VISVA-BHARATI
(A Central University)

Learning Outcomes based Curriculum Framework (LOCF) for

M.Sc. in ZOOLOGY
(CHOICE-BASED CREDIT SYSTEM)

[With effect from the Academic Session 2025-2026]

Department of Zoology
SikshaBhavana (Institute of Science)
Visva-Bharati (A Central University)
Santiniketan – 731235, West Bengal, India

Ordinance of M.Sc. in Zoology

Choice Based Credit System (CBCS) for M.Sc.in Zoology

[With effect from the Academic Session: 2025-2026]

Overall Course Objectives:

- **To introduce students across diverse fields of Zoology**
- **To develop in the students advanced in-depth knowledge of various fields of the subject**
- **To empower students with practical skills**
- **To provide quality education in different specializations**
- **To receive constructive feedback from the students and their time to time assessmentand evaluation**
- **To encourage the development of analytical skills and prepare them to appear for competitive examinations**

Pattern of examination in each semester

(i) **Internal assessment (continuous): 20% of the total marks in each paper (Theory and Practical).**

(ii) **Duration of each semester-end Theory examinations (80%) will be:**

a. **Three hours for each paper of 40 marks**
b. **Four hours for each paper exceeding 40 marks**

(iii) **Duration of each semester-end Practical examination (80%) will be: Four hours**

(iv) **Paper-Setting and Moderation of questions for Theory papers will be carried out jointly by Internal and External members, while answer scripts will be evaluated only by the Internal examiners.**

(v) **Practical examinations will be conducted jointly by Internal and External examiners.**

(vi) **The evaluation of Project work at the end of the Fourth Semester will be based on dissertations submitted by the students and Viva-voce. Assessment will be done by both Internal and External examiners.**

Department of Zoology
Siksha Bhavana (Institute of Science)
Visva-Bharati

Choice Based Credit System (CBCS) for M.Sc. in Zoology

Course Structure

Sl.No.	Study components	Semester component	Number of courses	Credits	Final credit	Marks	Full Marks
1	Core course	**I -III**	18	4	72	50	900
2	Elective course	**IV**	1	8	8	100	100
3	Optional course	**IV**	2	8 + 4	12	150	150
4	Project work	**IV**	1	4	4	50	50
	Total		**22**		**96**		**1200**

Internal Assessment – 20% (Theory and Practical)
Duration of Theory Examination : 3 hours each
Duration of Practical Examination : 4 hours each

Semester-wise Marks / Credit distribution

Semester	Core		Elective	Optional		Project Work
	Theory	Practical		Theory	Practical	
I	200	100				
II	200	100				
III	200	100				
IV			100	100	50	50
Total	**600**	**300**	**100**	**100**	**50**	**50**

Outline of M.Sc. Choice Based Credit System (CBCS) Syllabus in Zoology

Core Courses

Course No.	Course Type	Course Title	Credit	Marks	Contact Hours
		SEMESTER I			
MZCT – 101	Theory	**Fundamentals of Biochemistry**	4	50	
MZCT – 102	Theory	**Immunology**	4	50	
MZCT – 103	Theory	**Cell Biology**	4	50	
MZCT – 104	Theory	**Genetics and Molecular Biology**	4	50	
MZCP – 105	*Practical*	**Biochemistry and Immunology**	4	50	
MZCP – 106	*Practical*	**Cell Biology, Genetics and Molecular Biology**	4	50	
		SEMESTER II			
MZCT – 201	Theory	**Structure and functions of Animal Tissues**	4	50	
MZCT – 202	Theory	**Theoretical basis of Methods in Biology**	4	50	
MZCT – 203	Theory	**Ecology and Conservation Biology**	4	50	
MZCT – 204	Theory	**Animal Behavior and Evolution**	4	50	
MZCP – 205	*Practical*	**Ecology and Animal Behavior**	4	50	
MZCP – 206	*Practical*	**Preparation and Study of Animal Tissues**	4	50	
		Semester III			
MZCT – 301	Theory	**Developmental Biology**	4	50	
MZCT – 302	Theory	**Biology of Infectious Diseases**	4	50	
MZCT – 303	Theory	**Comparative Endocrinology**	4	50	
MZCT – 304	Theory	**Comparative Animal Physiology**	4	50	
MZCP – 305	Practical	**Developmental Biology & Biology of Infectious Diseases**	4	50	
MZCP– 306	Practical	**Comparative Endocrinology and Physiology**	4	50	
		Semester IV			
MZET – 401	Theory	Any one from the list of Elective papers	8	100	
MZOT – 402	Theory	Any one from the list of Optional theory papers	8	100	
MZOP – 403	*Practical*	Any one from the list of Optional practical papers	4	50	
MZPW –404	*Project*	*Based oneither***MZET-401** or **MZOT-402** papers	4	50	

Choice Based Credit System (CBCS) for M.Sc. in Zoology

Detailed Syllabus

First Semester

Total Credits: 24 **Marks: 300**

THEORY PAPERS

Core Theory Paper:

MZCT-101 (FUNDAMENTALS OF BIOCHEMISTRY) **Credits: 4** **Marks: 50**

About the course: The course offers an in-depth understanding of the principles of metabolic regulation, intermediary metabolism and oxidative phosphorylation. It provides a detailed insight into the mechanism of enzyme action with emphasis on the regulatory enzymes. The course covers different levels of protein structure in detail and aims to enlighten the students how structural information can be utilized for better understanding of biological function.

Learning outcomes: After successfully completing this course, the students will be able to:

- Understand the importance of metabolic regulation in maintaining homeostasis.
- Understand the structure and biological function of FoF1 ATPase.
- Understand the working mechanism of regulatory enzymes.
- Describe primary, secondary, tertiary and quaternary structures of proteins.

Contents:

1. Laws of thermodynamics and their applications; Concept of free energy and calculations based on free energy change.

2. pH and Buffers: Concept of acids and bases; Buffers; Biological buffer systems: the phosphate buffer system, the bicarbonate buffer system.

3. Metabolism: Biosynthesis and degradation of nucleotides; Concept of integration of metabolic pathways; Coordinated metabolic regulation with particular examples of Glycolysis & Gluconeogenesis, and Glycogenesis & Glycogenolysis; Regulatory enzymes.

4. Oxidative Phosphorylation: Review of electron transport chain; Structure and function of mitochondrial ATP synthase; Mechanism of rotational catalysis.

5. Protein structure: Primary, Secondary, Tertiary and Quarternary structure; Protein denaturation and folding.

6. Enzymes: Fundamental principles of enzyme kinetics and activation energy, Overview of Michaelis-Menten equation, related calculations, Double-Reciprocal plot. Mechanisms of enzyme action: Active site, substrate binding, transition state analogues and abzyme. Acid-base and covalent catalysis (chymotrypsin, carboxypeptidase).

Suggested readings:

- *Lehninger Principles of Biochemistry by David L. Nelson & Michael M. Cox, Publisher: W.H. Freeman and Company*
- *Biochemistry by Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer, Publisher: W.H. Freeman and Company*
- *Biochemistry: A Short Course by John L. Tymoczko, Jeremy M. Berg, LuberStryer, and Gregory J. Gatto Jr., Publisher: W.H. Freeman and Company*
- *Biochemistry: The Molecular Basis of Life by Donald Voet, Judith G. Voet, and Charlotte W. Pratt Publisher: Wiley*

Core Theory Paper:

MZCT-102 (IMMUNOLOGY) Credits: 4 Marks: 50

About the course: The course is designed to impart fundamental knowledge of innate and adaptive immunity. The students will be introduced to the mechanisms of humoral and cell-mediated immune responses. The course provides understanding of complement system and its activation. The students will learn about antigen presentation in detail.

Learning outcomes: After successfully completing this course, the students will be able to:

- Identify the major cellular components which comprise the innate and adaptive immune system.
- Understand the function of antigen presenting cells.
- Understand how B cells and T cells mediate immune responses.
- Understand how humoral and cell-mediated immune responses complement each other.

Contents:

1. Basic concepts of innate and adaptive immunity.
2. Complement system-activation, participation in T cell mediated immunity.
3. Antigen presenting cells, antigen presentation to T lymphocyte, MHC molecules.
4. Cell mediated immunity- Helper T cell, cytotoxic T cell, NK cell and their mode offunction.
5. Humoral Immunity- B cell and its activation. Origin, maturation and activation of immunoglobulin, Structural and functional variations of immunoglobulin molecules, B cell-T cell interaction.
6. Hypersensitivity and autoimmunity: Types of hypersensitivity, autoimmunity, autoimmune diseases and autoimmune disorder; peripheral tolerance and T regulatory cells.
7. Immunotherapy: Introduction to immunotherapy, immunological diseases, Chimeric antigen receptor T cells (CAR-T cells); Antibody therapies.
8. Transplantation: Immunological basis of graft rejection.

Suggested readings:

- *Janeway's Immunobiology by Kenneth Murphy and Casey Weaver, Publisher: Garland Science*
- *Kuby Immunology by Jenni Punt, Sharon Stranford, Peter J. Selin, and Abul K. Abbas, Publisher: W.H. Freeman and Company*
- *Essential Immunology by Ivan Roitt, Publisher: Wiley-Blackwell*
- *Cellular and Molecular Immunology by Abul K. Abbas, Andrew H. Lichtman, and Shiv Pillai, Publisher: Elsevier*
- *Immunology by David Male, Jonathan Brostoff, David B. Roth, and Ivan M. Roitt, Publisher: Elsevier*
- *Immunology: A Short Course by Richard Coico and Geoffrey Sunshine, Publisher: Wiley-Liss*

Core Theory Paper:

MZCT-103 (CELL BIOLOGY) Credits: 4 Marks: 50

About the course: The course provides knowledge of the structure and function of cellular organelles and transport across cell membranes. It also gives a detailed account of the molecular processes of replication, transcription, translation and explains the regulation of various cellular signal transduction pathways.

Learning outcomes: After successfully completing this course, the students will be able to:

- Understand the functions of cell membrane and organelles
- Understand the mechanisms involved in the flow of genetic information from genes to proteins
- Learn cellular signaling and its regulation.

Contents:

1. Model of membrane structure, lateral mobility of membrane components (FRAP, FLIP), mechanism of sorting and regulation of intracellular transport.
2. Structure and functions ofnucleus, peroxisomes, plastids, vacuoles, cytoskeleton.
3. Process of transcription, formation of initiation complex, RNA polymerases, transcription factors; transcription activators and repressors, capping, elongation and termination.
4. Ribosomes, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code.
5. Unit of replication, replication origin and fork, fidelity of replication.
6. Signal transduction pathways, second messengers, regulation of signaling pathways.

Suggested readings:

- *Molecular Biology of the Cell" by Alberts, Johnson, Lewis, Raff, Roberts, and Walter Publisher: Garland Science*
- *The Cell: A Molecular Approach by Geoffrey M. Cooper, Publisher: Sinauer Associates*
- *Molecular Cell Biology by Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Alan A. Schatz, Publisher: W. H. Freeman & Company*
- *Cell and Molecular Biology: Concepts and Experiments by Gerald Karp, Publisher: Wiley*
- *Principles of Cell Biology by George Plopper, Publisher: Jones & Bartlett Learning*

Core Theory Paper:

MZCT-104 (GENETICS AND MOLECULAR BIOLOGY) Credits: 4 Marks: 50

About the course: This is a composite course designed to provide advanced concepts of Genetics and Molecular Biology. Some key aspects include the C-value paradox, transposons and evolution of genomes. The course covers chromosomal aberrations, various human genetic disorders and DNA recombination and repair mechanisms. A strong emphasis will be laid on the modern tools and techniques used in genetic engineering and how it has revolutionized the pharmaceutical, health and agricultural industries.

Learning outcomes: After successfully completing this course, the students will be able to:

- Understand C-value paradox and analyze genome complexity.
- Understand the chromosomal basis of human genetic disorders.
- Learn about the various lesions in DNA and how these are repaired.
- Thoroughly understand recombinant DNA technology which holds application in biomedical science, agriculture and environment management.

Contents:

1. C-value paradox; unique and repetitive sequences in eukaryotic genome; multiple gene families; significance of genomic evolution in animals.

2. Transposable elements in prokaryotes and eukaryotes.

3. The human chromosomes, chromosomal abnormalities and human disorders.

4. DNA recombination (Homologous and Site-specific); DNA repairmechanisms in prokaryotes and eukaryotes (types: base excision, nucleotide excision, mismatch repair, direct repair, error-prone repair, and recombinational repair).

5. Recombinant DNA technology, Polymerase chain reaction (PCR), qRT-PCR genomic and cDNA libraries, genome analysis- Southern Blot hybridization and northern hybridization, preparation of probes, DNA sequencing, Human genome project.

6. Genomics (structural genomics, functional genomics, epigenomics, metagenomics and mutational genomics). Gene knockout technology; Genome-Editing technologies: Principles and Applications. Genome sequencing techniques. Next generation sequencing.

Suggested readings:

- *Genetics: A Conceptual Approach by Benjamin A. Pierce, Publisher: W. H. Freeman and Company*
- *Principles of Genetics by D. Peter Snustad, Michael J. Simmons, Publisher: Wiley*
- *Genomes 4 by Author: T.A. Brown, Publisher: Garland Science*
- *Molecular Biology of the Gene by James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick*

Core Practical Paper:

MZCP-105 (BIOCHEMISTRY AND IMMUNOLOGY) Credits: 4 Marks: 50

About the course: This is a course designed to enhance practical skills in various types of quantitative estimations and enzyme kinetics. The course will also enable students to isolate immune cells and study antigen-antibody interactions.

Learning outcomes: After successfully completing this course, the students will be able to:

- Perform biochemical tests for blood glucose, protein, DNA and RNA.
- Learn enzyme kinetics.
- Isolate splenocytes and thymocytes
- Analyze antigen-antibody interactions.

Contents:

1. Quantification of Blood glucose, Protein, RNA and DNA.
2. Study of Enzyme kinetics (*Salivary amylase*).
3. Isolation of splenocytes and peritoneal exudates cells from rat/mice.
4. Basic principle and applications of: Immunodiffusion, ELISA, RIA, Western blotting, and Immunoprecipitation.

Core Practical Paper:

MZCP-106 (CELL BIOLOGY, GENETICS & MOLECULAR BIOLOGY) Credits: 4 Marks: 50

About the course: This is a course designed to enhance practical skills in cell biology, genetics and molecular biology. The course aims to enlighten students about mitosis, karyotyping and *Drosophila* genetics. The students will learn the techniques of agarose gel electrophoresis and polymerase chain reaction.

Learning outcomes: After successfully completing this course, the students will be able to:

- Study the various phases of mitosis.
- Understand life cycle and mutations in *Drosophila*.
- Learn the techniques of agarose gel electrophoresis and PCR.
- Understand the applications of PCR in research, forensics and diagnostics.
- Develop keen interest in molecular biology.

Contents:

1. Preparation of metaphase chromosome from mouse bone marrow cells.
2. Meiotic chromosome preparation from grasshopper testes.
3. Preparation of karyotypes.
4. Drosophila genetics: Preparation of culture medium, Study of *Drosophila* Life cycle, wild and mutant flies.
5. PCR and DNA Gel Electrophoresis.

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Second Semester

Total Credits: 24 **Marks: 300**

THEORY PAPERS

Core Theory Paper:

MZCT-201 (STRUCTURE AND FUNCTIONS OF ANIMAL TISSUES) Credits: 4 Marks: 50

About the course: This is will enable the students learn about histology and histochemical techniques. It is designed to impart knowledge about tissue organization in vital organs.

Learning outcomes: After successfully completing this course, the students will be able to:

- Know principle of fixation and various fixatives
- Learn about different staining methods
- Understand the structural organization of vital organs
- Learn about principle and applications of FISH

Contents:

1. Preparation of animal tissues for microscopic studies:
   a. Fixation and Fixatives:Basic principle of fixation, Properties and classification of different fixatives.
   b. Biological Stains:Basic principle of staining, Sources, Chemistry and Properties ofHaematoxylin, Eosin, Carmine, Basic Fuchsin and Acid Fuchsin
2. Histochemical study of animal tissues (Basic principle and theoretical basis):Reactions for *Acid and Alkaline Phosphatases*, PA-Schiff Reaction, Feulgen Reaction, Metachromasia, Immunocytochemical reactions.
3. Histophysiology of:Stomach, Small Intestine, Large Intestine, Kidney, Liver
4. Fluorescent *in situ* hybridization (FISH): Basic principle and applications.

Suggested readings:

- *Functional Histology: A Text and Colour Atlas by G. S. Cotran, V. Kumar, and S. L. Robbins, Publisher: Elsevier*
- *Histology: A Text and Atlas by Michael H. Ross, Wojciech Pawlina, Publisher: Lippincott Williams & Wilkins*
- *Animal Histology and Histochemistry by P. L. Thangam and S. S. Mukherjee, Publisher: Wiley-Blackwell*

Core Theory Paper:

MZCT-202 (THEORETICAL BASIS OF METHODS IN BIOLOGY) Credits: 4 Marks: 50

About the course: This course is aimed to help the students learn various tools & techniques in Biology.

Learning Outcomes: After successfully completing this course, the students will be able to:

- Explain principles of microscopy, spectrophotometry, centrifugation, and chromatography
- Learn the principle and applications of flow cytometry
- Learn basics of cell culture

- Know about different bioinformatics-based tools used for data analyses

Contents:

1. Microscopy: Light microscopy: structural components of compound microscope; principle and application of bright field, phase contrast and fluorescence microscope.

2. Electron microscopy: Scanning Electron Microscopy and Transmission Electron Microscopy: Methods of biological sample preparations for Electron Microscopy.

3. Spectrophotometry: Basic principle and applications.

4. Different separation methods: Centrifugation, Electrophoresis (Native and SDS-PAGE), Size exclusion, affinity and ion-exchange chromatography. HPLC , LC/MS and GC/MS.

5. Electrophoresis: Two-dimensional gel electrophoresis, isoelectric focusing gels.

6. Basic principle and applications of: flow- cytometry.

7. Aseptic handling procedures; types of media used in animal cell culture; preparation of primary and secondary culture system; maintenance of cell culture and sub culture; Cell viability assays.

8. Data analytic resources: NCBI, EBI, ExPASy, Sequence and structure data- bases, Sequence analysis, Sequence-based database searches, Pair wise sequence alignments & Multiple sequence alignments, Taxonomy and phylogeny.

Suggested readings:

- *Principles and Techniques of Biochemistry and Molecular Biology" by John M. Wilson and Andrew Walker, Publisher: Cambridge University Press*
- *Modern Experimental Biochemistry" by Rodney R. Boyer, Publisher: Pearson*
- *Tools and Techniques in Biomolecular Science" by Aysha Divan and Janice Royds, Publisher: Springer*
- *Flow Cytometry: A Practical Approach" by A. Omerod, Publisher: Oxford University Press*
- *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications" by R. Ian Freshney, Publisher: Wiley-Blackwell*
- *Bioinformatics: Sequence and Genome Analysis" by David W. Mount, Publisher: Cold Spring Harbor Laboratory Press*

Core Theory Paper:

MZCT-203 (ECOLOGY AND CONSERVATION BIOLOGY) Credits: 4 Marks: 50

About the course: This course is designed with the objective of helping students understand the interactions of organisms (populations) and their environments and the consequences of these interactions for population, community, and ecosystem dynamics.It explains the importance of biodiversity to ecosystems or conservation of wildlife to environment.

Learning Outcomes: The successful learner will be able to

- Understand the consequences of pollution and cite the incidences/cases that were occurred in the past due to pollution.

- Understand and apply knowledge to problems related to biodiversity conservation.Apply the basic principles of conservation biology.

Contents:

1. System Ecology: Modern concepts of primary and secondary productivity, Lindeman's concept of community dynamics, Flow of energy through grazing and detritus pathways, Ecological efficiency ratios.

2. Population Ecology: Properties of population, Intrinsic rate of increase, Carrying capacity, Population growth, Survivorship, Population fluctuation, Density dependent and independent factors of population regulation, Metapopulation, Population interactions, Interspecific competition, Competition theory.

3. Community Ecology: Local and regional factors to structure communities, Guild and assemblage, Ecotone and habitat fragmentation, Niche pre-emption, Distributional relations of species in communities, Indictor species in communities, Diversity gradients, Factors cause diversity gradients.

4. Ecosystem health - Human impacts: Carrying capacity of Earth, Demographic transition, Ecological footprint, Basic concept of integrated ecosystem theories (emergy, exergy, ascendency, dissipation) and their application for ecosystem health assessment.

5. Environmental pollution: Types and sources of air, soil ,water and sound pollution, Effects of pollution on organisms, Control measures of pollution, Smog formation, Thermal inversion, Green house gases and global warming, Ozone hole, Acid rain, Circulation of pesticides and radio-isotopes in ecosystems and biomagnifications.

6. Conservation Biology: concept of conservation and preservation, Principles of Conservation Biology, Strategic species concept, Biodiversity and Conservation, Wild life concept.

Suggested readings:

- *Ecology by P. A. Colinvaux, Publisher: Wiley, John and Sons, Inc*
- *Ecology by C. J. Krebs Publisher: Benjamin Cummings*
- *Fundamentals of Ecology by E.P. Odum, Publisher: Brooks/Cole*
- *Ecology and field biology by Robert Leo Smith, Publisher: Harper and Row*
- *Ecology" by R.E. Ricklefs, Publisher: Chiron Pres*
- *Wildlife Ecology and Management by G. Caughley, G., and ARE Sinclair, Publisher: Blackwell Science.*
- *People and Wildlife, Conflict or Co-existenceR Woodroffe ,Thirgood, S. and Rabinowitz, A., Publisher: Cambridge University*
- *Research and Management Techniques for Wildlife and Habitats by T.A. Bookhout, Publisher: Allen Press.*
- *The Conservation Handbook: Research, Management andPolicyby W.J. Sutherland. Publisher: Blackwell Sciences*
- *Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory" by M.L. Hunter, J.B. Gibbs, and E.J. Sterling, Publisher: Blackwell Sciences*

Core Theory Paper:

MZCT-204 (ANIMAL BEHAVIOUR AND EVOLUTION) Credits: 4 Marks: 50

About the course: This course will help the learners understand and appreciate different types of animal behaviors, their adaptive, evolutionary and practical significance. It covers types, mechanisms and importance of the biological rhythms and biological clocks operating in the living organisms.

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Learning Outcomes: The successful learner will be able to

- Understand and be able to objectively evaluate the role of behavior in the protection and conservation of animals in the wild.
- Consider and evaluate behavior of all animals, including humans, in the complex ecological world, including the urban environment

Contents:

1. Approaches in behavioral studies, Types of behaviour, Fixed action pattern (FAP), Instinct, Motivation, Conflict and stress, Types of learning, Imprinting, Maintenance and body care activities, Forms of sleep, Escape and defense strategies, Evolutionarily stable strategy, Biological clocks, Circadian rhythm.

2. Aggression and appeasement, Altruism, Eusociality, Kin selection, Territory and home range, Social dominance and hierarchy, Habitat selection and optimality of foraging, Social communication, Reproductive strategy, Significance of courtship, Female choice, Parental investment and reproductive success.

3. Hardy -Weinberg Law.

4. Factors of evolution: natural selection, genetic drift, gene migration, mutation.

5. Basic concept of speciation.

6. Isolating mechanism.

7. Polymorphism; Origin of life; Molecular evolution.

Suggested readings:

- *Animal Behaviour (Ethology) by V. K. Agarwal, Publisher: S. Chand*
- *Animal Behaviour: An Evolutionary Approach by J. Alcock,Publisher: Sinauer Associates*
- *Behavioural Ecology: An Evolutionary Perspectiveon Behaviour by E. Danchin, L. A. Giraldeau, and F. Cezilly,Publisher: Oxford University Press*
- *An introduction to behavioural ecology by N. B. Davies, J. R. Krebs, and S. A. West Publisher: Wiley-Blackwell*
- *Animal Behaviour: Mechanisms, Ecology, Evolution by L. Drickamer, S. Vessey and E. Jakob, Publisher: McGraw-Hill*
- *Principles of Animal Behavior by L. A. Dugatkin, Publisher: Princeton University Press*
- *Evolution by N.H. Barton, D.E.G. Briggs, J.A. Eisen, D.B. Goldstein and N.H. Patel,Publisher: CSHL Press*
- *Genetics: Analysis and principles by Robert J. Brooker, Publisher: McGraw-Hill Science*
- *Evolution by T. Dobzhansky, F. J. Ayala, G. L. Stebbins and J. W. Valentine,Publisher: W.H.Freeman& Co Ltd*
- *Evolution by D. Futuyama. Publisher: Sinauer Associates*

- *Strickberger's Evolution by B. K. Hall, and B. Hallgrimson, 4th ed. Publisher: Jones and Bartlett.*
- *Principles of Population Genetics by D. L. Hartl, Publisher: Sinauer Associates*
- *Evolutionary Biology by D, Minkoff, Publisher:Sinauer Associates*
- *Molecular Evolution: A Phylogenetic Approach by R. D. M. Page, and E. C. Holmes, Publisher: BlackwellScience*
- *Evolution by M. Ridley, Publisher: Blackwell Science*

Core Practical Paper:

MZCP-205 (ECOLOGY AND ANIMAL BEHAVIOUR) Credits: 4 Marks: 50

About the course: This course aims to develop skills, concepts and experience to understand all aspects of animal behavior. It employs statistical approaches to analyze wildlife and conservation biology data.

Learning Outcomes: The successful learner will be able to

- Inculcate scientific quantitative skills, evaluate experimental design, read graphs, and analyse and use information available in scientific literature.
- Develop skills, concepts and experience to understand all aspects of animal behavior.

Contents

1. Estimation of major chemical parameters of water and soil samples: Dissolved oxygen (Winkler), GPP & NPP (light and dark bottle), Total hardness (EDTA), C.O.D. (Chromic acid digestion), Organic carbon in soil (Walkley & Black).
2. Determination of requisite size of quadrant by species area curve method, Application of Standard deviation and Standard error to experimental data, Analysis of growth rate in animals using Correlation coefficient, Estimation of biomass by Bomb calorimeter.
3. Demonstration of basic behavioral mechanisms (habituation to light stimulus in earthworm, aggregation in woodlouse, phototactic and geotactic responses in housefly, maintenance behavior in white rat, insight learning in animals).
4. Study of common behavior patterns in animals using visual aids, Study of specific behavior sequences in field condition and submission of photographs, Demonstration of home range patterns, escape and defense mechanisms in animals.
5. Parametric test: t-test (Sample, Pooled or Unpaired and Paired), ANOVA, (One way and Two way)

Core Practical Paper:

MZCP-206 (PREPARATION AND STUDY OF ANIMAL TISSUES) Credits: 4 Marks: 50

About the course: This will enable the students learn practical aspects of histology and get trained in histochemical techniques. It is designed to impart practical demonstration of tissue organization in vital organs.

Learning outcomes: After successfully completing this course, the students will be able to:

- Learn the method of histology
- Visualize structural features of vital organs
- Learn to operate microtomy and prepare tissue sections

Contents:

1. Preparation of animal tissues for microscopic studies:Fixation, Dehydration,Infiltration, Embedding
2. Microtomy of paraffin sections.
3. Hematoxylin-Eosin and Mallory trichome staining and permanent preparation of animal tissues.
4. Microscopic study of:Stomach, Small Intestine, Large Intestine, Liver, Kidney, Testis, Ovary
5. Histochemical demonstration of carbohydrate, lipid and protein.

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Third Semester

Total Credits: 24 **Marks: 300**

THEORY PAPERS

Core Theory Paper:

MZCT-301 (DEVELOPMENTAL BIOLOGY) **Credits: 4** **Marks: 50**

About the course: This course provides knowledge about the fundamental concepts of developmental genetics. It covers important aspects of mechanism of cell fate determination, regenerative medicine and genetics of axes specifications. The student will be introduced to genetics of aging and senescence as well.

Learning Outcomes: After successfully completing this course, the students will be able to:

- Understand differential gene expression in cell fate determination
- Learn about regeneration and regenerative medicine
- Study the genetics of axes specifications
- Know about the developmental concepts in evolution.

Contents:

1. Saga of germline differentiation, germ cell migration.

2. Genomic equivalence- concept and evidence, Differential gene expression and mechanism of cell fate determination.

3. Regeneration: Epimorphosis, morphallaxis, stem cell mediated regeneration and compensatory regeneration, Cartesian and polar coordinate models for pattern formation in morphallaxis and epimorphosis.

4. Regenerative medicine: Cellular potency; Stem cells: Adult stem cell (Haematopoietic stem cell, Neuronal stem cell, Intestinal stem cell, Mesenchymal stem cell, Stem cell niche), Embryonic (ESCs), Induced pluripotent stem cell (iPSCs). Therapeutic applications of stem cells, organoid.

5. Genetics of axes specification in *Caenorhabditis elegans* and in *Drosophila* sp.; Role of *Hox* gene in axis specification of mammal.

6. Genetics of aging and senescence; Genetics of developmental anomalies and birth defects.

7. Developmental mechanism of evolutionary changes: Evo-Devo concept, Heterochrony, Heterotropy. Heterometry, Heterotypy

Suggested readings:

- *Molecular Priciples of Animal Development by A. M. Arias and A. Stewart,Publisher: Oxford University Press*
- *Developmental Biology by M.J. F. Barresi and S.F. Gilbert. Publisher: Sinauer Associates*
- *Introduction to Embryology by B. Balinsky, Publisher: Holt Rinehart & Winston*

- *Developmental Biology by L. W. Browder, Publisher: CBS College*
- *Patten's Foundations in Embryology by B. M. Carlson, Publisher: McGraw Hill*
- *Analysis of Biological Development by K. Kalthoff, Publisher: McGraw Hill*
- *Moody, S.A. (Ed.) (2007). Principles of Developmental Genetics. Publisher: Academic Press*
- *Embryology – An Introduction to Developmental Biologyby S. Shostak, Publisher: Harper Collins*
- *Essential Developmental Biology by J. M. W. Slack, Publisher: Blackwell Twyman, R.W. (2001). Instant Notes-Developmental Biology. Publisher: Viva Books Private*

Core Theory Paper:

MZCT-302 (BIOLOGY OF INFECTIOUS DISEASES) Credits: 4 Marks: 50

About the course: This course is designed to help students understand the biology of emerging and re-emerging infectious diseases such as Polio, tuberculosis, dengue fever, influenza, hepatitis, giardiasis, amoebiasis, cholera and typhoid.It covers agents causing the diseases, morphology and life cycle, interactions with the host cell immune response and the vectors for the pathogens.

Learning Outcomes: After successfully completing this course, the students will be able to:

- Identify parasites, viruses and bacteria.
- Understand the process of virus and bacterial infections and how they reproduce
- Learn control strategies to prevent the diseases.
- Define and distinguish among endemic rates of disease, epidemics and pandemics.
- Know about different drugs and vaccines.

Contents:

1. Emerging and re-emerging infectious diseases- Polio, Tuberculosis, Dengue fever, Influenza, Hepatitis; structure, genome organization, translation and replication of the causative agent; pathogenicity and host immune response to infection, control and treatment. Types of Influenza virus and strains, pandemics, antigenic drift and antigenic shift; different phases of tuberculosis and multidrug resistance.

2. Food and water borne diseases- Pattern of disease, incidence, symptoms and diagnosis of *Giardiasis, Amoebiasis, Typhoid and Cholera,* route of transmission of infectious agents and host immune response.

3. Vector and Vector-pathogen interactions - behavior, mouth parts, type of diseases and vector potential of Mosquitoes, Ticks and Fleas.

4. Vaccines and virulence - historical perspectives, principles of vaccination types of vaccines (live attenuated, inactivated, subunit, conjugate, viral vector vaccines) and their mechanisms, vaccine development process, virulence factors and their role in disease progression.

Suggested readings:

- *Dengue and Dengue Hemorrhagic Fever by D. J. Gubler, E. E. Ooi, S. Vasudevan, J. Farrar, Publisher: CABI Publishing*
- *Principles of Virology by S.J.Flint, L.W. Enquist, V.R Racaniello and A. M. Skalka, Publisher: Wiley*
- *Introduction to Modern Virology. by N. J Dimmock, and S. B Primrose,Publisher: Blackwell Scientific Publications, London*
- *The biology of viruses by B. A Voyleys, Publisher: McGraw-Hill*

- *Field's Virology: Emerging Viruses by P.M. Howley, D M. Knipe, S. Whelan, Publisher: Lippincott Williams & Wilkins*

Core Theory Paper:

MZCT-303 (COMPARATIVE ENDOCRINOLOGY) Credits: 4 Marks: 50

About the course: This course covers in detail the endocrine system and mechanism of hormone action. It provides concepts of comparative anatomy and evolution of hypothalamic-hypophysial system in vertebrates. The details of important endocrine glands and their hormones are also provided in this course.

Learning Outcomes: After successfully completing this course, the students will be able to:

- Know the structure, function and regulation of endocrine glands
- Learn about mechanism of hormone action and second messengers
- Understand the comparative anatomy of hypothalamic-hypophysial system in vertebrates
- Gain knowledge about neuroendocrine control in insects

Contents:

1. Characteristic features of the endocrine system. Chemical nature and classification of animal hormones.

2. Molecular mechanism of hormone actions, cell signaling: Mechanism of actions of steroid and peptide hormones emphasizing the role of second messengers.

3. Hypothalamo-hypophysial system in vertebrates:Components, comparative anatomy and evolution of hypothalamic neuro-secretory nuclei and neurohypophysial hormones;

Adenohypophysis: Anatomy, cellular characteristics and distribution of pituitary cell types and functions; Chemical nature, site of synthesis and functions of hypothalamic hormones.

4.Biosynthesis and functions of: (a) Thyroid, (b) Parathyroid, (c) Pancreas, (d) Adrenal, and (e) Pineal hormones

5.Gonads (Testis and Ovary): Structure of testis and ovary; Organization and physiological roles of androgens, estrogen, progesterone, relaxin and inhibin; Steroid hormones: biosynthetic pathways.

6. Gastrointestinal hormones (secretin, gastrin and cholecystokinin).

7. Neuroendocrine system in insects: Components, chemical nature of different hormones, role in the regulation of different physiological and behavioral activities.

Suggested readings:

- *Molecular Endocrinology by M. Bolandar,Publisher: Elsevier Science*
- *Basic and Clinical Endocrinology by F. S. Greenspan, and F. G. Gardener, Publisher: McGraw Hill.*
- *Endocrinology by M. E. Hadley, Publisher: Pearson Education*
- *Vertebrate Endocrinology by D. O. Norris, Publisher: Academic Press.*
- *Williams Textbook of Endocrinology by S. Melmed, K. S. Polonsky, P. R. Larsen, and H. M. Kronenberg, Publisher: Saunders*

Core Theory Paper:

MZCT-304(COMPARATIVE ANIMAL PHYSIOLOGY) Credits: 4 Marks: 50

About the course: This courseprovides an integrated understanding of vital physiological mechanisms in vertebrates. It covers all the important physiological processes in detail.

Learning Outcomes: After successfully completing this course, the students will be able to:

- Understand all physiological processes of vertebrates &analyse them biochemically.
- Correlate the comparative physiology of the systems and understand their regulation & control.

Contents:

1. Physiology of circulation: Composition and functions of blood and lymph and mechanisms blood coagulation in vertebrates and invertebrates.
2. Physiology of respiration: Chemistry and functions of respiratory pigments in vertebrates and invertebrates; Respiratory centers: organization and function; Hemoglobin and gaseous transport
3. Physiology of excretion: Urine formation and regulation, Acid-base balance, Renal function test.
4. Autonomic nervous system: Classification, Anatomy and Functions in vertebrates.
5. Physiology and regulation of osmoregulation in vertebrates.
6. Hormonal regulation of Estrous and Menstrual cycles

Suggested readings:

- *Berne and Levys' Physiology by B. M. Koppen and B. A. Stanton, Publisher: Mosby.*
- *Review of Medical physiology by W. F. Ganong, Publisher: McGraw Hill.*
- *Concise Medical Physiology by S. K. Chaudhuri, Publisher: New Central Book Agency (P) Ltd.*
- *Animal Physiology by R.W. Hill, G.A. Wyse and M. Anderson, Publisher: Sinauer Associates Inc*
- *General and comparative Physiology by W. S. Hoar, Publisher: Prentice-Hall of India.*
- *Eckert's Animal Physiology – Mechanisms and Adaptation by D. Randall, W. Burggren and K. French Publisher: W. H. Freeman.*
- *Human Physiology: From cells to systems, L. Sherwood, Publisher: Thomson Brooks Cole*
- *Animal Physiology: Adaptation and Environment, K.N. Schmidt, Publisher: Low Price Cambridge Edition*
- *Environmental Physiology of Animals by P. Willmer, G. Stone, and I. Johnston, Publisher: Wiley Blackwell*

Core Practical Paper:

MZCP-305 (DEVELOPMENTAL BIOLOGY & BIOLOGY OF INFECTIOUS DISEASES) Credits: 4 Marks: 50

About the course: This course provides practical knowledge about developmental concepts, and also vectior biology.

Learning Outcomes: After successfully completing this course, the students will be able to:

- Identify developmental stages of chick embryo
- Prepare polytene chromosomes
- Identify common insect vectors

Contents:

1. Microscopic observation of transverse sections of chick embryo at various hours of incubation.
2. Study of regeneration.
3. Preparation of polytene chromosome.
4. Study of Imaginal disc of *Drosophila* sp./Regeneration of *Planaria*/ *Hydra*/ Amphibia.
5. Study of protozoan parasites from gut content.
6. Detection of quality of milk sample by methylene blue reductase test.
7. Determination of antibiotic sensitivity.
8. Gram staining.
9. Serial dilution: Agar Plate procedure quantitative viable cells.
10. Identification of common insect vectors.

Core Practical Paper:

MZCP-306 (COMPARATIVE ENDOCRINOLOGY AND PHYSIOLOGY) Credits: 4 Marks: 50

About the course: This courseprovides practical knowledge about concepts in comparative endocrinology and physiology.

Learning Outcomes: After successfully completing this course, the students will be able to:

- Perform surgical procedures of Orchidectomy; Ovariectomy; Adrenalectomy
- Identify different stages of estrous cycle
- Develop skill in assessing various male and female reproductive parameters

Contents:

1. Surgical procedures in laboratory rat for: Orchidectomy; Ovariectomy; Adrenalectomy.
2. Study of vaginal smear of adult female rat for identification of different stages of estrous cycle.
3. Androgen bioassay by sialic acid assay.
4. Biochemical estimation of fructose in seminal vesicle.
5. Study of stages of spermatogenesis and spermiogenesis using histological slides of testis.
6. Studies on mammalian ovarian follicular growth and development using histology slides.
7. Study of various sperm parameters (sperm count, motility and viability).

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FourthSemester

Total Credits: 24 **Marks: 300**

THEORY PAPERS

Elective Theory Paper: Choose any one Elective Theory paper from the following list: I to VI)

I. Elective Theory Paper:

MZET-401 (POPULATION AND COMMUNITY ECOLOGY) **Credits: 8** **Marks: 100**

About the course: The course offers knowledge to apply a mathematical or conceptual model to population or community dynamics, abundance and other community attributes. It explains the various laws and regulations that influence how natural resources are used and protected. It also aims to illustrate the different attributes of community ecology.

Learning outcomes: After successfully completing this course, the students will be able to:

- Know about wildlife and conservation biology and how different principles are used to manage wildlife conservations and management.
- Be familiar with the laws and regulations that influence how natural resources are used and protected.
- Know about the different special projects to protect and conserve biodiversity in India.
- Develop awareness about biodiversity conservation.

Contents:

1. Ecological statistics and data analysis: Scale of measurements, Statistical inferences, Probability theory, Test of association, measure of association, Similarity and distance coefficient, Cluster analysis.

2. Quantitative ecology: Average rate of growth, instantons rate of change, the derivative of a function, Summation and area under curve, differential equations in ecology, Matrix operations, simulation.

3. Population ecology: Population growth, Exponential, logistics and Gompertz growth, Calculation of doubling time, Carrying capacity, Discrete population growth, Age structured population growth, Leslie matrix and Euler equation in population growth.

4. Community Ecology: Community interactions, Relative Abundance, Species abundance models, Lotka-Volterra equation on Competition and predation, Host-disease interaction, Resource partitioning; Character displacement.

5. Wildlife management: Wildlife concept, cause of extinction, wild life protection act; Measure of conservation strategies; Red data book, green book, national park, wild life sanctuaries; Indian case studies on conservation / management strategy (project tiger, biosphere reserves).

Suggested readings:

- *Ecology by P. A. Colinvaux, Publisher: Wiley, John and Sons, Inc*
- *Ecology by C. J. Krebs Publisher: Benjamin Cummings*

- *Fundamentals of Ecology by E.P. Odum, Publisher: Brooks/Cole*
- *Ecology and field biology by Robert Leo Smith, Publisher: Harper and Row*
- *Ecology" by R.E. Ricklefs, Publisher: Chiron Pres*
- *Wildlife Ecology and Management by G. Caughley, G., and ARE Sinclair, Publisher: Blackwell Science.*
- *People and Wildlife, Conflict or Co-existence R Woodroffe ,Thirgood, S. and Rabinowitz, A., Publisher: Cambridge University*
- *Research and Management Techniques for Wildlife and Habitats by T.A. Bookhout, Publisher: Allen Press.*
- *The Conservation Handbook: Research, Management and Policy by W.J. Sutherland. Publisher: Blackwell Sciences*
- *Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory" by M.L. Hunter, J.B. Gibbs, and E.J. Sterling, Publisher: Blackwell Sciences*

II. Elective Theory Paper:

MZET-401 (ENTOMOLOGY) **Credits: 8** **Marks: 100**

About the course: This course introduces the students to the fundamental concepts of entomology covering the morphology, anatomy and physiology of insects.

Learning outcomes: After successfully completing this course, the students will be able to:

- Know the various types of mouth parts, special organs & metamorphosis of insects
- Learn the physiological processes in insects
- Develop idea about comparative insect physiology

Contents:

1. Classification of insects up to families of selected orders: Coleoptera, Hemiptera, Orthoptera, Diptera, Hymenoptera and Lepidoptera, Integument: Structure and functions of cuticle, Moulting and Sclerotization.

2. Structure and modification of Mouthparts, Legs, Antennae and wings in insects; Colouration in insects.

3. Importance of insects in nature and human life, Co-evolution of insects and human civilization, Insect-plant interactions (Pollination, Gall formation, Feeding and defense strategies), Sensory organs in insects.

4. Comparative idea about structure and physiology of circulatory, nervous and reproductive systems, Haemolymph, Neuroendocrine system, Unusual types of development, Factors affecting fecundity and fertility in insects.

Suggested readings:

- *The Insects: Structure and Function by R. F. Chapman, S. J. Simpson, and A. E. Douglas, Publisher: Cambridge University Press*
- *General and Applied Entomology by B. V. David and T. N. Ananthakrishnan, Publisher: Tata McGraw-Hill*
- *The Insects – an outline of Entomology by P. J. Gullan, and P. S. Cranston, Publisher: Blackwell*

- *Insect Molecular Genetics– An introduction to principles and Applications by M.A. Hoy, Publisher: Academic Press.*
- *Medical and veterinary Entomology by D. S. Kettle, Publisher: CAB International.*
- *Physiological Systems in Insects by M. Klowden, Publisher: Academic Press.*
- *Medical and Veterinary Entomology by G.R. Mullen and L.A. Durden, Publisher: Academic Press*
- *Biological and Biotechnological control of Insect pests by J. E. Rechcigl and N. A. Rechcigl, Publisher: Lewis Publishers.*
- *The Science of Entomology by S. W. Romoser and J. G. Stoffolano, Publisher: McGraw Hill.*
- *A textbook of Applied Entomology by K. P. Srivastava, and G.S. Dhaliwal, Publisher: Kalyani*

III. Elective Theory Paper:

MZET-401 (FISH BIOLOGY) **Credits: 8** **Marks: 100**

About the course: This paper covers in details important aspects of fish biology.

Learning outcomes: After successfully completing this course, the students will be able to:

- Know the classification of fish
- Learn about swim bladder and sensory systems in fish
- Understand the physiology of digestion, respiration and reproduction.

Contents:

1. Classification of fish up to living order.
2. Swim bladder and maintenance of buoyancy; Locomotion in fish and hydrodynamics.
3. Olfactory and gustatory system and chemoreception; mechanoreception; Electric organ, electroreceptors and electroreception; Bioluminescence in Fish.
4. Food and feeding habits; Digestive system; Aquatic and aerial respiration.
5. Age and growth of fish.
6. Biology and importance of *Catla catla*, *Clarias batrachus*, *Anabas testudineus*
7. Physiology of digestion; Fish bioenergetics.
8. Reproductive system: Structure of gonads, gametogenesis, vitellogenesis.
9. Hormonal and environmental control of reproduction.

Suggested readings:

- *Biology of Fishes by C. E. Bond, Publisher: Saunders*
- *The Physiology of Fishes by D. H. Evans,Publisher: CRC Press.*

- *The Freshwater Fishes of the Indian Region by K. C. Jayaram, Publisher: Narendra Publishing House, New Delhi.*
- *A textbook of Fish Biology and Fisheries by S.S. Khanna, H.R. Singh, Publisher: Narendra Publishing House, New Delhi.*
- *Ichthyology by K. F. Lagler, J. E. Bardach, R. R. Miller and D. R. Passino,Publisher: John Wiley & Sons, New York.*
- *Biotechnology and Genetics in Fisheries and Aquaculture by A. R. Beaumont and K. Hoare, Publisher: Blackwell*

IV. Elective Theory Paper:

MZET-401 (MOLECULAR CELL BIOLOGY & GENETICS) Credits: 8 Marks: 100

About the course: The course offers detailed insight of the cell cycle and its regulation. It provides better understanding of the concepts of gene regulation in prokaryotes, bacteriophages and eukaryotes. It covers the different aspects of cellular communication and cancer biology. The students will learn about the different modes of cell death and its physiological significance.

Learning outcomes: After successfully completing this course, the students will be able to:

- Know about cell cycle checkpoints and its regulation in cancer progression.
- Develop concepts about the uniformity and differences in the regulation of gene expression in different systems.
- Relate control of gene expression with extracellular environmental signals and metabolic cues.
- Understand the biology of Cancer.
- Learn about the genes and proteins involved in carrying out apoptosis, necrosis and autophagy.
- Know the conditions inducing cell death and its role in normal physiology and in disease.

Contents:

1. Cell division and cell cycle: Mitosis and meiosis, their regulation; Steps in cell cycle; Control of cell cycle.
2. Biology of Cancer: Normal and cancer cells, Cell transformation, DNA and tumor viruses, Chromosomal basis of human cancer, Regulation of cell cycle in cancer progression.
3. Cellular Communication: General principles of cellular communication, cell adhesion and roles of different adhesion molecules, gap junctions, extra cellular matrix, integrins.
4. Cell Death: Different types of cell death (Intrinsic and extrinsic pathways of apoptosis; necrosis, pyroptosis; ferroptosis, and mechanism of autophagy).
5. Control of gene expression in prokaryotes: Principles of gene regulation and regulatory proteins; Regulation of gene expression in bacteria with reference to *lac* operon, *trp* operon, SOS response, rRNA genes, CRISPR-Cas system.
6. Control of gene expression in phages: Regulatory strategies in virulent and temperate phages.
7. Control of gene expression in eukaryotes: Nucleosomes, Promotersand Enhancers, Activators and coactivators; Regulation of genes of galactose metabolism in yeast.Chromatin remodeling, Histone modifications; Gene silencing: antisense RNA, microRNAs, RNAi.

Suggested readings:

- *Molecular Biology of the Cell" by Alberts, Johnson, Lewis, Raff, Roberts, and Walter Publisher: Garland Science*
- *The Cell: A Molecular Approach by Geoffrey M. Cooper, Publisher: Sinauer Associates*
- *Molecular Cell Biology by Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Alan A. Schatz, Publisher: W. H. Freeman & Company*
- *Cell and Molecular Biology: Concepts and Experiments by Gerald Karp, Publisher: Wiley*
- *Principles of Cell Biology by George Plopper, Publisher: Jones & Bartlett Learning*
- *Genetics: A Conceptual Approach by Benjamin A. Pierce, Publisher: W. H. Freeman and Company*
- *Principles of Genetics by D. Peter Snustad, Michael J. Simmons, Publisher: Wiley*

V. Elective Theory Paper:

MZET-401 (PARASITOLOGY) **Credits: 8** **Marks: 100**

About the course: This course gives the students updated knowledge on parasite host interactions and various symbiotic associations, epidemiology of infection, the types of helminth parasite its development right from egg structure, hatching and the factors involving its development to adult. It covers host-parasitic interactions with vertebrate and invertebrate host as well as study of different parasites infected plants of economic importance and the interaction with its host. The course deals with physiology of the parasites which include nutrition uptake, nutrition in the parasites and the energy metabolism.

Learning Outcomes: After successfully completing this course, the students will be able to:

- Know about the biology, physiology and biological roles, development of parasites and its interaction with the host.
- Develop interest in pursuing research on various aspects of parasite physiology
- Relate the knowledge for controlling the infection and help in the welfare of mankind.

Contents:

1. Introduction to parasitism, microenvironment and phases of parasitism, general pathogenicity parasites in invertebrate hosts, life cycle of trematodes as a system of adaptation, systematic account and diagnostic features of various orders of Eucestoda.
2. Cuticle and tegument: Ultrastructure and function of tegument of trematodes and cestodes, cuticle of nematodes, apicoplast in *Plasmodium* and kinetoplast in trypanosomatids,

3. Epidemiology and control of parasitic diseases, principle and concept- burden and impact of neglected tropical diseases (lymphatic filariasis and schistosomiasis), epidemiology and control of soil transmitted helminth (hook worm: *Ancylostoma*and round worm: *Ascaris lumbricoides*), global health initiatives for neglected diseases.

4. Biology of Helminth eggs: structure, egg formation, egg laying and hatching of nematode, cestode and trematode eggs.

5. Biology of Plant nematodes: structure, life cycle, pathogenesis and control of *Meloidogyne incognita, Tylenchulussemipenetrans*and *Anguina tritici*, disease resistance mechanism in plants.

6. Nutrition in parasites: Feeding apparatus and feeding mechanism in nematodes, uptake of food by *Plasmodium*.

7. Energy metabolism: Carbohydrate uptake and glycolysis in anaerobic, aerobic and apicompexa and helminthes with reference to *Ascaris lumbricoides.*

Suggested readings:

- *General Parasitology by T.C. Cheng, Publisher: Academic Press*
- *The physiology and biochemistry of Cestodes by J.D. Smyth and D.P.McManus, Publisher: Cambridge University Press*
- *Physiology of Nematodes by D.L.Lee and H.J.Atkinson, Publisher: Cambridge University Press*
- *Medical Parasitologyby A.K Hati, Publisher: Allied Publishers Private Limited*
- *Modern Parasitology by F.E.G. Cox, Publisher : Wiley-Blackwell*
- *Medical and Veterina entomology by G.R.Mullen and L.A.Durden, Publisher : Academic Press*
- *Helminths, Arthropods and Protozoas of domesticated animals by E.G.L. Soulsby, Publisher : EWP*
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VI. Elective Theory Paper:

MZET-401 (ENVIRONMENTAL TOXICOLOGY) Credits: 8 Marks: 100

About the course: This course is aimed to generate in students awareness about various toxicants, heavy metal toxicity, environmental pollution and ecological impact assessment.

Learning outcomes: After successfully completing this course, the students will be able to:

- Develop an understanding of general principles of toxicology
- Know about various toxicants in foods, pesticides and agrochemicals
- Learn about the process of recycling and reuse technologies of solid and liquid waste.
- Be aware about the applications of toxicological principles

Contents:

1. Toxicants in the environment: Food additives and contaminants; air pollutants, Water pollutants and Soil pollutants.

2. General principles of Toxicology: Toxicologic evaluation; Absorption, distribution and excretion of toxicants; Metabolism of toxic substances; Factors influencing toxicity.

3. Systemic Toxicology: Brief analyses of toxic responses of the Liver, Kidney, Central Nervous System, Blood, Reproductive System.

4. Applications of Toxicology: Forensic Toxicology; Occupational Toxicology; Regulatory Toxicology.

Suggested readings:

- *Environmental chemisrtry by A. K. De, Publisher: New Age International (P) Ltd. Publishers.*
- *Fundamental Toxicology by J.H. Duffus and H.G.J. Worth Publisher: RSC publishing*
- *Casarett and Daul's Toxicology: The Basic Science of Poisons by C. D. Klaassen, Publisher: McGraw-Hill, New York*
- *Basic Toxicology: Fundamentals, Target organs and Risk Assessment by F. C. Lu, Publisher: Taylor and Francis.*
- *Fundamentals of Toxicology by K.Pandey, J. P. Shukla and S. P. Trivedi, Publisher: New Central Book Agency*
- *Molecular Toxicology by N. Plant, Publisher: Bios Scientific*
- *Principles of Toxicology by K. E. Stine and T. M. Brown, Publisher: CRC, Taylor and Francis*
- *Introduction to Toxicology by J. Timbrell, Publisher: Taylor and Francis*
- *Principles of Ecotoxicology by C. H. Walker, S. P. Hopkin, R. M. Siblyand D. B. Peakall, Publisher: Taylor and Francis*

Core (Optional) Theory Paper:

(Choose any one Optional Theory paper from the following list: I to VI)

I. Core (Optional) Theory Paper:

MZOT-402 (APPLIED AND THEORETICAL ECOLOGY) **Credits: 8** **Marks: 100**

About the course: This course is designed to accurately comprehend and draw appropriate inferences from numeric data, statistical analysis, and predictive model of ecology. It aims to impart knowledge on aquatic ecology and ecosystem management, and illustrates mathematical or conceptual models to population or community dynamics.The course helps to predict consequences of human actions on both local and global ecosystems.

Learning Outcomes: After successfully completing this course, the students will be able to:

- Understand the changing role and value of ecosystems to humans.
- Learn the impacts of land use and environmental management decisions on ecosystems and society.
- Predict the consequences of human actions on both local and global ecosystems.
- Assess problems and threat of anthropogenic practices to ecosystem health.

Contents:

Group A: Ecosystem Health and Human impacts

1. Concepts of ecosystem health

2. Ecosystem services, Introduction to models of ecosystem services

3. Human impacts on ecosystem (IPAT, GLOBIO), land use pattern and mapping, agroecosystem health and services; water management

4. Ecological risk assessment; Introduction to ecological risk assessment models; Climate risk, future scenario of climate risk, Climate risk management

Group B:Theoretical Ecology:

1. Models in ecology (modeling elements, modeling procedure, complexity of models, types of models),
2. Ecosystem modeling tools and technique, EcoService Model Library (ESML), Species Distribution Model
3. Energy, Exergy, Entropy and Ecology, Steady state and stability, local and global stability, limit cycle, phase doubling, chaos, catastrophe theory, Goal functions, ecological indicators and orientors.
4. Ecological system theory, Models of Ecological system theory

Suggested readings:

- *Ecology by P. A. Colinvaux, Publisher: Wiley, John and Sons, Inc*
- *Ecology by C. J. Krebs Publisher: Benjamin Cummings*
- *Fundamentals of Ecology by E.P. Odum, Publisher: Brooks/Cole*
- *Ecology and field biology by Robert Leo Smith, Publisher: Harper and Row*
- *Ecology" by R.E. Ricklefs, Publisher: Chiron Pres*
- *Wildlife Ecology and Management by G. Caughley, G., and ARE Sinclair, Publisher: Blackwell Science.*
- *People and Wildlife, Conflict or Co-existence R Woodroffe ,Thirgood, S. and Rabinowitz, A., Publisher: Cambridge University*
- *Research and Management Techniques for Wildlife and Habitats by T.A. Bookhout, Publisher: Allen Press.*
- *The Conservation Handbook: Research, Management and Policy by W.J. Sutherland. Publisher: Blackwell Sciences*
- *Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory" by M.L. Hunter, J.B. Gibbs, and E.J. Sterling, Publisher: Blackwell Sciences*

II. Core (Optional) Theory Paper:

MZOT-402 (APPLIED ENTOMOLOGY) Credits: 8 Marks: 100

About the course: This course covers fundamental concepts about applied entomology.

Learning Outcomes: After successfully completing this course, the students will be able to:

- Know toxicity of various pesticides and pest control practices
- Learn integrated pest management
- Understand the processes of sericulture, apiculture, lac culture
- Know in detail the various insect vectors and their control measures

Contents:

Group A:

1. Classification and properties of pesticides (organochlorine, cyclodiene, organophosphate, carbamate, botanical insecticides), Modern pest control techniques (microbial, hormonal and genetic control of pests), Concept of biomarkers and Bioassay

2. Conventional pest control practices (cultural, mechanical, physical, chemical and biological methods, fumigation), Green revolution and its impact in agroecosystem, Pesticide resistance and outbreak of pests, Integrated Pest Management

Group B:

1. Crop Husbandry and Forest Entomology: Biology and control of Paddy and Sugarcane pests; Biology of termites in relation to environment: i. Odontotermes sp. ii. Microtermes sp. iii. Macrotermes sp.; Recent trends and strategies in termite management; Eco-friendly management of forest insects pests: i. Defoliators ii. Xylophagous insects iii. Canker forming insects.

2. Industrial, Medical and Veterinary entomology: Potentials of Silkworm and Sericulture, Bees and Apiculture, Lac-insects and Lac culture; Insects of Medical and Veterinary importance, Human lice and rat fleas, Bot-flies and Mosquitoes (Diseases and control).

Suggested readings:

- *The Insects: Structure and Function by R. F. Chapman, S. J. Simpson, and A. E. Douglas, Publisher: Cambridge University Press*
- *General and Applied Entomology by B. V. David and T. N. Ananthakrishnan, Publisher: Tata McGraw-Hill*
- *The Insects – an outline of Entomology by P. J. Gullan, and P. S. Cranston, Publisher: Blackwell*
- *Insect Molecular Genetics– An introduction to principles and Applications by M.A. Hoy, Publisher: Academic Press.*
- *Medical and veterinary Entomology by D. S. Kettle, Publisher: CAB International.*
- *Physiological Systems in Insects by M. Klowden, Publisher: Academic Press.*
- *Medical and Veterinary Entomology by G.R. Mullen and L.A. Durden, Publisher: Academic Press*
- *Biological and Biotechnological control of Insect pests by J. E. Rechcigl and N. A. Rechcigl, Publisher: Lewis Publishers.*
- *The Science of Entomology by S. W. Romoser and J. G. Stoffolano, Publisher: McGraw Hill.*
- *A textbook of Applied Entomology by K. P. Srivastava, and G.S. Dhaliwal, Publisher: Kalyani*

III. Core (Optional) Theory Paper:

MZOT-402 (FISHERIES AND AQUACULTURE) **Credits: 8** **Marks: 100**

About the course: This course introduces the students to the economic importance of fish.

Learning outcomes: After successfully completing this course, the students will be able to:

- Differentiate between natural and induced breeding in fish.
- Manage hatcheries and fish farm in future.
- Develop technical knowledge of fish nutrition.
- Learn about marine fishery resources of India.

Contents:

Group A:

1. Marine fisheries resources in India: Potentiality and scope of exploitation, major capture fisheries: oil sardine, mackerel, Bombay duck and hilsa
2. Major open estuarine and riverine systems in India and their fisheries potential.
3. Conservation of fisheries resources.
4. Fishing crafts and gears
5. Broodstock development and maintenance; Induced breeding of cultivable species; Hybridization; Hatchery management.
6. Preparation and management of nursery, rearing and grow out ponds.
7. Role of soil and water quality in productivity of ponds.
8. Composite fish culture and integrated fish farming; Ornamental fish culture.

Group B:

1. Aquatic weeds and their control.
2. Fish diseases and their control.
3. Brackish water Prawn farming.
4. Molluscan fisheries: Culture of edible oyster and Pearl culture technology.
5. Aquafeed formulation and their evaluation; Role of probiotics in aquaculture.
6. Sex manipulation, monosexculture, production of sterile stock, selective breeding; transgenic fish.
7. Spoilage, processing and preservation of fish and prawn.
8. Fish by-products.

Suggested readings:

- *Biology of Fishes by C. E. Bond, Publisher: Saunders*
- *The Physiology of Fishes by D. H. Evans,Publisher: CRC Press.*
- *The Freshwater Fishes of the Indian Region by K. C. Jayaram, Publisher: Narendra Publishing House, New Delhi.*
- *A textbook of Fish Biology and Fisheries by S.S. Khanna, H.R. Singh, Publisher: Narendra Publishing House, New Delhi.*
- *Ichthyology by K. F. Lagler, J. E. Bardach, R. R. Miller and D. R. Passino, Publisher: John Wiley & Sons, New York.*
- *Biotechnology and Genetics in Fisheries and Aquaculture by A. R. Beaumont and K. Hoare, Publisher: Blackwell*

IV. Core (Optional) Theory Paper:

MZOT-402 (MOLECULAR GENETICS) Credits: 8 Marks: 100

About the course: The course imparts knowledge of molecular mutagenesis and various analytical techniques. The course gives an extensive account of *Drosophila* genetics and the genetic basis of cancer.

Learning outcomes: After successfully completing this course, the students will be able to:

- Know about site directed mutagenesis.

- Understand DNA microarrays, chromosome painting, restriction mapping and DNA fingerprinting.
- Develop understanding about pattern formation and homeotic loci in *Drosophila*. I
- Understand the functions of oncogenes, tumour suppressor genes and their role in cancer.

Contents:

1. Molecular mutagenesis: Site directed mutagenesis. Sequence tagged sites, DNA microarrays, karyotyping and chromosome painting
2. Restriction mapping: RFLP, RAPD, AFLP, SSCP, SNP mapping. DNA Fingerprinting
3. Gene transfer techniques: Germ line transformation in *Drosophila* and transgenic mice: Strategies and methods.
4. Genome editing: CRISPR/Cas9 system
5. Sex determination and dosage compensation
6. Cancer Genetics: Oncogenes, tumour suppressor genes and their role in cancer

Suggested readings:

- *Genetics: A Conceptual Approach by Benjamin A. Pierce, Publisher: W. H. Freeman and Company*
- *Principles of Genetics by D. Peter Snustad, Michael J. Simmons, Publisher: Wiley*
- *Genomes 4 by Author: T.A. Brown, Publisher: Garland Science*

V. Core (Optional) Theory Paper:

MZOT-402 (MOLECULAR PARASITOLOGY) Credits: 8 Marks: 100

About the course: The course is designed to offer knowledge of surface coat structure of protozoan and helminth parasites, synthesis of surface proteins and their interaction with the host cell and the immune responses from the host on to the parasites, different antigenic proteins in *Trypanosoma*. It will enable students to learn designing and development of vaccines. The course also provides understanding of the mode of action of different drugs in controlling the infection and gives an account of techniques involved in molecular diagnosis of parasites.

Learning outcomes: After successfully completing this course, the students will be able to:

- Understand the experimental paradigms and can integrate the recent advances in parasite host interactions taking into account the knowledge on the physiology, behavior and activity rhythms of the different parasite for anthelmintic drug development
- Gain an in-depth knowledge of immune responses of the host on to the parasites and also understand the long period of parasite survivability in the host.
- Identify research gaps and pursue research in anthelmintic drug development or vaccine for the welfare of humankind.

Contents:

1. Surface coat of *Plasmodium sp., Leishmania sp., Schistosoma sp., Wuchereriasp.*and*Echinococcus sp.* – structure, synthesis, interaction with host cell and protection.

2. Antigenic variation in African trypanosomiasis and malaria, structure of variant surface glycoprotein (VSG), antigenic variation by VSG gene rearrangement and strategies for evading host immune response.

3. Vaccinepotential candidates, challenges and clinical trials against malaria, leishmaniasis, schistosomiasis and filariasis.

4. Drug development against protozoa and helminth parasites, potential drug targets in helminths and protozoas, strategies for identifying and prioritizing drug target, differential selection of drugs, mode of action of some common drugs and mechanism of resistance to current antiparasitic drugs.

5. Diagnosis of protozoa and helminthic diseases through RFLP, *in situ*hybridistion, blottingtechniques, qRT PCR and droplet digital PCR, isolation of DNA and RNA from protozoan and helminth parasites.

Suggested readings:

- *Molecular Mechanisms of Trypanosomabrucei Antigenic Variation by Mark C. Field and Michael P. Barry*
- *African Trypanosomes: Trypanosomabrucei edited by Ingrid E. Holst and John M. Kelly*
- *Molecular Medical Parasitology edited by J.Joseph Marr, Timothy W Nilsen and Richard W. Komuniecki, Publisher: Academic Press*
- *Chemotherapeutic Targets in Parasites-Contemporay strategies by Tag E. Mansour, Publisher: Cambridge University Press*

VI. Core (Optional) Theory Paper:

MZOT-402 (ECOTOXICOLOGY AND ENVIRONMENTAL MANAGEMENT) Credits: 8 Marks: 100

About the course: The course is designed to offer knowledge about pesticides and pest control practices. They will be exposed to the concepts of ecotoxicology and sustainable environment management.

Learning outcomes: After successfully completing this course, the students will be able to:

- Understand the concept of integrated pest management
- Know the properties of various groups of pesticides
- Become aware about natural resources and their management
- Develop ideas of waste recycling methods

Contents:

Group A:

1. Classification and properties of pesticides (organochlorine, cyclodiene, organophosphate, carbamate, botanical insecticides), Modern pest control techniques (microbial, hormonal and genetic control of pests)

2. Conventional pest control practices (cultural, mechanical, physical, chemical and biological methods, fumigation), Pesticide resistance and outbreak of pests, Integrated Pest Management

Group B:

1. Concept of Ecotoxicology, General principles and types of ecotoxicity tests, Brief idea about Environmental Impact Assessment using bioassay models, Biodegradation and bioremediation

2. Natural resources and their management, Renewable energy sources, Green revolution and its impact in agroecosystem, Sustainable agriculture, Organic farming, Green belt, Vermicomposting as a model of organic waste recycling

Suggested readings:

- *Environmental chemisrtry by A. K. De, Publisher: New Age International (P) Ltd. Publishers.*
- *Fundamental Toxicology by J.H. Duffus and H.G.J. Worth Publisher: RSC publishing*
- *Casarett and Daul's Toxicology: The Basic Science of Poisons by C. D. Klaassen, Publisher: McGraw-Hill, New York*
- *Basic Toxicology: Fundamentals, Target organs and Risk Assessment by F. C. Lu, Publisher: Taylor and Francis.*
- *Fundamentals of Toxicology by K.Pandey, J. P. Shukla and S. P. Trivedi, Publisher: New Central Book Agency*
- *Molecular Toxicology by N. Plant, Publisher: Bios Scientific*
- *Principles of Toxicology by K. E. Stine and T. M. Brown, Publisher: CRC, Taylor and Francis*
- *Introduction to Toxicology by J. Timbrell, Publisher: Taylor and Francis*
- *Principles of Ecotoxicology by C. H. Walker, S. P. Hopkin, R. M. Sibly and D. B. Peakall, Publisher: Taylor and Francis*

Core (Optional) Practical Paper:

(Choose any one Optional Practical paper from the following list: I to VI)

I. Core (Optional) Practical Paper:

MZOP-403 (ECOLOGICAL MODELING) Credits: 4 Marks: 50

About the course: The course covers in detail quantitative analyses of different ecological principles. It will enable the students to undertake simulation dynamic modeling in computer by using self made code in "R" and get acquainted with software packages.

Learning outcomes: After successfully completing this course, the students will be able to:

- Learn quantifications of different ecological theories and principles.
- Know about computer simulation by running differential equations and matrix analysis using ecological data.

Contents:

1. Survey and estimation population growth of any population.
2. Species diversity measures – Richness, Heterogeneity and Evenness, Niche breadth, Niche overlap, Measurement of habitat and dietary preference.
3. Use of R programming in developing population models.
4. Use of Stella software for building of conceptual ecological models, transformation of mathematical models from conceptual ecological models, Running of the mathematical model, Calibration, Sensitivity analysis and validation.
5. Use of online ecosystem services model.
6. Use of QGIS and remote sensing for climate modeling.
7. Use Species Distribution Model.

II. Core (Optional) Practical Paper:

MZOP-403 (ENTOMOLOGY) **Credits: 4** **Marks: 50**

About the course: The course provides practical knowledge about permanent slide preparations of whole body and mouth parts of insects. Students will gain ideas of insect biodiversity and learn to do bioassays.

Learning outcomes: After successfully completing this course, the students will be able to:

- Learn about insect biodiversity
- Prepare whole mounts of insect body parts
- Perform probit analysis
- Learn about toxicity bioassays

Contents:

1. Insect biodiversity: collection, and submission of locally available harmful insects.
2. Identification of orders: Coleoptera, Hemiptera, Orthoptera, Hymenoptera, Lepidoptera and Diptera up to family characters.
3. Permanent slide preparation of whole insects and body parts of insects of applied importance ; Detection of chitin in integument.
4. Bioassay of pesticides (LC_{50}, LT_{50}) using aquatic and soil insects.
5. Probit analysis and interpretation of toxicological data.
6. Collection and laboratory rearing of soil Collembola for toxicity studies.

III. Core (Optional) Practical Paper:

MZOP-403 (FISH AND FISHERIES) **Credits: 4** **Marks: 50**

About the course: The course provides practical knowledge about fish biology and fisheries including studies on fish feeding habits, gonads, hypophysation of carps.

Learning outcomes: After successfully completing this course, the students will be able to:

- Identify fish, prawn and aquatic weeds
- Perform plankton studies
- Learn artificial peral culture
- Know about fish feeding habits, gonads, air breathing organs etc.
- Prepare whole mounts of fish parasites

Contents:

1. Identification of fish and prawn.
2. Identification of aquatic weeds.

3. Plankton study: Volumetric estimation and counting; staining and identification of some common Zooplanktons and phytoplanktons.
4. Feeding habit study: Study of buccopharynx and alimentary canal and gut content analysis.
5. Study of fish gonads: GSI and Fecundity and oocyte culture.
6. Study of digestive enzymes of fish through zymogram.
7. Germinal vesicle breakdown (GVBD) and ovulation in fish.
8. Hypophysation of carps.
9. Implantation of nucleus for artificial pearl culture.
10. Dissection: Urinogenetal system of any bony fish, Air breathing Organs, Weberian ossicles of carp and olfactory organ of *Channa*.
11. Whole mount of fish parasites.

IV. Core (Optional) Practical Paper:

MZOP-403 (MOLECULAR CELL BIOLOGY AND GENETICS) Credits: 4 Marks: 50

About the course: This is a course designed to enhance practical skills in cell biology, genetics and molecular biology. The course aims to enlighten students about isolation of hepatocytes and assessing cell count and viability. The students will learn various DNA-based molecular techniques and understand the applications.

Learning outcomes: After successfully completing this course, the students will be able to:

- Isolate hepatocytes and count the living and dead cells
- Isolate DNA and learn methods to assess its purity and concentration.
- Analyze RFLP and RAPD.
- Perform SNP analysis.
- Gain expertise in working with DNA
- Understand the applications of DNA-based techniques

Contents:

1. Cell fractionation of hepatocytes
2. Isolation of genomic DNA from mice liver.
3. Restriction digestion of DNA.
4. RFLP/ RAPD/ SSCP / SNP analysis.
5. Demonstration of qRT-PCR and confocal microscopy.

V. Core (Optional) Practical Paper:

MZOP-403 (PARASITOLOGY) Credits: 4 Marks: 50

About the course: This course is aimed to provide practical knowledge skills in identification of helminth eggs and soil nematodes. It also covers histology of representative groups of hemniths and help students learn mounting and immunoprecipitation techniques.

Learning outcomes: After successfully completing this course, the students will be able to:

- Perform faecal examination to identify helminth eggs
- Identify soil nematodes
- Perform histological studies and whole mounting of parasites
- Learn the technique of immunoprecipition

Contents:

1. Faecal Examination – by direct smear and salt flotation techniques for Identification of various types of helminth eggs
2. Identification of soil nematode by Baerman's apparatus
3. Histology of helminth representative groups for study of body organization
4. Evaluation of some nematicides by *in vitro* test
5. Collection, preservation and mounting of common plant parasite nematodes of field crops and helminth parasites of vertebrates
6. Detection of serum antibodies against antigen by immunoprecipitation reaction in agar gel medium

VI. Core (Optional) Practical Paper:

MZOP-403 (ENVIRONMENTAL TOXICOLOGY) Credits: 4 Marks: 50

About the course: This course gives practical training in in vitro toxicity assays and bioassays of pesticides. It covers basic skills of performing toxicity evaluations and interpretation of toxicological data.

Learning outcomes: After successfully completing this course, the students will be able to:

- Determine LD50 of a suitable toxicant
- Perform toxicity assays and probit analysis

Contents:

1. Determination of LD_{50} of a suitable toxicant in white rat.
2. In vitro toxicity assay in isolated hepatocytes: Hoechst assay, MTT assay, Trypan Blue Exclusion, Neural Red Uptake, DNA laddering.
3. In vitro inhibition of rat brain Acetylcholinesterase by an organophosphate pesticide.
4. Distribution of ^{203}Hg in different tissues in white rat.
5. Estimation of B.O.D. and C.O.D. values of polluted water samples.
6. Bioassay of pesticides (LC_{50}, LT_{50}) using aquatic and soil invertebrates.
7. Probit analysis and interpretation of toxicological data.

PROJECT PAPER (DISSERTATION & VIVA VOCE) Total Credits: 4 Marks: 50 (30+20)

Project Paper: MZPW-404 Based on MZET-401 or MZOT-402 (Topic to be selected in consultation with Supervisor)

About the course: This is a course designed to present an oral explanation of a biological principle/hypothesis/phenomenon. The students will be introduced to review writing, referencing, citation and scientific literature search for acquiring new knowledge. The course imparts proficiency in quantitative methods, qualitative analysis, and critical thinking needed in scientific research.

Learning outcomes: After successfully completing this course, the students will be able to:

- Develop concept of a particular topic by review of the available literature.

- Analyze and interpret the research data.
- Learn to write a scientific report and get acquainted with citations and referencing styles.
- Gain practical experience of open presentation and discussion.

I. Paper: **MZPW-404** (ECOLOGY-IV)Dissertation and Viva-Voce Full Marks -50

II. Paper: **MZPW-404** (ENTOMOLOGY-IV)Dissertation and Viva-Voce Full Marks -50

III. Paper: **MZPW-404** (FISH AND FISHERIES-IV)Dissertation and Viva-Voce Full Marks -50

IV. Paper: **MZPW-404** (MOLECULAR CELL BIOLOGY & GENETICS-IV)Dissertation and Viva-Voce Full Marks -50

V. Paper: **MZPW-404** (PARASITOLOGY-IV)Dissertation and Viva-Voce Full Marks -50

VI. Paper: **MZPW-404** (ENVIRONMENTAL TOXICOLOGY-IV)Dissertation and Viva-Voce Full Marks -50

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