

SAURASHTRA UNIVERSITY

RAJKOT

(ACCREDITED GRADE "A" BY NAAC)



FACULTY OF SCIENCE

Syllabus for

M. Sc. (ZOOLOGY)

Choice Based Credit System

With Effect From: 2016-17

DEPARTMENT OF BIOSCIENCES

UGC - CENTRE OF ADVANCED STUDY

SAURASHTRA UNIVERSITY

RAJKOT – 360 005

M.SC. ZOOLOGY SYLLABUS
CHOICE BASED CREDIT SYSTEM (CBCS)
(Total 96 Credits)

PROGRAMME OUTCOMES (PO)

PO1: Critical Thinking

Recognize and think critically towards the science curricula with sound knowledge and theoretical skills by questioning and plausible explanations.

PO2: Social Interactions

Students can communicate scientific information through effective formal and informal methods generally used in sciences.

PO3: Academic Competence

Develop competence in basic sciences and in the content of the specific courses that constitute the principal knowledge of their degree. Compare and contrast the characteristics of animals that differentiate them from other forms of life. Understand and be aware of relevant theories, paradigms, concepts and principles of zoology. Understand the structure and functions of cell types. Apply the knowledge of Zoology to understand the complex life Processes and phenomena.

PO5: Core academic skills

Acquire the skills in handling scientific instruments, planning and performing in laboratory experiments. Acquire time management and self-management skills.

PO6: Continuous Learning

Recognize the need for, and have the preparation and ability to engage in independent and life-long learning. To inculcate the value based education and entrepreneurial skills among the students.

PO7: Research and Development

To inculcate the scientific temperament in the students and outside the scientific community. Conduct basic scientific research and provide inputs for societal benefits.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO1: Ability to connect and apply biological knowledge to other disciplines and to integrate knowledge into their personal and professional lives.

PSO2: Explain the origin of life with context to the origin of eukaryotic cell and endosymbiotic theory of origin, fossil records, Darwinism and Neo- Darwinism, experimental evidences.

PSO3: Illustrate zoological science for its application in branches like medical, entomology, apiculture, aquaculture and agriculture etc.

PSO4: Understand animal interactions with the environment and identify the major groups of organisms with an emphasis on animals and classify them within a phylogenetic framework.

PSO5: Participate in animal management programmes in an effective manner.

PSO6: Work safely and effectively in the field, in laboratories and in animal facilities.

PSO7: Demonstrate competence in handling and statistical analysis of data gained from practical.

PSO8: Learn communication and IT skills, including the collation and statistical analysis of data, citing & referencing work appropriately, communicating using a range of formats.

PSO9: Individuals with aptitude and skill in research in different branches of Zoology as well as related disciplines.

Subject Code	Title of the Course	Course Credits	No. of Hrs. Per Week	Weightage For Internal Examination	Weightage For Semester End Examination	Total Marks	Duration of Semester End Exam in Hrs.
Provide Sub. Code	Prog. In C & Numerical Methods	4	4	30	70	100	2.5
M.Sc. Zoology SEMESTER – I							
Zool - 101	Cell Biology (Core)	4	4	30	70	100	2.5
Zool - 102	Molecular Biology, Genetics & Evolution (Core)	4	4	30	70	100	2.5
Zool - 103	Biodiversity & Biosystematics (Core)	4	4	30	70	100	2.5
Zool - 104	Biostatistics and Bioinformatics** (Multidisciplinary / Interdisciplinary)	4	4	30	70	100	2.5
Zool - 105	Combined Practical	8	14			200	2.5
Zool - 106	Seminar / Tutorial Course* - 1	0	2				
M.Sc. Zoology SEMESTER – II							
Zool - 207	Biochemistry (Core)	4	4	30	70	100	2.5
Zool - 208	Biotechnology & Immunology (Core)	4	4	30	70	100	2.5
Zool - 209	Environmental Science (Core)	4	4	30	70	100	2.5
Zool - 210	Analytical Techniques** (Multidisciplinary / Interdisciplinary)	4	4	30	70	100	2.5
Zool - 211	Combined Practical Course	8	14			200	
Zool - 212	Seminar / Tutorial Course* - 2	0	2				
M.Sc. Zoology SEMESTER – III							
Zool - 313	Structure & Functions of Invertebrates (Core)	4	4	30	70	100	2.5
Zool - 314	Mammalian Physiology (Core)	4	4	30	70	100	2.5

	Elective Course** (any one of the following)						
Zool - 315	Human Parasitology (Elective)	4	4	30	70	100	2.5
Zool - 316	Developmental Biology & Adaptation (Elective)	4	4	30	70	100	2.5
Zool - 317	Animal Ecology (Elective)	4	4	30	70	100	2.5
Zool - 318	Combined Practical Course	4	8			150	
Zool - 425	Dissertation/ Project*	0	9				
Zool - 106 & Zool - 212	Seminar / Tutorial Course* - 1 and 2	2	0				
M.Sc. Zoology SEMESTER – IV							
Zool - 419	Aquaculture & Fisheries Technology (Core)	4	4	30	70	100	2.5
Zool - 420	Neurobiology (Core)	4	4	30	70	100	2.5
	Elective Course** (any one of the following)						
Zool - 421	Marine Ecology (Elective)	4	4	30	70	100	2.5
Zool - 422	Wildlife Biology & Animal Behaviour (Elective)	4	4	30	70	100	2.5
Zool - 423	Endocrinology and Reproductive Physiology (Elective)	4	4	30	70	100	2.5
Zool - 424	Combined Practical Course	4	8			150	
Zool - 425	Dissertation/ Project*	12	9			200	
Zool - 426	Educational Tour/ Field work*	2	0			50	

M.SC. ZOOLOGY SYLLABUS
CHOICE BASED CREDIT SYSTEM (CBCS)
(Total 96 Credits)

Details of M. Sc. Syllabus:

SEMESTER-I:

4 Papers (100 Marks each*)	: 400	
1 Combined Practical	: 200	600

SEMESTER-II:

4 Papers (100 Marks each*)	: 400	
1 Combined Practical	: 200	600

SEMESTER-III:

3 Papers (100 Marks each*)	: 300	
1 Combined Practical	: 150	500
Seminars	: 50	

SEMESTER-IV:

3 Papers (100 Marks each*)	: 300	
1 Combined Practical	: 150	450
Tour / Field Work	: 50	
M.Sc. Dissertation	: 200	250
(Thesis:150 & Viva 50)		

Grand Total : **2400**

* 70 Theory + 30 Internal

M.SC. ZOOLOGY SYLLABUS
CHOICE BASED CREDIT SYSTEM (CBCS)
(Total 96 Credits)

Course Code	Course Name	Hours /Week	Credits
SEMESTER - I			
Zool - 101	Cell Biology (Core)	04	04
Zool - 102	Molecular Biology, Genetics & Evolution (Core)	04	04
Zool - 103	Biodiversity & Biosystematics (Core)	04	04
Zool - 104	Biostatistics and Bioinformatics** (Multi/ Inter disciplinary)	04	04
Zool - 105	Combined Practical Course	14	08
Zool - 106	Seminar Course – 1*	02	00
TOTAL			24
SEMESTER - II			
Zool - 207	Biochemistry (Core)	04	04
Zool - 208	Biotechnology & Immunology (Core)	04	04
Zool - 209	Environmental Science (Core)	04	04
Zool - 210	Analytical Techniques** (Multidisciplinary / Interdisciplinary)	04	04
Zool - 211	Combined Practical Course	14	08
Zool – 212	Seminar Course – 2*	02	00
TOTAL			24
SEMESTER - III			
Zool - 313	Structure & Functions of Invertebrates (Core)	04	04
Zool - 314	Mammalian Physiology (Core)	04	04
Elective Course** (any one of the following)		04	04
Zool - 315	Human Parasitology (Elective)		
Zool - 316	Developmental Biology & Adaptation (Elective)		
Zool - 317	Animal Ecology (Elective)		
Zool - 318	Combined Practical Course	08	04
Zool - 425	Dissertation / Project Course: Part-1*	09	00
Zool-106+212	Seminar Course (1 + 2)*	00	02
TOTAL			18
SEMESTER - IV			
Zool - 419	Aquaculture & Fisheries Technology (Core)	04	04
Zool - 420	Neurobiology (Core)	04	04
Elective Course** (any one of the following)		04	04
Zool - 421	Marine Ecology (Elective)		
Zool - 422	Wildlife Biology & Animal Behaviour (Elective)		
Zool - 423	Endocrinology and Reproductive Physiology (Elective)		
Zool - 424	Combined Practical Course	08	04
Zool - 425	Dissertation / Project Course*	09	12
Zool - 426	Educational Tour / Field Work Course*	00	02
TOTAL		00	30
GRAND TOTAL		144	96

* (a) **Dissertation / Project** commences in III Semester but evaluated and Grade Points are to be added in 4th Semester. (b) **Educational Tours / Field Works** may be carried out in any Semester or all Semesters, but evaluated and Grade Points are to be added in the 4th Semester only. (c) **Seminar / Tutorial Courses** may be carried out in first two Semesters but evaluated and Grade Points are to be added in the 3rd Semester only.

DISSERTATION (Elective): Any one subject is to be chosen from the following (Subjects offered may change from time to time depending on the availability of expertise): Ecology, Wildlife Biology, Behavioural Ecology, Biodiversity, Marine Biology, Marine Biodiversity, Coastal Ecology, Eco-Toxicology, Physiology, Muscle Stem Cell Growth & Development, Insect Biology, Aracnology,

Ornithology, Avian Biology, Taxonomy.

** Elective and Multidisciplinary / Interdisciplinary Courses may or may not have practical and/or field work.

ZOOL. 101: CELL BIOLOGY

OBJECTIVES:

The course provides to equip students with a basic knowledge of the structural and functional properties of cells. Aspects of differentiated cell systems and tissues and their properties. Aspect of cell cycle and cell death. And, introduce the fascinating mechanism of cell signaling.

COURSE OUTCOME:

CO-1: Understand the Scope of cell biology, because cell is the basic unit of life.

CO-2: Understand the Main distinguishing characters between plant cell and animal cell.

CO-3: To study and understand the whole cell organelles with their structure and function.

CO-4: Understand the cell cycle and know the importance of various cells in body of organisms.

CO-5: Understand the various applications of cells by using cell biology like study of various types of tumour.

CO-6: Understand the Animal cells and various cell organelles by using microphotographs.

Unit-1 : Cell Structure & Cell Cycle

- 1.1 Cell Concept, Ultrastructure of Plasma Membrane, microbial and Plant Cell Wall.
- 1.2 Ultrastructure of Nucleus and Nucleolus. Pore Complex of Nuclear envelop.
- 1.3 Ultrastructure of Chromosome, Chromosomal Models, Special types of chromosomes.
- 1.4 Cell Cycle, G₁/S Transition, Cyclines and cyclin dependent kinases. Regulation of CDK - cycline activity.

Unit-2 : Cellular Organization

- 2.1 Mitochondria: Membrane Organization, Biogenesis and role in cellular energetics.
- 2.2 Chloroplasts: Ultrastructure, biogenesis, Photosynthetic units and reaction centres.
- 2.3 Ultrastructure and functions of Lysosome, Peroxisomes & Glyoxisomes.
- 2.4 GERL System and its functions. Vacuoles and their role in cell structure and function.

Unit-3 : Cytoskeleton, Cellular Transport & Sorting

- 3.1 Cytoskeleton: Ultrastructure and functions of Microtubules, microfillaments and associated proteins.
- 3.2 Cytoskeleton: Ultrastructure and functions of Actin, Myosin, IF and associated proteins.
- 3.3 Intracellular Junctions and their functions. Ca⁺⁺ dependent homophillic and non-homophillic cell-cell adhesion.
- 3.4 Transport across cell membrane: diffusion, active transport and pumps, uniports, symports and antiports.

Unit-4 : Cellular Communication, Apoptosis and Cancer

- 4.1 Cell surface receptors and their mode of action. Phenomenon of exocytosis and endocytosis
- 4.2 Second messenger system, MDP kinase pathways
- 4.3 Apoptosis: Mechanism and significance
- 4.4 Cell biological approach of cancer, AIDS

SUGGESTED READING : Cell Biology – De Robertis, Cell Biology – C.B. Power, www.cellsalive.com ; Bruce Alberts - Molecular Biology of The Cell, Bruce Alberts et al – Essential Cell Biology, II Edition.

ZOOL. 102: MOLECULAR BIOLOGY, GENETICS & EVOLUTION

OBJECTIVES:

The course provides an insight into the life processes at the subcellular and molecular levels. Other important aspects include DNA and molecular genetics including gene cloning. The origin of life and the related evolutionary processes. The evolutionary theories and the process of species formation will be elaborated in view of the natural selection process.

COURSE OUTCOME:

CO-1: Understand how DNA encodes genetic information and the function of mRNA and tRNA

CO-2: Understand the process of DNA replication, transcription and translation.

CO-3: Apply the principles of Mendelian inheritance.

CO-4: Understand the cause and effect of alterations in chromosome number and structure.

CO-5: Relate the conventional and molecular methods for gene manipulation in other biological systems.

CO-6: Discuss and analyse the epigenetic modifications and imprinting and its role in diseases.

CO-7: Get new avenues of joining research in related areas such as genetic engineering of cells, cloning, genetic disorders, human fertility programme, genotoxicity, etc

Unit-1. Population Genetics

1.1 Principles of Mendalian genetics

1.2 Hardy-Weinberg genetic equilibrium, Natural selection

1.3 Genetics of Speciation

1.4 Origin of life: Coacervates, Miller's experiment, theories of organic evolution

Unit-2. DNA as a hereditary material

2.1 Structure of Nucleic acids, Structural differences in prokaryotic and eukaryotic DNA

2.2 DNA constancy and C-value paradox,

2.3 DNA replication and DNA methylation

2.4 Linkage and genetic (chromosome) mapping

Unit-3. Gene structure and function (Prokaryotic and Eukaryotic)

3.1 Loci, alleles, and Gene structure

3.2 Genetic code

3.3 Transcription

3.4 Translation

Unit-4. Structural Changes in DNA material and Extra Chromosomal inheritance

4.1 Molecular basis of spontaneous and induced mutations,

4.2 Chromosomal aberration

4.3 DNA damage and repair

4.4 Extra-chromosomal inheritance

SUGGESTED READINGS: Benjamin Lewise - Genes-VII, Lehninger - Fundamentals of Biochemistry

ZOOL. 103: BIODIVERSITY & BIOSYSTEMATICS

OBJECTIVES:

The course provides information about the patterns and processes of evolution above the species level. Besides elaborating the process of speciation, it also categorically differentiates between the three methods of phylogenetic analysis viz., evolutionary systematics, phonetics and cladistics.

COURSE OUTCOME:

CO-1: Understand the evolution, history of phylum.

CO-2: Understand about the Non Chordate animals.

CO-3: To study the external as well as internal characters of non-chordates.

CO-4: To study the distinguishing characters of non-chordates.

CO-5: Understand the economic importance of Molluscs

CO-6: Understand the various internal systems like Digestive system, nervous system with the help of charts.

CO-7: Understand the functions of Gemmules and spicules.

Unit – 1: Biodiversity

- 1.1 Basic Concepts of Biodiversity: Genetic, species and ecological diversity.
- 1.2 Terrestrial, Marine Biodiversity, Eco-tourism and Biodiversity. Conservation and Sustainable use of Biodiversity. Ecosystem monitoring and Rehabilitation.
- 1.3 Threats to Biological Diversity: Habitat Destruction, Invasive species, Disease, Over-exploitation, Pollution, Climate change and Biodiversity.
- 1.4 Structure and functions of the Convention on Biological Diversity (CBD), CBD mechanisms and working bodies. National Action Plan.

Unit – 2: Microbial Taxonomy

- 2.1 Principles of systematics and classification of microbes.
- 2.2 Introduction to akaryotes, virus, archea & bacteria, cyanobacteria and prokaryotes
- 2.3 Fungus like protists: Cellular slime moulds, plasmodial slime moulds. General features of Fungus
- 2.4 Classification of Zygomycetes, Ascomycetes, Basidiomycetes, Mycorrhizea

Unit – 3: Plant Taxonomy

- 3.1 Principles of systematics and classification of Plants.
- 3.2 General features and Classification of green protists like diatom, dinoflagellates, lichens and algae
- 3.3 Non-tracheophytes (Mosses) and Non-Seed Tracheophytes (Ferns and Fern allies).
- 3.4 Seed plants: Gymnosperm and Angiosperms

Unit – 4: Animal Taxonomy

- 4.1 Principles of systematics and classification of Animals.
- 4.2 Classification of Protista (Flagellates, Amoebas, Ciliates and Apicomplexans).
- 4.3 Major invertebrate phyla, Lower chordates
- 4.4 Vertebrates: Fish, Amphibia, Reptiles, Birds and Mammals

SUGGESTED READING: Odum, EP- Fundamentals of Ecology

ZOOL. 104: BIOSTATISTICS AND BIOINFORMATICS

OBJECTIVES:

The course is aimed at introducing the application of bioinformatics and statistics in biology. The course gives an insight into the key concepts and methods used in bioinformatics; and computer storage, retrieval, analysis, visualization and distribution of information data related to biological macromolecules like DNA, RNA and proteins. It provides foundation on statistical methods to enable students to compute and interpret basic statistical parameters. As an interdisciplinary field it integrates biology, computer science, chemistry and statistics together sequence analysis structure analysis and functional analysis of biological data.

COURSE OUTCOME:

CO-1: Know the theory behind fundamental bioinformatics analysis methods.

CO-2: Be familiar with widely used bioinformatics databases.

CO-3: Know basic concepts of probability and statistics.

CO-4: Describe statistical methods and probability distributions relevant for molecular biology data.

CO-5: Know the applications and limitations of different bioinformatics and statistical methods.

CO-6: Perform and interpret bioinformatics and statistical analyses with real molecular biology data.

CO-7: Acquire knowledge of various databases of proteins, nucleic acids. Primary, secondary and composite databases. BLAST, FASTA, DOT PLOT

CO-8: Make phylogenetic predictions or prediction of structure of proteins and nucleic acids

CO-9: Develop understanding in Primer designing

CO-10: Understand data mining tool and its practical application in a case study

CO-11: Apply the knowledge in future course of their career development in higher education and research.

Unit – 1: Basics and concepts of Biostatistics

- 1.1 Data, Tabulation, Classification, Frequency distribution and Graphics
- 1.2 Measure of Central Tendency – Mean, Mode & Median: Definition, Objectives, Merits, Demerits & Uses

- 1.3 Measure of Dispersion – Range, Variance, Standard deviation, Coefficient of Variation
- 1.4 Confidence limit and confidence interval

Unit – 2: Statistical tests in Biology

- 2.1 Student's t-test: Paired and Unpaired
- 2.2 Analysis of Variance
- 2.3 Regression and Correlation analysis
- 2.4 Chi-square test

Unit – 3: Basics of Bioinformatics and Biological Database

- 3.1 Introduction of Bioinformatics (Biological and IT links), Basic terminology
- 3.2 Application of bioinformatics in various fields: Medicine, Agriculture, Industries etc.
- 3.3 Types of biological database, File formats and Structure of database
- 3.4 Primary and Secondary database

Unit – 4: Sequence alignment, Gene prediction and Basic concepts of Omics

- 4.1 Sequence alignment: Nucleotide and Protein sequences, Pairwise and multiple sequence alignment, Phylogenetic relationship and importance of the study
- 4.2 Gene prediction: Gene structure in prokaryotic and eukaryotic systems, Prediction tools for the gene
- 4.3 Genomics: Definition and importance of the study
- 4.4 Other Omics (Transcriptomics, Proteomics and Metabolomics: Definition and importance of the study)

SUGGESTED READING: Fundamentals of Biostatistics – by Khan , Khanum; Introduction to Biostatistics: by Pranab Kumar Banerjee; Fundamentals of Biostatistics – by V.B. Rastogi ; Fundamentals of Biostatistics - by P. hanmanth Rao, K. Janardhan ; Manual of Biostatistics- by J.P. Baride, A.P. Kulkarni, R.D. Muzumdar ; Fundamental of Biostatistics – Veer Bala Rastogi; Biostatistics – PN Arora, PK Malhan ; An Introduction to Biostatistics – N. Gurumani; Statistics – KK Sharma; Introduction to Biostatistics – RR Sokal & FJ Rohlf ;Introductory Biostatistics – Chap T. Le

ZOOL 105: SUGGESTED COMBINED PRACTICAL COURSE (FROM)

101. Cell Biology

1. Preparation of paraffin blocks of animal tissue – Understanding the cytological and histological techniques
2. Section cutting, spreading and staining methods, Microscopy
3. Supra – vital Cytological staining of cellular organelles
4. Cellular metabolites: Permanent Cytological Staining
5. Nucleic Acids: Permanent Cytological Staining
6. Cytogenetics: Onion root tip squash preparation for mitosis
7. Dipteran salivary gland squash preparation for giant chromosome
8. Cytological Staining of Barr body
9. Cytogenetics: Stages of meiosis
10. Histological and Cytological Staining of Drumstick
11. Enzyme histochemistry & Cytochemistry
12. Observations on permanent cytological slides

102. Molecular Biology, Genetics & Evolution

1. To confirm thalassemia by NESTROFT (Necked Eye Single Tube RBCs Osmotic Fragility Test)
2. To induce polyploidy in root of Allium cepa and observe cytological changes in cell
3. To study karyotype of human chromosome
4. Identification of normal male and female karyotype
5. Identification of Turner syndrome using Karyotype
6. Identification of Klinefelter syndrome using the karyotype
7. Identification of Down syndrome using the karyotype
8. Identification of Edwards syndrome using the karyotype
9. To perform linkage analysis and Map construction with example
10. To perform Pedigree analysis and Probabilities with example
11. Staining of Microbial Cells: Monochrome, Negative & Gram Staining
12. Bacterial Motility (Hanging Drop Method)
13. Bacteriological Media Composition & Preparation and Bacterial Cultivation Methods

103. Biodiversity & Biosystematics

1. General features & classification of Invertebrates up to class or order
2. General features & classification of vertebrates up to class or order
3. General features and classification of diatoms, dinoflagellates, lichens and algae
4. General features and classification of non-tracheophytes and non-seed tracheophytes
5. General features and classification of Gymnosperms
6. General features and classification of angiosperms
7. Negative staining, Differential staining (Gram's staining)
8. Specialized staining: Capsule staining, Spirocheck staining, Metachromatic granule staining, Cell wall staining
9. Hanging drop techniques for motility

104. Biostatistics & Bioinformatics

Biostatistics:

1. Frequency Distribution
2. Standard Deviation and Coefficient of Variation
3. Confidence limits for the population mean
4. Students 't' test
5. Analysis of Variance
6. Regression and Correlation
7. Chi Square Test

Bioinformatics :

8. Basic Terminologies in Bioinformatics
9. Biological databases
10. NCBI Search for Gene Sequences
11. UniProt Knowledgebase (UniProt KB) Search for Protein Sequences
12. RCSB PDB search for Protein 3D Structures
13. Pair wise Sequence Alignment using NCBI BLAST
14. Pair wise Sequence Alignment using Bio edit
15. Multiple Sequence alignment using CLC Protein Workbench
16. Multiple Sequence alignment using Clustal X
17. Analysis of 3 D structure of protein by Rasmol

M.Sc. ZOOLOGY : SEMESTER - II

ZOOL. 207: BIOCHEMISTRY

OBJECTIVES:

The course provides an introduction to the structure of biomolecules with emphasis on the techniques used for structure determination and analysis. The course covers basic aspects of sample preparation for analysis and aims to enlighten the students how structural information can be utilized for better understanding of biological processes.

COURSE OUTCOME:

CO-1: Understand the concept of enzyme, its mechanism of action and regulation.

CO-2: Learn the preparation of models of peptides and nucleotides.

CO-3: Learn biochemical tests for amino acids, carbohydrates, proteins and nucleic acids.

CO-4: Learn measurement of enzyme activity and its kinetics.

Unit – 1 : Carbohydrates, Lipids and Fatty Acid metabolism

- 1.1 Monosaccharides and disaccharides: Types and properties
- 1.2 Polysaccharides: Homopolysaccharides and heteropolysaccharides
- 1.3 Classification and properties of simple and compound lipids
- 1.4 Function of lipids, Metabolism of fatty acids: Beta oxidation

Unit – 2 : Protein Structure and Function

- 2.1 Properties of amino acid, titration curves and function of proteins
- 2.2 Primary and Secondary structure of protein
- 2.3 Tertiary structure of protein, Ramchandran Plots
- 2.4 Quaternary structure of protein: globular and fibrous

Unit – 3 : Enzymes: Basic Concepts and Kinetics

- 3.1 An introduction to enzymes: Nomenclature and classification
- 3.2 Principles and mechanism of enzymes catalysis: single and multisubstrate, Coenzymes and cofactors
- 3.3 Kinetic properties of enzymes, Michaelis-Menten Model, Double reciprocal plot
- 3.4 Enzyme Inhibition: Competitive, Non-competitive, Uncompetitive and Mixed type

Unit – 4 : Metabolism: Basic Concepts and Regulation

- 4.1 Concept of Bioenergetics: laws of thermodynamic, Entropy and Enthalpy, Energy rich compounds and electron carriers
- 4.2 Glycolysis and Citric Acid Cycle
- 4.3 Other pathways of carbohydrate metabolism ED, Pentose Phosphate, Glyoxylate, Gluconeogenesis
- 4.4 Allosteric proteins, Feedback inhibition

SUGGESTED READING: Fundamentals of Biochemistry by Voet and Voet; Principles of Biochemistry - L. Stryer; Principles of Biochemistry -Lehninger, D.W.Nelson & M.M.Cox; Harper's Illustrated Biochemistry Robert K. Murray; Biochemistry : U. Satyanarayana ; Color Atlas of Biochemistry : Jan Koolman; Biochemistry : Reginald H. Garret; Protein structure and function : Mike Williamson; Biochemistry : Mary K. Campbell , Shawn O. Farrell

ZOOL. 208: BIOTECHNOLOGY & IMMUNOLOGY

OBJECTIVES:

This course gives an insight into the direct manipulation of DNA to alter the characteristics of an organism in a particular way. It envisages concepts, mechanisms, biological designs, functions and evolutionary significance of genetic modification or manipulation in special organisms and also discusses the recent advance in recombinant DNA technology. To acquire a knowledge of immunochemical techniques in qualitative and quantitative analysis of antibodies and antigens. An understanding of the factors that determine the effectiveness of immune responses to microorganisms (bacteria, viruses, parasites) and how protective immunity can be elicited by vaccination.

COURSE OUTCOME:

CO-1: Develop an understanding of the fundamental molecular tools and their applications of DNA modification and cloning.

CO-2: Appreciate shifting their orientation of learning from a descriptive explanation of biology to a unique style of learning through graphic designs and quantitative parameters to realize how such research and innovations have made science interdisciplinary and applied.

CO-3: Develop future course of their career development in higher education and research with a sound base.

CO-4: Apply their knowledge with problem solving approach to recommend strategies of genetic engineering for possible applications in Biotechnology and allied industry.

CO-5: Understand the structure and function of immunoglobulins.

CO-6: Understand the technique of cell and tissue culture. Learn the preparation of solution of given percentage and molarity.

Unit – 1 : Biotechnology -1.

- 1.1 Bioremediation: Principles and Methods,
- 1.2 Techniques of immobilization of enzymes & cells
- 1.3 Applications of Immobilized Enzymes & Cells
- 1.4 Principles and techniques of animal tissue culture

Unit – 2 : Biotechnology -2

- 2.1 Basics of genetic engineering
- 2.2 DNA isolation techniques
- 2.3 Restriction enzymes, Gene targeting
- 2.4 Vectors : plasmids, cosmids and phages, Host vector system, Screening of the recombinant clones

Unit – 3 : Plant Tissue culture

- 3.1 Principles and Techniques of Plant Tissue Culture
- 3.2 Basic Steps of Plant Tissue Culture
- 3.3 Selection of Plant Culture Media
- 3.4 Types of Plant Tissue Cultures

Unit – 4 : Immunology

- 5.1 Antigen Antibody: Structure of Ig, Ig Classes & Biological Activities, Factors Influencing Immunogenicity, Monoclonal Antibodies
- 5.2 Innate and Adaptive Immune System
- 5.3 Antigen-Antibody Interactions: ELISA Test, Agglutination, Precipitation, Immunofluorescence
- 5.4 Delayed and Immediate Hypersensitive Reactions, Autoimmunity

SUGGESTED READING:

ZOOL. 209: ENVIRONMENTAL SCIENCE

OBJECTIVES:

It will give a brief introduction to the atmosphere and ocean circulation.

COURSE OUTCOME:

CO-1: Develop understanding on the concept and issues of global environmental change.

CO-2: Analyse the causes and effects of depletion of stratospheric ozone layer.

CO-3: Examine the climate change and its effect on living beings.

CO-4: Understand the physical basis of natural greenhouse effect on man and materials.

CO-5: Evaluate human influenced driver of our climate system and its applications.

CO-6: Know the biotic and abiotic components of ecosystem.

CO-7: Food chain & food web in ecosystem.

CO-8: Understand diversity among various groups of animal kingdom.

CO-9: Understand Animal community & ecological adaptation in animals.

CO-10: Scope, importance and management of biodiversity

Unit-1 Environment

- 1.1 Definition, principles and Scope of Environmental science.
- 1.2 Earth, Man and Environment, Ecosystems, Pathways in Ecosystems, Physico-chemical and Biological factors in the Environment, Geographical classification and zones.
- 1.3 Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere.
- 1.4 Scale of Meteorology, pressure, temperature, precipitation, humidity, radiation and wind.
- 1.5 Atmospheric stability, inversions and mixing heights, windroses

Unit-2 Ecosystem

- 2.1 Definition, Principles and scope of ecology, Human ecology and human settlement,
- 2.2 **Ecosystems:** Structure and functions, abiotic and Biotic components, food chains, food web, ecological pyramids, population, community ecology and parasitism, prey-predator relationships
- 2.3 Biomes of the world
- 2.4 Overview of Sanctuaries, National park and Botanical garden

Unit-3 Pollution

- 4.1 Air: Natural and anthropogenic sources of pollution, primary and secondary pollutants, Transport and diffusion of pollutants. Gas laws governing the behavior of pollutants in the atmosphere. Methods of monitoring and control of air pollution SO₂, NO_x, CO, SPM. Effects of pollutants on human beings, plants, animals, materials and on climate. Acid rain, Air Quality Standards
- 4.2 Water: Types, Sources and consequences of water pollution, physic-chemical and bacteriological sampling and analysis of water quality. Standards, sewage and waste water treatment and recycling. Water quality standard
- 4.3 Soil: Physico-chemical as bacteriological sampling as analysis of soil quality, Soil pollution control, Industrial waste effluents and heavy metals, their interactions with soil components. Degradation of different insecticides, fungicides and weedicides in soil. Soil organic and inorganic components
- 4.4 Global Environmental problems: Ozone depletion, global warming and climatic change, clean development mechanism.

Unit-4 Environmental Impact Assessment

- 3.1 Introduction to environment impact analysis, Environmental impact statement and environmental management plan, Impact Assessment methodologies
- 3.2 Generalized approach to impact analysis
- 3.3 Procedure for reviewing environmental impact analysis and statement
- 3.4 Principles of Remote sensing and its applications of environmental sciences, Application of GIS in Environmental management

SUGGESTED READING:

ZOOL. 210: ANALYTICAL TECHNIQUES

OBJECTIVES:

This is the only laboratory course taught independently of lecture courses. It has full hands on approach to expose the students to modern techniques and methodologies. The diverse techniques from microscopy to spectroscopy, calorimetry, chromatography ELISA, tissue culture to cloning etc. are included to make the student well versed with these protocols and methods.

COURSE OUTCOME:

CO-1: Understand the purpose of the technique, its proper use and possible modifications/ improvement.

CO-2: Learn the theoretical basis of technique, its principle of working and its correct application.

CO-3: Learn the construction repair and adjustment of any equipment required for a technique.

CO-4: Learn the accuracy of technique.

CO-5: Learn the maintenance laboratory equipments/ tools, safety hazards and precautions.

CO-6: Understand the technique of cell and tissue culture. Learn the preparation of solution of given percentage and molarity.

CO-7: Understand the process of preparation of buffer. Learn the techniques of separation of amino acids, proteins and nucleic acids.

Unit – 1 : Microscopy and Autoradiography

- 1.1 Theories of Tissue fixation and staining techniques
- 1.2 Principles of Transmission and Scanning Electron microscopy
- 1.3 Principles of Phase Contrast and Fluorescence Microscopy
- 1.4 Principle and applications of Autoradiography

Unit – 2 : Spectroscopy

- 2.1 Basic principles of Spectroscopy, UV, IR, Raman, ESR, ORD
- 2.2 CD and structure of proteins using NMR and ESR
- 2.3 Neutron and X-Ray diffraction for elucidation of 3D structure
- 2.4 Molecular modelling, Mass Spectrometry

Unit – 3 : Chromatographic techniques

- 3.1 Basic Principle and types of Chromatography
- 3.2 Gas Chromatography, GC-MS, LC – MS / MS
- 3.3 Ion Exchange Chromatography, gel permeation, Affinity and reverse phase chromatography
- 3.4 HPLC and FPLC

Unit – 4 : Centrifugation and Electrophoretic Techniques

- 1.1 Principle and applications of Centrifugation techniques
- 1.2 Basic principles of Electrophoresis, Agarose gel, native and SDS-PAGE
- 1.3 Isoelectric focusing, 2D-PAGE and their uses in protein research
- 1.4 Fractionation and Blotting Techniques

ZOOL. – 211 : COMBINED PRACTICAL COURSE

207. Biochemistry: Suggested Laboratory Work

1. To prepare a titration curve of a weak acid with a strong base
2. To prepare a titration curve and determine the pK and pI value of an amino acid
3. Qualitative analysis of Carbohydrates
4. To prepare a calibration curve of reducing sugars by DNSA
5. Extraction and estimation of reducing and non-reducing sugars by DNSA method.
6. To prepare a calibration curve of protein by Folin-Lowry method
7. Extraction and estimation of protein by Folin-Lowry method
8. To prepare a calibration curve of amino acid using Ninhydrin reaction method
9. Extraction and estimation of free amino acid content in germinating seeds by ninhydrin reaction method
10. To prepare a calibration curve for para nitrophenol
11. Estimation of enzyme acid phosphatase activity from given plant material
12. Determination of V_{max} and K_m
13. To separate amino acids by ascending paper chromatography
14. To determine acid value of fats and oils
15. To determine saponification value of fats and oils
16. Protein purification Table

208. Biotechnology: Suggested Laboratory Work

1. Isolation & Identification of Bacteria, Yeasts & Fungi
2. Biochemical Tests: Metabolic Activities of Enteric Bacteria: Sugar Fermentation, IMViC, H₂S production, Phenylalanine Deaminase Urea Hydrolysis, Nitrate Reduction, Amylase, Protease
3. Detection of Extracellular Alkaline Protease from Haloalkaliphilic Actinomycetes
4. Determination of Alkaline Protease from Haloalkaliphilic Actinomycetes using Anson-Hagihara's Method
5. Concept of Totipotency
6. Direct ELISA Technique

7. Indirect ELISA Technique
8. Antigen preparation
9. Preparation of plant tissue culture media
10. Callus culture from leaf material

209. Environmental Science: Suggested Laboratory Work

1. To determine water holding capacity of soil
2. To determine field capacity of soil
3. To determine soil-moisture by oven drying
4. To estimate the amount of organic carbon by Walkley and Black titration method
5. To estimate total nitrogen from given soil
6. To estimate the amount of Ca from given soil sample
7. To estimate the amount of Mg from given soil sample
8. To determine the amount of carbonate in the soil by rapid test
9. To determine the amount of nitrate by rapid test
10. To determine the base deficiency of soil by rapid test
11. To determine reductivity of soil by rapid test
12. To determine the amount of organic carbon by Walkley's titration method
13. To determine the amount of chloride by rapid test
14. To determine phosphate content in the soil
15. To study the meteorological apparatus
16. Dissolved oxygen (DO)
17. Biological oxygen demand (BOD)
18. Chemical oxygen demand (COD)
19. Bacteriological analysis by MNP
20. Color, turbidity, odour and pH, TS, TDS and TSS
21. Chloride estimation
22. Sulfate estimation
23. Ca-Mg Hardness
24. Phosphorus Phosphate estimation
25. Estimation of Nitrite-Nitrogen of given water sample

210. Analytical Technique: Suggested Laboratory Work

1. Demonstration of a state-of-the-art compound microscope with Brightfield, Phase-Contrast, Fluorescence and Darkfield operational details.
2. Demonstration of computer controlled brightfield microscopy
3. Demonstration of Image capturing and Image analysis by Image Analysis software
4. Determination of various image analysis parameters (cell or tissue length, width, diameter etc.) by using both microscopy and image capturing and analyses.
5. Demonstration of Stereo zoom dissecting microscope
6. Determination of various image analysis parameters (Tissue or Organism length, width, diameter etc.) by using both microscopy and image capturing and analyses.
7. Localization of anthocyanin in plant tissue
8. Localization of phenols in plant tissue
9. Localization of Tannins in plant tissue
10. Localization of alkaloids in plant tissue
11. Localization of lignins in plant tissue
12. Localization of starch in plant tissue
13. Localization of flavanoids in plant tissue
14. Determination of molecular mass of Protein by size exclusion chromatography (Theoretical)
15. PCR amplification of gene
16. DNA sequencing of the amplified gene
17. Electrophoresis of PCR product

M.Sc. ZOOLOGY : SEMESTER - III

Zool. – 313: STRUCTURE & FUNCTIONS OF INVERTEBRATES (CORE)

OBJECTIVES:

The course makes a detailed comparison of the anatomy of the different taxa of non-chordates. It also highlights how in the taxonomic hierarchy, there is an increase in the complexity of structure and function. The course thus gives an overview of the intricate life processes and adaptive radiations in non-chordates

COURSE OUTCOME:

CO-1: Develop an understanding of the characters used to classify besides being able to differentiate the organisms belonging to different taxa.

CO-2: Have hands on experience of materials demonstrating the diversity of protists and non-chordates.

CO-3: Understand the relative position of individual organs and associated structures through dissection of the invertebrate representatives.

CO-4: Realize that very similar physiological mechanisms are used in very diverse organisms.

CO-5: Get a flavor of research by working on project besides improving their writing skills. It will further enable the students to think and interpret individually.

CO-6: Undertake research in any aspect of animal physiology in future.

Unit -1.

- 1.1 Taxonomic procedures, animal collection, handling and preservation of Invertebrates.
- 1.2 Classification, organization and general characteristics of major invertebrate phyla.
- 1.3 Organization and general characteristics of minor phyla.
- 1.4 Organization and general characteristics of lower vertebrates.

Unit -2.

- 2.1 Strategies and evolutionary significance of larval forms.
- 2.2 Larval forms of free living invertebrates.
- 2.3 Larval forms of parasitic invertebrates.
- 2.4 Patterns of feeding and digestion in Invertebrates

Unit -3.

- 3.1 Locomotor organs and mode of locomotion in Invertebrates
- 3.2 Respiratory organs, pigments and mode of respiration in invertebrates
- 3.3 Excretion in Invertebrates
- 3.4 Reproduction in Invertebrates

Unit-4.

- 4.1 Agricultural pests and their pathogenicity
- 4.2 Pests of stored grains and their pathogenicity
- 4.3 Insect pest management: Chemical, environmental and biological control
- 4.4 Useful insects, general consideration and systematic. Silk, Lac and Honey

Zool - 314: MAMMALIAN PHYSIOLOGY (CORE)

OBJECTIVES:

The course deals with various physiological functions in mammals. It also gives an account of the metabolic/ biochemical pathways and the probable impact of environment on them.

COURSE OUTCOME:

CO-1: Understand the Importance of physiology and branches of it.

- CO-2:** Understand the terms-Osmosis, diffusion, pH and Buffer.
CO-3: Understand the Digestion and Excretion process, by studying the organs of it.
CO-4: Understand the process of Metabolism.
CO-5: Understand the term Detoxification.
CO-6: Understand the Circulatory system and Lymphatic system.
CO-7: Study the nervous system.
CO-8: Understand the process of vision and hearing.
CO-9: Understand the process of muscle contraction.

Unit -1.

- 1.1 Overview of mammalian digestive system. Physiological role of digestive juices.
- 1.2 Integumentary system. Skin glands and appendages.
- 1.3 Overview of mammalian reproductive system.
- 1.4 Ultrastructure and functions of mammalian Malpighian Corpuscles, proximal and distal convoluted tubules, Hennel's loop. Physiology of Urine formation.

Unit - 2.

- 2.1. Physiology of respiration: Detailed accounts of Ventilation, diffusion and Perfusion.
- 2.2. Cardio-vascular system. Structure and functions of special cardiac tissue, mechanism of heart beat.
- 2.3. O₂ transport.
- 2.4. CO₂ transport.

Unit - 3.

- 3.1. Ultrastructure of actin and myosin. Physiology and molecular basis of muscle contraction and the events therein.
- 3.2. Lymphatic System and its functions
- 3.3. Physiology of Thermoregulation
- 3.4. Osmoregulatory mechanisms in aquatic, terrestrial and desert animals.

Unit -4.

- 4.1. Sense of hearing - Ear: Organ of Corti and the physiology of hearing.
- 4.2. Sense of vision - Eye: Rod and Cone cells, biosynthesis of visual pigments and the photochemical reaction.
- 4.3. Sense of Smell : Ultrastructure of the Receptor cells, physiology of the sense of smell.
- 4.4. Sense of Taste : Ultrastructure of the Receptor cells, physiology of the sense of taste.

Zool – 315: HUMAN PARASITOLOGY (ELECTIVE)

OBJECTIVES:

This is a composite course with remarkable utility and importance Parasitology component takes care of the parasites and parasitism, emphasizing the influence of parasites on the ecology and evolution of free living species, and the role of parasites in global, public, and health. Immunology part provides the students with the fundamental knowledge of the immune system and its protective roles against diseases.

COURSE OUTCOME:

- CO-1:** To study and understand the scope and branches of Medical Zoology.
CO-2: To aware the students for various parasites and diseases which spreads in human with the help of study of host-parasite relationship.
CO-3: To increase awareness for the health in students.
CO-4: Understand the various disease causing vectors like Mosquitoes.
CO-5: To aware about the typhoid, cholera likes disease.

Unit-1.

- 1.1 Host – parasite relationship, importance of parasitic life cycle and infection
- 1.2 Classification of parasites and methods for diagnosis of parasitic disease
- 1.3 Protozoan and Amoebic parasites, lesions, diagnosis, pathogenesis, treatment & control
- 1.4 Classification, life cycle, pathogenesis, diagnosis, treatment and control of Flagellates and Haemoflagellates.

Unit-2

- 2.1 Plasmodiums: morphology, life cycle, immunity, pathogenesis, control and epidemiology
- 2.2 Life cycle and clinical feature of Apicomplexa, their importance in AIDS
- 2.3 Tape worms, their pathogenesis and control
- 2.4 Life cycle, pathogenicity, treatment and control of diseases caused by Trematodes.

Unit-3.

- 3.1 Nematodes, the diseases caused by them, their treatment and control
- 3.2 Tissue Nematodes, diseases caused by them, their treatment and control
- 3.3 Arthropods Vector and their classification, Mode of transmission and pathogenesis of diseases caused by Arthropod vectors
- 3.4 Control mechanisms of Arthropod vectors

Unit-4.

- 4.1 Opportunistic parasitic infections in people with HIV or AIDS
- 4.2 Sexually transmitted parasites
- 4.3 Parasitic infections in people with immunodeficiency, cancer and transplant recipients.
- 4.4 Diagnostic methods in parasitology

Zool – 316: DEVELOPMENTAL BIOLOGY & ADAPTATION (ELECTIVE)

OBJECTIVES:

The major objective of this course is to provide students with a sound coverage of human reproductive biology within the framework of Human Biology. It also envisages the detailed structure and function of the male and female reproductive tracts, gametogenesis, fertilization, early embryogenesis, foetal development and preparation for birth, and maternal adaptations to pregnancy.

COURSE OUTCOME:

CO-1: To understand Pregnancy: conception and blastocyst formation, implantation and delayed implantation, placenta: formation, types and functions, hormones in pregnancy.

CO-2: Explain and contrast the processes of spermatogenesis, oogenesis.

CO-3: Demonstrate an understanding of the hormonal control of reproduction in males and how this is regulated.

CO-4: Distinguish between the main stages of embryonic, foetal and neonatal development

Unit - 1.

- 1.1. Process of spermatogenesis. Structure and functions of Leydig cell and its regulation. Semen composition and functions of semen, assessment of sperm functions.
- 1.2. Process of Oogenesis, ovulation, Production of corpus luteum and its functions
- 1.3. Fertilization. Pre-fertilization and post-fertilization events.
- 1.4. Role of maternal contribution in early development. Cleavage patterns & fate map, cell differentiation

Unit - 2.

- 2.1. Blastulation of frog and chick
- 2.2. Gastrulation of frog and chick
- 2.3. Early embryonic development
- 2.4. Extra embryonic membranes and placenta

Unit - 3.

- 3.1. Levels of adaptation. Mechanisms of adaptation. Acclimation and acclimatization.
- 3.2. Physiological adaptations to terrestrial environment.
- 3.3. Physiological adaptations to freshwater environment
- 3.4. Physiological adaptations to marine, shore and estuarine environment.

Unit - 4.

- 4.1. Physiological adaptations in extreme terrestrial environment.

- 4.2. Physiological adaptations in extreme aquatic environment.
- 4.3. Parasitic adaptations
- 4.4. Basic concept of environmental stress and strain, concept of elastic and plastic strain, stress resistant, avoidance and tolerance.

Zool. – 317 : ANIMAL ECOLOGY (ELECTIVE)

OBJECTIVES:

This course focuses on the diversity of living forms particularly animals with a detailed inference on the loss of species due to various reasons and the need of their conservation.

COURSE OUTCOME:

CO-1: Engage in field-based research activities to understand well the theoretical aspects taught besides learning techniques for gathering data in the field.

CO-2: Analyse a biological problem, derive testable hypotheses and then design experiments and put the tests into practice.

CO-3: Solve the environmental problems involving interaction of humans and natural systems at local or global level.

Unit – 1 : Population Ecology

- 1.1 Population, population dispersion, types.
- 1.2 Population dynamics, demography, factors affecting population growth rate.
- 1.3 Biotic potential, exponential and logistic growth models,
- 1.4 Population density, r-selected and k-selected species, measurements of population indices. realized and fundamental niche

Unit – 2 : Community Ecology

- 2.1 Community concept, structure, indices
- 2.2 Resource partitioning, predation and prey populations, parasitism.
- 2.3 Plant defence against herbivores, defence against predators, defensive colouration, mimicry, chemical defence.
- 2.4 Keystone species

Unit – 3: Marine & Coastal Ecology

- 3.1. The shore environment. Physico-chemical and biological factors of intertidal zone. Distribution of life on rocky shores, sandy shores and muddy shores.
- 3.2. Zonation and adaptation of organisms in the intertidal habitats.
- 3.3. Benthos: Distribution of shallow water benthic organisms. Distribution and adaptation of deep-sea benthic organisms. Marine animal associations: commensalisms symbiosis and parasitism.
- 3.4. Coral reef ecology: Special features of coral reef habitats and distribution of coral reef organisms. Mangrove systems: Special features of mangrove habitats and distribution of plants and animals in mangrove ecosystems.

Unit – 4 : Environmental Monitoring and Bio deterioration

- 4.1 Anthropogenic activity and Environment: Environmental monitoring methods. Toxicology: Classification of toxicants and xenobiotics including metals, pesticides, solvents and POPs. Lethal and sub lethal effects of pollutants, evaluation of toxicity tolerance, bioassay.
- 4.2 Role of biotechnology in environmental pollution control: Indicator organisms, Test organisms, Monitoring organisms, Enzymes.
- 4.3 Coastal developmental activities-environmental issues. Micro and Macro fouling, corrosion of metals and alloys in the sea, effects of bio-fouling and bio deterioration on marine structures.
- 4.4 Environmental Policy and Environmental Impact Assessment. Anti-corrosion and fouling application of biotechnology in controlling the bio deterioration of wood and synthetic substances in the sea. Red tides: Cause character and effects on the organisms of Marine environment

Zool. – 318 : COMBINED PRACTICAL COURSE

Z-313: Structure & Functions of Invertebrates

1. Systematic study of lower invertebrate through permanent slides (protozoa to porifera).
2. Systematic study of lower invertebrate through permanent slide (coelenterate to aschelminthes).

3. To study the mouth parts of some insects (Arthropoda) through permanent slide.
4. To study the methods of protozoan culture.
5. To study isolation and identification of various protozoa from given water sample.
6. Systematic study of phylum coelenterate through specimen.
7. Systematic study of phylum Platyhelminthes through specimen.
8. Demonstration of alimentary canal of *Pheretima Posthuma* (earthworm).
9. Demonstration of blood glands, ovary, nephridia, setae and testes of earthworm.
10. Demonstration of reproductive system of *Pheretima Posthuma*.
11. To study the systematic study of minor phyla.
12. To study the systematics of lower chordates through specimen.
13. Preparation of permanent mounting of a given material.

314. Mammalian Physiology

1. Anatomical and Physiological perspectives of mammalian circulatory system
2. Anatomical and Physiological perspectives of mammalian Urino-genital system
3. Anatomical and Physiological perspectives of mammalian Brain and cranial nervous system
4. Anatomical and Physiological perspectives of mammalian neck nerves
5. Physiological characteristics of skeletal muscle, pectin, medullated and non-medullate nerves
6. Tissue (block) preparation for the histological studies of mammalian tissues.
7. Permanent histological preparation of major tissues
8. Permanent histological preparation of few endocrine glands
9. Spotting of histological slides
10. Histochemical studies on Enzyme activity

315. Human Parasitology

1. Life cycle of different Human parasites
2. Characteristic features of different human parasites
3. Observations of histological / permanent preparation of various human parasites

316. Developmental Biology & Adaptation

1. Studies on the permanent slides of different stages of frog embryo.
2. Studies on the permanent slides of different stages of chick embryo.
3. Studies on the different stages of chick embryo. Permanent preparation of chick embryo
4. Chick embryo transplantation

317. Animal Ecology

1. Studies on the animals from different ecological habitats of the intertidal zones.
2. Studies on the adaptational characteristics of different ecological habitats.
3. Studies on the population indices (Density, Abundance, Frequency) of ecological habitats.
4. Studies on the community indices of ecological habitats.

M.Sc. ZOOLOGY : SEMESTER - IV

Zool. – 419: AQUACULTURE & FISHERIES TECHNOLOGY (CORE)

OBJECTIVES:

This course will give the students an understanding of the principles of aquaculture, including production systems, water quality, nutrition, spawning, larval culture and culture methodologies with special reference to fish, and prawn. The course will include an opportunity to conduct hands-on activities related to culture and husbandry of animals

COURSE OUTCOME:

CO-1: To understand the Aquaculture concept, Culture systems: Freshwater aquaculture systems: Freshwater prawn culture, fish culture in paddy fields, Brackish water culture, Mariculture: Oyster culture, Crab culture, Lobster culture, mussel culture, culture of Eels, Culture of aquatic weeds.

CO-2: To understand the Composite fish culture and Preparation and management of fish culture ponds.

CO-3: Transport of fish seed and Brood fish and Harvesting: Fishing techniques, preservation & processing of fish and Fish pathology.

CO-4: To understand Fresh water prawn culture and Pearl culture, Pearl producing mollusks, pearl formation, collection of oysters, rearing of oysters, insertion of nucleus, harvesting of pearls, composition & quality of pearl.

CO-5: To understand the Technologies in Fisheries development: Recirculation technology, Geographic Information System (GIS) technology, passive Acoustics in fisheries, Use of Information Communication Technology (ICT) in fishes: production aspects, marketing aspects.

Unit – 1

- 1.1 Diversity of Fish, Systematics and Taxonomy: Origin of fish, Jawless fish, cartilaginous and bony fish.
- 1.2 Aquaculture and its importance: Advantages, scope and status of aquaculture in India and Gujarat. Aquaculture techniques and controlling factors.
- 1.3 Fishing vessels: Materials for manufacturing boats, parts of boats, types of boats both traditional and modern used in India as well as in Gujarat, their characteristics and advantages.
- 1.4 Fishing gears: structure and applications of gill net, hoop net, scine net, purse – scine net, drift net, trawl net and hook – line net.

Unit – 2

- 2.1 Fish Preservation: Need of preservation, common criteria for freshness, methods of preservation and their advantages.
- 2.2 Fish Processing: Methods used in industries, their advantages and applications.
- 2.3 Fish by-products: Common and industrial fish by-products and their uses.
- 2.4 Fish marketing and fisheries management: Production and Marketing strategies, over fishing problem, fisheries management, fishing community and other factors.

Unit-3

- 3.1 Freshwater capture and culture fisheries, status in India and Gujarat, fishing gears and main fishing centres.
- 3.2 Estuarine capture and culture fisheries. Status of Gujarat compared to National Status, fishing gears and main fishing centres, development of estuarine brackish water culture fishery.
- 3.3 Marine capture fisheries: Status of Gujarat in comparison to the National status. Pomfret fishery, Bombay duck fishery, Prawn fishery, deep – sea fishery, fishing gears, fishing season and main landing centres of Gujarat.
- 3.4 Marine capture fisheries: Lobster, crab, molluscan and Pearl Oyster fisheries of Gujarat State.

Unit-4

- 4.1 Accessory respiratory organs in fish: Need, detailed structure and respiratory functions of external gills, skin, lining of the gut, labyrinthiform organ, saccular organ air bladder.
- 4.2 Colour changing in fish: Detailed morphological structure of chromatophore cells, their types and pigment content, physiology of colour change and controlling factors. Reproductive strategies of fish: Spawning migration, location of egg deposit, mode of fertilization and parental care.
- 4.3 Induced breeding: Fish breeding, hypophysation technique, factors controlling induced breeding, fish seed collection, transport and stocking.
- 4.4 Fish diseases and control: Common fungal, bacterial, protozoan and other diseases of fish, symptoms and control methods.

Zool. – 420: NEUROBIOLOGY (CORE)

OBJECTIVES:

This course will start from the basics of the nervous system of invertebrates and will gradually move towards a more complex vertebrate nervous system. The students will also be taught about the types of synapse, neurotransmitters and their receptors besides other related aspects.

COURSE OUTCOME:

CO-1: Understand the structure of brain and improved methods to study it.

CO-2: Develop treatments for neurodegenerative diseases (such as Alzheimer's and Parkinson's diseases) and mental illnesses.

CO-3: Understand the structure of different lobes of the brain and their corresponding functions.

CO-4: Understand intricacies of nerve impulse conduction.

Unit-1

- 1.1 Nervous system in Invertebrates, Evolution of brain.
- 1.2 Basic plan of nervous system in vertebrates
- 1.3 Morphology and functions of different parts of human brain
- 1.4 Histogenesis of nerve tissue. Classification, structure and functions of neurons, neuroglia.

Unit-2

- 2.1 Formation of myelin sheath, resting equilibrium, action potential and measurements.
- 2.2 Synapses and their classification, ultrastructure of synapse
- 2.3 Neurotransmitters, their classification and functions.
- 2.4 Glucose and energy metabolism in brain.

Unit-3

- 3.1 Neuropeptides and their functions.
- 3.2. Endorphins; opiate peptides, pain killers and their functions
- 3.3 Memory: STM, LTM, Physiology of memory.
- 3.4 Role of Central Nervous System in hypertension

Unit-4

- 4.1 Epilepsy and its control
- 4.2 Melatonin: chemical structure & functions.
- 4.3 Depressions and their control.
- 4.4 EEG, brain topography and its applications

Zool. – 421 : MARINE BIOLOGY (Elective)

OBJECTIVES:

The program of study aims to provide students with a broad-based foundation in science together with extensive subject knowledge in the discipline of marine biology. It also aims to develop a range of transferable research, analytical and communication skills.

COURSE OUTCOME:

CO-1: A student will collaboratively and independently.

CO-2: Use basic ecosystem principles, identify and understand the biology of various marine phyla to characterize marine

habitats.

CO-3: Use scientific techniques to quantitatively describe parameters of marine habitats and understand the relationship of physical parameters to distribution of biota.

CO-4: Use an understanding of research, laboratory and/or field experiences to organize data to illustrate and articulate basic ecological principles.

CO-5: Use critical thinking to evaluate human impacts on marine ecosystems and consider how local consumer and policy decisions can be informed by an understanding of the interconnectedness of marine habitats and the critical relationship of the sea to human cultures.

Unit - 1: Physical and Chemical Oceanography

- 1.1 Physical oceanography light, temperature, salinity, density and pressure distribution in the oceans. Currents: Relative currents, wind currents, upwelling and sinking.
- 1.2. Tides: tide-producing forces and tide characteristics. Circulation patterns and currents. Ocean-land-atmospheric interactions: Monsoons, cyclones, anticyclones
- 1.3 Chemical Oceanography: Salinity and chlorinity, pH and carbon dioxide systems in the sea water.
- 1.4. Distribution of nutrients and their cycles. Eutrophication. Dissolved and particulate organic matter in the sea: its chemical nature and properties.

Unit - 2. Biological Oceanography & Marine Living Resources

- 2.1 Introduction of plankton nekton and benthos; general classification and composition of plankton; floating mechanism of plankton. Collection of plankton, instruments and nets employed, methods of fixation and preservation of plankton, Distribution of plankton in space and time.
- 2.2. Primary production: Survey of methods, factors affecting Primary production: Phytoplankton – zooplankton relationships.
- 2.3. Marine food chains (pelagic and benthic). Mass-mortality in sea: Red water phenomenon.
- 2.4. Marine Microbiology: Marine Bacteria: general account of their role in the economy of the sea.

Unit - 3. Estuaries and Coastal Zone management

- 3.1. Estuarine and coastal environment: classification and physico – chemical parameters of estuaries. Distribution of estuarine plankton, nekton and benthos. Estuarine birds, estuarine food web. Mangroves, sea-grasses, marine fungi.
- 3.2. Marine and coastal living resources and their management.
- 3.3. Coastal Zone Management: Impact of dredging, mining and pollution on coastal habitats and their management methods.
- 3.4. Remote sensing application in coastal zone management. Coastal zone regulations.

Unit - 4. Marine Pollution, Conservation and Tourism

- 4.1. Marine Pollution: Major sources of pollution. Sewage: Domestic, Industrial, agricultural and aquacultural discharges, their composition and fate in the marine environment, toxicity and treatment methods, sewage disposal system. Environmental Impact Assessment Methods of coastal activities.
- 4.2. Oil pollution: Sources and fate of oil, composition and toxicity of oil, biological effects treatment procedures. Enzymatic removal of hazardous organic substances from aqueous effluents.
- 4.3. Thermal and radioactive pollution: Source and characteristics, strategies for disposal of RNA and Heated effluents, biological effects and alternative uses of waste dumping, mining and dredging operations, their effects on the organisms and marine environment
- 4.4. Marine Tourism of India and Abroad, Famous Beaches of India, Eco-tourism and recreational tourism, marine Amusement parks and their impact on Tourism, various causes affected to Eco-tourism.

Zool. – 422 : WILDLIFE BIOLOGY & ANIMAL BEHAVIOUR (Elective)

OBJECTIVES:

The course is an introduction to wildlife management and gives an account of the tools used by wildlife managers. Topics covered are to equip students with adequate knowledge of various biodiversity monitoring methodologies, conservation and management issues of vertebrate pests, wildlife conflict and over abundant species, wildlife health and diseases.

COURSE OUTCOME:

CO-1: Develop an understanding of how animals interact with each other and their natural environment

CO-2: Develop the ability to use the fundamental principles of wildlife ecology to solve local, regional and national conservation and management issues

CO-3: Develop the ability to work collaboratively on team-based projects

CO-4: Demonstrate proficiency in the writing, speaking, and critical thinking skills needed to become a wildlife technician

CO-5: Gain an appreciation for the modern scope of scientific inquiry in the field of wildlife conservation management

CO-6: Develop an ability to analyze, present and interpret wildlife conservation management information.

Unit-1. Outline of Ecological sub-divisions of Indian Wildlife

- 1.1 Review and classification of Indian herpetofauna, birds and mammals
- 1.2 Himalayan Mountain Systems and Indian Deserts
- 1.3 Peninsular Indian sub-region and Tropical Evergreen Forests
- 1.4 Andaman - Nicobar Islands and Mangrove Forests (Sundarvan)

Unit-2. Conservation and Development

- 2.1 Causes of wildlife depletion and Legislation
- 2.2 Biosphere reserves and Zoos in India
- 2.3 Important National National Parks & Sancturaies of India
- 2.4 National Parks & Sanctuaries of Gujarat

Unit-3. Wildlife Management, Protection & Case Histories

- 3.1 Extensive and intensive management, instruments used for wildlife management
- 3.2 Identification of Damage & Control methods
- 3.3 Endangered species, Project Tiger, Gir Lion Sanctuary Project, Crocodile, Hangul and Musk Deer Projects.
- 3.4 Wildlife and migratory route. International Trade in Endangered species

Unit-4 Animal Behaviour

- 4.1. Animal behaviour : Classification, instinct, imprinting, learning, foraging and feeding behaviour.
- 4.2. Sexual behaviour, social behaviour and parental care. Socio-biology of birds and mammals
- 4.3. Circadian rhythm, Kin selection concept, its importance in hymenoptera and altruism.
- 4.4. Adaptive radiation, zoogeographical realms and types of distribution. Migration of fish, birds and mammals

Zool – 423: ENDOCRINOLOGY & REPRODUCTIVE PHYSIOLOGY (Elective)

OBJECTIVES:

The major objective of this course is to provide students with a sound coverage of human reproductive biology within the framework of Human Biology. It also envisages the detailed structure and function of the male and female reproductive tracts. The course envisages information on endocrine system with emphasis on the structure of hypothalamus and anterior pituitary. The associated hormones and the related disorders will be explained.

COURSE OUTCOME:

CO-1: Learn about hypothalamo and hypapophysial axis.

CO-2: Understand about different endocrine glands and their disorders.

CO-3: Understand the mechanism of hormone action.

CO-4: To understand Reproductive organ: male and female gonads, duct systems and sex accessories, external sexual dimorphisms

CO-5: Understand the Reproductive patterns: Environmental factors and breeding, continuous and seasonal breeders.

CO-6: Understand the Sexual cycles: puberty, oestrous and menstrual cycles. Ovarian event: follicular phase, cycling of non-pregnant uterus and vagina.

CO-7: Know how sexually transmitted diseases may contribute to altered neonatal or reproductive function.

CO-8: Critically assess relevant scientific literature in Human Reproductive Biology and present their argument in oral and written work.

Unit - 1.

- 1.1. Local and endocrine hormones, their characteristics.
- 1.2. Mechanism of hormone action.
- 1.3. Characteristics of pituitary hormone secreting cells, neurohypophysis and its hormones.
- 1.4. Pituitary hormones and their functions and control.

Unit - 2.

- 2.1. Ultrastructure of Thyroid gland. Biosynthesis of thyroid hormones, control of thyroid hormone secretion, thyrocalcitonin, hypo and hyper thyroidism, goiter.
- 2.2. Ultrastructure of Parathyroid gland and its hormones.
- 2.3. Ultrastructure of endocrine Pancreas, its hormones and their functions.
- 2.4. Insulin and blood - glucose regulation.

Unit-3.

- 3.1. Ultrastructure of Adrenal glands, its hormones and their functions.
- 3.2. Renin - Angiotensin system and its role in blood pressure regulation.
- 3.3. Functions of kidney hormones.
- 3.4. Local hormones and their functions

Unit – 4.

- 4.1. Gonadal hormones and their functions. Physiology of sexual development.
- 4.2. Hormonal control of reproduction. Reproductive disorders.
- 4.3. Causes of Infertility in human, its control and management.
- 4.4. Contraceptive technologies. IVF and other assisted reproductive technologies.

Zool. – 424 : COMBINED PRACTICAL COURSE

419. Aquaculture & Fisheries Tech.

1. Classification of fish
2. Studies on the various types of fishing gears.
3. Studies on various types of fishing vessels.
4. Studies on the organoleptic methods for freshness determinations of fish.
5. Anatomical consideration of the brachial system of fish.
6. Identification of unknown fish up to the genus level by using identification keys.
7. Length-weight relationship in prawns.
8. Gonado-Somatic Index and Fecundity Index of fish

Z-420: Neurobiology

1. To study the nervous system of *Pheretima Posthuma* (earthworm).
2. To study the nervous system of Sepia (cuttle fish).
3. To study the nervous system of Aplysia (sea hare).
4. Demonstration of brain slicer and slicing.
5. To study the electron micrograph of nerve cells and study of cell organelles.
6. To study various cell organelles and neuronal components of nerve cell and some diagrams.
7. Study of the indigenous device and some diagrams with reference to some nerve physiology.
8. To study about electroencephalogram.
9. To study about brain topography and its application.

421. Marine Biology

1. Determination of Dissolve Oxygen (DO) concentration of given water sample by Winkler's methods.
2. Determination of Biological Oxygen Demand (BOD) from given water sample by Winkler's methods.
3. Estimation of primary productivity.
4. Determination of Total Dissolve Solids (TDS).
5. Determination of chlorinity and salinity.
6. Determination of total alkalinity and conductivity.

422. Wildlife Biology & Animal Behaviour

1. Field Study: Bird Watching.
2. Field study: Behavioural activity of wild animals
3. To study the occurrence of activities
4. To study the scale pattern of given materials
5. Several tools and technique used for wildlife study
6. Advance research methods : 3S techniques
7. Dentition and dental formulae in mammals
8. To study tracks of animals and birds
9. Functional anatomy and biomechanism in animals
10. Behavioural ethogram in birds
11. Zoogeographical realms and types of distribution
12. Studies on Herps
13. Extensive and intensive managements for conservation
14. Habitat case studies

423. Endocrinology & Reproductive Physiology

1. Anatomical features of the male reproductive system of mice/rat.
2. Anatomical features of the female reproductive system of mice/rat.
3. Endocrine glands mice/rat.
4. Histological study of the permanent slides of endocrine glands.
5. Symptoms and disorders related to changing hormonal level.

DISSERTATION PROJECT WORK

Dissertation research work is offered to students of Semester III & IV to carry out research according to the provision of objectives and teacher guide. Students are allowed to apply in other national and international level research institutes, Universities and industries of high repute to pursue one year dissertation research project for the partial fulfillment of M.Sc. Zoology degree.