and Rural Development, Bombay.


**Student Learning Outcomes:**

LO1: Will be familiar with the methods of planning for aquaculture development

LO 2: Will have knowledge of construction & management of aquaculture ponds

LO 3: Will learn about aquaculture of different shell fish & fin fish of freshwater and

brackish water

LO 4: Will get an understanding of water quality & feed management

LO 5: Will be familiar with post harvest technology

**PAPER-IV: MEDICAL PARASITOLOGY**

**Course Specific Objectives**

- Understanding important parasitic diseases, including their life cycles, vectors of transmission, distribution and epidemiology, pathophysiology and clinical manifestations, treatment and prevention and control.

- Help the student to fins a placement as medical parasitologists, veterinary parasitologists,
- conservation biologists, epidemiologist, and pathologist in various diagnostic centres and labs.

**Course objectives**

CO 1: An overview of biological basis of parasitic lifestyles.

CO 2: It includes host responses and parasite evasion of host defense mechanisms.

C O 3: The students are exposed to knowledge on parasites that not only infect humans but also animals.

C O 4: It emphasizes on the evolutionary aspect of host-pathogen interactions leading to host specificity.

C O 5: The students learn about transmission, epidemiology, diagnosis, clinical manifestations, pathology, treatment and control of major parasites.

CO 6: It includes through knowledge on the major parasitic groups like Helminthes and Protozoans.

C O 7: The course has been structured in a way that the students assimilate the classroom knowledge for applied aspects of parasitology and public health.

CO 8: The student gets an insight into immune mechanisms exhibited by parasites present in various habitats and representing different groups.

CO 9: Students will be able to demonstrate a broad and diverse background in parasitology and related subjects and a strong foundation for professional programs of study or employment to internalize and use the knowledge offered related to veterinary techniques,

**PART-A:**

1.0 Introduction to parasites of man, scope and definition of parasitism

2.0 Protozoa: Course Objectives: The successful completion of the course gives,

1.0 Introduction to parasites of man, scope and definition of parasitism

2.0 Protozoa

2.1 Morphology, life cycle, pathogenicity of Entamoeba histofytica, different diagnosis of Naegleria, Acanthameoba

2.2 Intestinal flagellates: Giardia, Trichomonas

2.3 Haemoflagellates: Trypanosoma, Leishmania

2.4 Apicomplexans: Plasmodium, differential diagnosis; Toxoplasma,

3.0 Helminths

3.1 Morphology, life cycle, Pathogenicity and control of trematodes and cestodes Clonorchis sinensis Paragonimuswestermani Blood flukes, Schistomes

3.2 Taenia solium, T. saginata, Hymenolepis nana

3.3 Nematodes: Soil transmitted helminthes: Ascaris lumbricoldes, Enteroblus vermicularis, Ancylostoma The duodenale

3.4 Filarial worms: Wuchareriabancrofti, Bugia Malaya, Trichinella spiral Is, Trichuris

4.0 Theory of infection and control

**Part-B: VETERINARY PARASITOLOGY**

1.0 Introduction to Parasitism: Scope and definition

2.0 Protozoa

2.1 Parasites of fishes; Myxozoa and Microspora

2.2 Parasites of poultry: Histomonas, Eimeria tenella and Leucocytozoon

2.3 Parasites of cattle: Babesia, Theiteria

3.0 Helminth parasites of Domestic animals: Morphology, life cycle and pathogenicity

3.1 Trematode: Fasciola, Schistosomes, Amphistomes, Dicrocoelium

3.2 Cestodes: Moniezia, Echinococcus, Dipylidium Spirometra

3.3 Nematodes: Haemonchus, Oesophagostomum, Trichostrongylus, Dactylocaulus

3.4 Zoonosis: Definition, classification and examples

4.0 Economic importance of parasites of sheep, goat and cattle

**PRACTICAL-A:**

1. Smear preparation for protozoa
2. Preparation of whole mounts for helminthes
3. Parasitology In focus

**PRACTICAL-B:**

1. Representative examples of protozoa and helminth parasites of birds and domestic animals
2. Preparation of wet and dry smears
3. Host examination for parasites 4. Stool examination and identification of ova

**REFERENCES:**

**PART-A:**


1. Manson's Tropical disease by Cook
2. Concepts and Principles of Epidemiological studies
3 Parasitology in focus


**PART-B:**


1. Levine, N.D. Textbook of Veterinary Protozoology.
2. Parasitology in focus.


**Student Learning outcomes:**

LO 1: Demonstrate through tests and on writing assignments an understanding of parasitism, biology behind host- parasite interactions including the diversity of symbiotic associations and their populational and dynamic nature

LO 2: Get acquainted with epidemiological concepts of parasitic infections of global importance, develops familiarity with protozoan and helminth parasites of humans.

LO 3: Understands harmful effects, pathological changes and immunological alterations associated with parasitic infections.

LO 4: Understands the role of vectors as intermediate hosts in parasite transmission and can utilize this knowledge to bring awareness in the society on control strategies.

LO 5: Analyze research challenges in diagnosis, treatment and control of parasitic infections in humans and in veterinary contexts through examination of evidence.

LO 6: Get employability and can undertake research, analyze case studies, interpret data and use evidence to address problems in parasitology, including clinical, public health and biological issues