DHANAMANJURI UNIVERSITY
MANIPUR

DHANAMANJURI
UNIVERSITY

SYLLABUS FOR 2 YEARS M.Sc. ZOOLOGY IN ACCORDANCE WITH THE UGC CURRICULUM AND CREDIT FRAMEWORK

Approved by Academic Council of Dhanamanjuri University
Vide Resolution No.....

2026

Dean
School of Life Sciences
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1. INTRODUCTION

The National Education Policy (NEP) 2020 envisions a transformative framework for higher education in India, emphasizing flexibility, multidisciplinary learning, and outcome-based curriculum design. In alignment with this vision, the University Grants Commission (UGC) has developed a new Curriculum and Credit Framework for post-graduate programmes in June 2024. The duration of post-graduate programme will be 1 (one year) or 2 (two) years. The re-structured PG programme is focussed on skill development, critical thinking, and experiential learning, aligning with global standards and industry needs. The revised framework encourages academic mobility, while integrating modern pedagogical approaches and digital tools. This reform, in line with the NEP 2020, aims to enhance student employability, innovation, and holistic understanding of the subject. Dhanamanjuri University has also implemented the opening of both 1-year and 2-year PG programmes and developed Curriculum and Credit Framework along with Course structures.

2. LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)

Nature and Extent of the M. Sc. Programme in Zoology

The Learning Outcome-Based Curriculum Framework (LOCF) for the M.Sc. Programme in Zoology is designed to reflect the depth, breadth, and interdisciplinary nature of advanced zoological education. The programme encompasses Discipline Specific Core Papers such as Cell Biology, Molecular Biology, Genetics, Tools & Techniques in Biological Sciences, Biostatistics, Bioinformatics, Developmental Biology, Biochemistry, Immunology, Animal physiology & Endocrinology, Environmental Biology, Applied Zoology, Animal Biotechnology, and Gene Manipulation. The Discipline Specific Elective Papers include Entomology, Fishery, Animal Physiology & Endocrinology, Parasitology, and Genetics & Molecular Biology. The curriculum promotes research aptitude, scientific reasoning, and ethical awareness, enabling students to engage with contemporary challenges in human health, biodiversity conservation, ecosystem management, and sustainable development. Through structured learning outcomes, the LOCF ensures that graduates acquire not only subject-specific expertise but also transferable skills in communication, data analysis, and interdisciplinary collaboration, preparing them for academic, research, and professional roles in zoological sciences.

Programme Objectives

a. To provide students with an in-depth and interdisciplinary understanding of animal and human life.

b. To cover a wide range of topics, from cellular and molecular processes to recent advances in Zoology and allied sciences.

c. To build strong foundational knowledge through core subjects such as Cell Biology, Genetics, Animal & Human Physiology, Gene Manipulation, Biochemistry, Immunology, etc.

d. To offer flexibility through a range of elective courses such as Entomology, Fishery, Physiology, Parasitology, Genetics & Molecular Biology, Ecology, etc.

e. To focus on both theoretical learning and practical skill development including dedicated laboratory sessions, hands-on training, field works, etc.

f. To integrate traditional zoological studies with cutting-edge scientific advancements.

g. To cultivate critical thinking, scientific inquiry, and research competencies. This approach instils confidence in students, preparing them for careers in academic research, teaching, public policy, etc.

Programme Attributes

a. Advanced disciplinary, interdisciplinary, and multidisciplinary knowledge.
b. Mastery of core and elective courses.
c. Research Competence.
d. Field and Laboratory Skills.
e. Proficiency in specimen collection, biodiversity documentation, microscopy, biochemical assays, and data analysis.
f. Critical Thinking and Problem Solving.
g. Effective Communication and Increased Aptitude.
h. Skills in scientific writing, oral presentation, and public outreach tailored to academic policy and community audiences.
i. Ethical and Environmental Awareness.
j. Familiarity with statistical tools, software applications, and digital platforms relevant to zoological research.
k. Preparedness for continuous professional development, competitive examinations, and higher research pursuits.

3. PROGRAMME LEARNING OUTCOMES (PLO)

Upon successful completion of the M.Sc. Programme in Zoology, students will be able to:

a. Acquire comprehensive knowledge in biological sciences starting from cellular level upto well developed organ system levels with regulatory mechanisms, both at the molecular and genetic levels.
b. Develop scientific principles and methodologies to design experiments, collect and analyze biological data, and interpret findings in zoological research.
c. Utilize advanced tools and techniques in molecular biology, genetics, physiology, and bioinformatics for problem-solving and innovation in animal sciences.
d. Critically evaluate scientific literature and engage in evidence-based reasoning to address theoretical and applied questions in zoology.
e. Conduct independent and collaborative research with ethical responsibility, contributing to biodiversity conservation, environmental sustainability, and societal well-being.
f. Communicate effectively through scientific writing, presentations, and outreach activities tailored to academic, professional, and public audiences.
g. Integrate interdisciplinary knowledge from allied fields such as environmental science, biotechnology, and data science to enhance zoological understanding and applications.
h. Demonstrate leadership, teamwork, and adaptability in academic, research, and field-based settings, contributing to institutional and community initiatives.
i. Engage in lifelong learning and professional development, preparing for careers in academia, research institutions, environmental agencies, and related sectors.
j. Promote regional and global awareness of biodiversity issues, with a special focus on the ecological and cultural significance of Northeast India's fauna.

4. COURSE STRUCTURE

Total Marks: 2050
Total Credits: 82

Semester I

Paper Code	Paper Type	Paper Title	Internal Assessment Marks	End-Semester Marks	Total Marks	Number of Credits
ZOO-501	DSC	Cell Biology, Molecular Biology & Genetics	20	80	100	4
ZOO-502	DSC	Tools and Techniques in Biological Sciences	20	80	100	4
ZOO-503	DSC	Lab based on ZOO-501 & ZOO-502	-	100	100	4
ZOO-504	DSC	Biostatistics & Bioinformatics I	20	80	100	4
ZOO-505	DSC	Developmental Biology	20	80	100	4
ZOO-506	DSC	Lab based on ZOO-504 & ZOO-505	-	100	100	4
Total					**600**	**24**

Semester II

Paper Code	Paper Type	Paper Title	Internal Assessment Marks	End-Semester Marks	Total Marks	Number of Credits
ZOO-507	DSC	Biochemistry and Immunology	20	80	100	4
ZOO-508	DSC	Lab based on ZOO-507	-	100	100	4
ZOO-509	DSC	Animal Physiology & Endocrinology	20	80	100	4
ZOO-510	DSC	Lab based on ZOO-509	-	100	100	4
XXX-000	VAC/ AEC	Environment and Climate Change/Disaster Management/Foreign language	-	50	50	2
Total					**450**	**18**

Semester III

Paper Code	Paper Type	Paper Title	Internal Assessment Marks	End-Semester Marks	Total Marks	Number of Credits
ZOO-611	DSC	Environmental Biology and Applied Zoology	20	80	100	4
ZOO-612	DSC	Lab based on ZOO-611	-	100	100	4
ZOO-621	DSE	Entomology I	20	80	100	4
ZOO-622	DSE	Entomology II	20	80	100	4
ZOO-623	DSE	Entomology Lab	-	100	100	4
ZOO-631	DSE	Fishery I	20	80	100	4
ZOO-632	DSE	Fishery II	20	80	100	4
ZOO-633	DSE	Fishery Lab	-	100	100	4
ZOO-641	DSE	Animal Physiology and Endocrinology I	20	80	100	4
ZOO-642	DSE	Animal Physiology and Endocrinology II	20	80	100	4
ZOO-643	DSE	Animal Physiology and Endocrinology Lab	-	100	100	4
ZOO-651	DSE	Parasitology I	20	80	100	4
ZOO-652	DSE	Parasitology II	20	80	100	4
ZOO-653	DSE	Parasitology Lab	-	100	100	4
ZOO-661	DSE	Genetics and Molecular Biology I	20	80	100	4
ZOO-662	DSE	Genetics and Molecular Biology II	20	80	100	4
ZOO-663	DSE	Genetics and Molecular Biology Lab	-	100	100	4
Total					**500**	**20**

Semester IV

Paper Code	Paper Type	Paper Title	Internal Assessment Marks	End-Semester Marks	Total Marks	Number of Credits
ZOO-613	DSC	Animal Biotechnology, Principles of Gene Manipulation and Bioinformatics II	20	80	100	4
ZOO-614	DSC	Lab based on ZOO-613	-	100	100	4
ZOO-624	DSE	Entomology III	20	80	100	4
ZOO-634	DSE	Fishery III	20	80	100	4
ZOO-644	DSE	Animal Physiology and Endocrinology III	20	80	100	4
ZOO-654	DSE	Parasitology III	20	80	100	4
ZOO-664	DSE	Genetics and Molecular Biology III	20	80	100	4
ZOO-RM	DSC	Research Methodology	10	40	50	2
ZOO-625/ ZOO-635/ ZOO-645/ ZOO-655/ ZOO-665/	DSE	Research (Thesis/Dissertation/Project work/Field work/Patent)	-	150	150	6
Total					**500**	**20**

- **Abbreviations**: ZOO: Zoology; DSC: Discipline Specific Core; DSE: Discipline Specific Elective; VAC: Value Added Course; AEC: Ability Enhancement Course.
- Students who exit at the end of 1st year in a 2-Year PG programme shall be awarded a PG Diploma.

SEMESTER I

ZOO-501
(CELL BIOLOGY, MOLECULAR BIOLOGY AND GENETICS)

COURSE LEARNING OBJECTIVES

- To provide a comprehensive understanding of the structural organization and diverse physiological functions of major cell organelles
- To comprehend the unique characteristics mitochondrial DNA and the processes involved in the synthesis and localization of mitochondrial proteins.
- To provide the conceptual understanding of molecular mechanisms governing the transport of macromolecules across the nuclear envelope.
- To gain detail knowledge of the phases of cell cycle and its regulatory mechanisms and acquire conceptual understanding of complex cell signal transduction pathways.
- To understand the mechanisms of DNA replication, transcription, translation, post-translational modification of proteins and gene regulation.
- To apprehend the methods of gene/genome mapping in *Drosophila* and human.
- To gain insights on different types of gene mutations and methodologies employed for detecting induced gene mutations.
- To understand the various forms of DNA damage and their repair mechanisms.
- Elucidate the genetic and molecular mechanisms of sex determination in *Drosophila* and humans.

COURSE LEARNING OUTCOMES

On completion of the course, the students will be able to:

- Clearly explain the structural organization of major cell organelles and their functional correlations.
- Evaluate the unique characteristics mitochondrial DNA and describe the processes of synthesis and localization of mitochondrial proteins.
- Explain the molecular mechanisms governing the transport of macromolecules across the nuclear envelope.
- Analyze the different phases of cell cycle, demonstrate how cell cycle is regulated and also explain the dynamics of cellular signalling pathways.
- Demonstrate the mechanisms of DNA replication, transcription, translation, post-translational modification of proteins and gene regulation in both prokaryotes and eukaryotes.
- Execute and interpret the various methods of gene/genome mapping in *Drosophila* and human.
- Identify the different types of gene mutations and evaluate the methodologies for detecting induced gene mutations.
- Identify the various forms of DNA damage and explain the repair mechanisms involved.
- Explain the genetic and molecular mechanisms of sex determination in *Drosophila* and humans.

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: **15 Lectures/20 Marks**

1. Mechanism of transport of molecules through nuclear envelope.
2. Structure and functions of endoplasmic reticulum, Golgi bodies and lysosome.
3. Mitochondria: structure and functions, mitochondrial DNA, synthesis and localization of mitochondrial proteins.

Unit 2: **15 Lectures/20 Marks**

1. Cell cycle and its regulation including check points.
2. Cell signalling: cell surface receptors and signal transduction pathways.

Unit 3: **20 Lectures/30 Marks**

1. Mechanism of DNA replication, proof reading in DNA replication, mechanism of DNA damage and repair.
2. Mechanism of transcription and translation, eukaryotic mRNA processing, translational proof reading and post-translational modification of proteins.
3. Mechanism of gene regulation in prokaryotes and eukaryotes.

Unit 4: **20 Lectures/30 Marks**

1. Methods of gene mapping: 3-point test cross in *Drosophila*, gene mapping and pattern of inheritance by pedigree analysis, human genome mapping.
2. Tetrad analysis in *Neurospora*; Gene mutation: types of gene mutations, methods for detection of induced mutations, P-element insertional mutagenesis in *Drosophila*.
3. Mechanism of sex determination in *Drosophila* and humans; basic concept of dosage compensation.

Recommended Books

1. Bruce Alberts, A. Johnson, J. Lewis, D. Morgan, M. Raff, K. Roberts, P. Walter: In Molecular Biology of the cell, 6thEdn, 2015; Publisher: Garland Science, Taylor & Francis Group, New York
2. H. Lodish, D. Baltimore & others: In Molecular Cell Biology, 5th Edn, 2006, Publisher: W.H. Freeman and Company, New York
3. Stryer, L: Biochemistry, W.H. Freeman & Co, New York, 2012.
4. Michael M. Cox and David L. Nelson: In Lehninger Principles of Biochemistry, 5th Edn.2010; W.H. Freeman and Company, New York
5. Lewin, B: Genes IX, Oxford University Press, 2012.
6. Becker, Kleinsmith, Hardin: The World of the Cell, (6th Ed), Pearson Education, 2007.
7. Geoffrey, M. Cooper: The Cell – A Molecular Approach, (2nd Ed.) ASM Press, Wahsington, D.C.
8. Freifelder, D.: Molecular Biology, Jones &Bartleth Pub. Inc.
9. De Robertis, EMF & EDP De Robertis: Cell and Molecular Biology, BI Waverly Pvt. Ltd.1997.

[All the books shall be of latest editions]

ZOO-502
(TOOLS AND TECHNIQUES IN BIOLOGICAL SCIENCES)

COURSE LEARNING OBJECTIVES

- To understand the principles and biological applications of various light (Bright field, Dark field, Phase contrast, Confocal, Fluorescence) and electron microscopy techniques (TEM, SEM).
- To familiarize students with the theoretical foundations of spectrophotometry (Beer-Lambert Law) and resonance spectroscopy (NMR/ESR) for molecular and structural analysis.
- To master the mechanics of separating complex biological mixtures using diverse chromatographic methods (Paper, TLC, HPLC, GC-MS) and electrophoretic techniques.
- To comprehend the units and measurement of radioactivity, the concept of radioisotope half-life, and the application of autoradiography.
- To explore antibody production and its critical role in advanced immunoassays, including ELISA, immunoblotting (Western blot), immunoprecipitation, and flow cytometry.
- To provide insights into the isolation and characterization of proteins and nucleic acids through blotting techniques (Southern, Northern) and DNA sequencing.
- To analyze the principles, types, and applications of Polymerase Chain Reaction (PCR) in modern molecular research.

COURSE LEARNING OUTCOMES

On completion of this course, students will be able to:

- Explain the working principles of various light and electron microscopes and select appropriate microscopy methods based on the specific requirements of observing live cells, tissues, or ultra structures.
- Prepare biological tissues for specialized imaging procedures, specifically for SEM and TEM analysis.
- Apply the Beer-Lambert Law to prepare calibration curves and perform quantitative analysis of analytes such as glucose or amino acids.
- Describe the operational principles and structural identification capabilities of NMR, ESR, and mass spectrometry (GC-MS).
- Implement chromatographic separations and interpret results using methods like Thin Layer Chromatography (TLC) and Column Chromatography.
- Execute and analyze protein and nucleic acid separations using one-dimensional and two-dimensional gel electrophoresis, as well as isoelectric focusing.
- Perform calculations related to half-life and utilize appropriate techniques to measure the radioactivity of isotopes safely.
- Detail the process of antibody generation and explain the mechanisms behind antibody-based assays such as ELISA, Western blotting, and Radioimmunoassay (RIA).
- Demonstrate proficiency in isolating proteins and nucleic acids and explain the methodologies behind various DNA sequencing techniques.
- Discuss how PCR can be used to amplify DNA or RNA*in vitro* and interpret the resulting data for molecular studies.

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: **15 Lectures/25 Marks**

Principles and applications of bright field, dark field, inverted& upright, phase contrast, confocal, and fluorescence microscopes; principle and application of transmission electron microscope and scanning electron microscope.

Unit 2: **25 Lectures/40 Marks**

Spectrophotometry: Beer-Lambert's Law; principles and applications of colorimeter, UV-visible spectrophotometer and flame photometer; nuclear magnetic resonance (NMR) and electron spin resonance (ESR); spectroscopy: principle and application. Chromatography: principle and application of paper and thin layer chromatography (TLC), column chromatography, high performance liquid chromatography (HPLC), and gas chromatography-mass spectrometry (GC-MS).

Unit 3: **10 Lectures/20 Marks**

Unit of radioactivity and half-life; measurement of radioactivity; autoradiography; antibody generation; enzyme-linked immunosorbent assay (ELISA); southern blot, western blot and northern blot; immunoprecipitation; radioimmunoassay (RIA); flowcytometry.

Unit 4: **10 Lectures/15 Marks**

Electrophoresis: principle and application of gel electrophoresis; analysis of RNA, DNA and proteins by one- and two-dimensional gel electrophoresis and isoelectric focusing gels; isolation of protein and nucleic acids; DNA sequencing methods; polymerase chain reaction (PCR): principle, types and applications.

Recommended books:

1. Robert, B: Introduction to Instrumental Analysis (Latest Ed.), McGraw Hill International Publ.
2. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology (8th edition, 2018), Cambridge University Press
3. Wilson, K. and Goulding, K.H.: A Biologist Guide to Principles and Techniques of Practical Biochemistry, ELBS Ed.
4. Alexander J.: Fundamental laboratory approaches for biochemistry and biotechnology Alexandra (2022); Publisher Kaufman press.
5. Wilson, K. & Walker, J.: Practical Biochemistry (2003), Cambridge University Press.
6. Plummer, D.T.: An Introduction to Practical biochemistry (3rd Ed. 2003), Tata-McGraw-Hill Publ. Co., New Delhi.
7. Boyer: Modern Experimental Biochemistry and Molecular Biology (2nd Ed. 1993), Benjamin/Cumin.
8. Switzer and Garrity: Experimental Biochemistry (Latest Ed.), Freeman and Company.
9. Bruce Alberts, Rebecca Heald, Alexander Johnson, David Morgan, Martin Raff :Molecular Biology of the cell, 7thEdn, 2022; Publisher: W. W. Norton & Company
10. H. Lodish& others: Molecular Cell Biology, 9th Edn, 2021, Publisher: W.H. Freeman and Company, New York.

[All the books shall be of latest editions]

ZOO-503
(LAB BASED ON ZOO-501 & ZOO-502)

No. of Credits: 04
Total Marks: 100

Cell biology, Molecular biology & Genetics **40 marks**

1. Study of mitotic and meiotic cell divisions in grasshopper/silkworm/fish/rat
2. Demonstration of sex-chromatin (Barr body) in buccal smear and hair bud cells.
3. Design of a primer for gene amplification
4. Polymerase chain reaction (PCR) [Demonstration].
5. Preparation and study of human/mammal metaphase chromosomes.
6. Chromosome banding pattern (C, G H, Q banding).
7. Study of inheritance pattern of some human/animal traits by using pedigree charts.
8. Study of linkage map based on the data of *Drosophila* cross.

Tools and techniques in biological sciences **40 Marks**

1. Use of Bright Field Microscope for the Study of Live Yeast Cells / Human Cheek Epithelial Cells.
2. Preparation of tissue for SEM and TEM procedure.
3. Demonstration of Paper and Thin Layer Chromatography.
4. Verification of Beer-Lambert's Law and preparation of calibration curve of glucose/amino acids.
5. Spectrophotometric estimation of DNA.
6. Determination of molecular mass of proteins by SDS-PAGE/Protein Analysis by SDS-PAGE.
7. Agarose Gel Electrophoresis of DNA.
8. Demonstration of Sanger DNA Sequencing(Simulation-Based).
9. Determination of Half-Life of radioactive isotope.
10. Use of ELISA to quantify antibody /antigen concentration.

Laboratory Record Book: **10 marks**

Viva Voce: **10 marks**

ZOO-504
(BIOSTATISTICS AND BIOINFORMATICS I)

COURSE LEARNING OBJECTIVES

- To integrate biology, statistics and ethics for comprehensive learning.
- To promote analytical reasoning, data interpretation, and problem-solving in biological contexts.
- To build competencies in data analysis, coding, and bioinformatics for careers in research and industry.
- To emphasize digital tools, databases, and programming for biological data management.
- To support data-driven approaches to biodiversity, conservation, and ecological modelling.
- To foster responsible data handling, transparency, and respect for intellectual property.

COURSE LEARNING OUTCOMES

On completion of this course, students will be able to:

- Apply statistical methods to biological data.
- Utilize computational tools for biological analysis.
- Perform bioinformatics analyses using biological databases.
- Demonstrate proficiency in data handling and programming.
- Design and execute data-driven biological research.
- Critically evaluate scientific literature and computational outputs.
- Understand ethical and societal implications of biological data use.

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: **10 lectures/20 marks**

1. Introduction to biostatistics, scope and application of statistics in biological sciences.
2. Population and sampling: Characteristics, advantages and methods of sampling and sampling errors.
3. Types of data and methods of data collection; Data arrangement and presentation, formation of tables and charts (bar diagrams, histograms, pie diagrams, etc.).

Unit 2: **20 lectures/ 30 marks**

1. Measures of central tendency and dispersal: Computation of mean, median and mode from grouped and ungrouped data.
2. Measures of dispersion: Computation of variance, standard deviation, standard error and their coefficient; Skewness and Kurtosis.
3. Probability distributions: Normal, Binomial and Poisson; Hypothesis testing: Student's t-test, Chi-square test and F-test; Analysis of variance; Regression and correlation; Interpretation of ANOVA results and non-parametric test.

Unit 3: **10 lectures/20 marks**

1. Introduction to Bioinformatics: Definition, scope, applications and limitations; Types of databases: Biological database, primary, secondary and specialized databases, nucleic acid databases (Genbank, DDBJ, EMBL, NDB), protein databases (Swissprot, PIR, TrEMBL, PDB).
2. Basic Concepts of Sequence Alignment: Scoring Matrices (PAM, BLOSUM), Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA).
3. Local and global alignment, pair wise and multiple sequence alignments, similarity, identity and homology of sequences.

Unit 4: **20 lectures/ 30 marks**

1. Basic ideas of molecular phylogenetics, gene phylogeny (gene tree) and species phylogeny (species tree); Construction methods of phylogenetic tree; Application of phylogeny (evolutionary study and pedigree analysis).
2. Genomics: Types, significance and techniques of genome sequencing; Overview of proteomics: proteome analysis, application of proteomics;
3. Drug discovery: Introduction to drug discovery, application of drug discovery.

Recommended books:

1. Kwanchai A. Gomez, Arturo A. Gomez: Statistical Procedures for Agricultural Research, 2nd Edition, Inter science publication, John Wiley & Son, New York
2. Snedcor, G.W. and W.G. Cochran: Statistical Method, 7th Edition, Iowa State University Press, Ames, USA.
3. Freederic, E. Croxton and Dudley: Applied General Statistics, 2nd en, New Delhi.
4. Bliss, CI: Statistics in Biology, Vol. 1 & 2, Mc-Graw Hill, New York.
5. Jin, Xiong: Essential of Bioinformatics, Cambridge University Press, 2007
6. 2. David W. Mount. Bioinformatics: sequence and Genome Analysis, Cold Spring Harbor Laboratory Press; 2nd edition
7. Prakash, S. Lohar: Bioinformatics, MJP Publishers, Chennai, 2015.
8. S.C.Rastogi,N. Mendiratta and P. Rastogi: Bioinformatics-Methods and Applications, PHI Learning Private Limited, Delhi, 2013.
9. Sharma,V., Munjal,A. and Shanker, A.: A Text Book of Bioinformatics, Rastogi Publications, Meerut- 2008.
10. C.S.V. Murthy: Bioinformatics: Himalaya Publishing House Pvt. Ltd. Mumbai, 2008.

[***All the books shall be of latest editions***]

ZOO-505
(DEVELOPMENTAL BIOLOGY)

COURSE LEARNING OBJECTIVES

- To develop an advanced understanding of gametogenesis, fertilization, early embryonic development, and stem cell biology in animals.
- To examine the cellular, molecular, and genetic mechanisms regulating cell specification, differentiation, embryonic induction, and developmental patterning.
- To analyse developmental processes using classical embryological experiments, transplantation studies, mutants, and transgenic model systems.
- To interpret the role of intercellular communication, gene regulation, and epigenetic mechanisms in controlling developmental pathways.
- To enhance practical and analytical skills in developmental biology through interpretation of developmental models, experimental data, and research-based case studies.
- To promote scientific reasoning, research aptitude, and scholarly communication related to developmental and regenerative biology.

Course Learning outcome

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

- Explain the processes of spermatogenesis, oogenesis, fertilization, cleavage, gastrulation, and early embryonic development in mammals with conceptual clarity.
- Differentiate the mechanisms of cell specification, determination, differentiation, totipotency, and pluripotency in developmental systems.
- Analyse the molecular and cellular basis of embryonic induction, organizers, competence, and cell-to-cell communication during development.
- Evaluate the influence of environmental factors, gene regulation, and epigenetic modifications on developmental gene expression and developmental outcomes.
- Interpret developmental pathways and pattern formation mechanisms in model organisms such as *Drosophila*, *Xenopus*, *Caenorhabditis elegans*, chick, and amphibians.
- Apply knowledge of mutants, transgenics, and experimental embryology techniques to investigate developmental processes and developmental abnormalities.
- Assess the cellular and molecular mechanisms underlying regeneration, including epimorphic, morphallactic, and compensatory regeneration, and their biomedical significance.
- Demonstrate higher-order analytical, research, and scientific communication skills through critical evaluation of developmental biology concepts, experimental findings, and contemporary regenerative therapies.

COURSE CONTENT

No. of Credits: 04

Total Marks: 100

Unit 1: **15 Lectures/25 marks**

1. Spermatogenesis and Oogenesis in mammal/human.
2. Mechanism of fertilization and Prevention of polyspermy in mammal/human.
3. Early embryonic development: Pattern of cleavage and events during cleavage, blastula formation, and gastrulation in mammals.
4. Developmental dynamics of cell specification: Stem cells and developmental commitment, totipotency and pluripotency.

Unit 2: **12 Lectures/20 marks**

1. Transplantation, Determination, Differentiation (chemical and molecular basis), Competence, Embryonic induction and organizers.
2. Morphogenesis: Cellular, Genetics, and Molecular basis.
3. Cell to cell communication during early development; Environmental control of gene regulation; Epigenetic regulation of developmentally relevant genes.
4. Teratogenesis: Environmental impact on human development; Teratogenic agents-alcohols, retinoic acid and endocrine disruptors.

Unit 3: **18 Lectures/30 marks**

1. Axes and pattern formation in *Drosophila*, amphibia and chick.
2. Vulva formation in *Caenorhabditis elegans*.
3. Organizer formation and mesoderm specification in *Xenopus*.
4. Limb development in vertebrates

Unit 4: **15 Lectures/25 marks**

1. Regeneration: Types, Cellular and Molecular aspects of regeneration.
2. Epimorphic regeneration of Salamander limbs.
3. Morphallactic regeneration in *Hydra*.
4. Compensatory regeneration in Mammalian liver.
5. Regeneration therapy.

Recommended Books:

1. Balinsky, B.I.: An introduction to Embryology, W.B. Saunders-Toppan Co. Japan.
2. Waddington, C.H.: Principles of Development and differentiation.
3. Berril and Carp: Developmental Biology.
4. Rastogi, V. B. and M.S. Jayaraj: Developmental Biology, Kedarnath Ramnath, Meerut.
5. Berril, N.J.: Developmental Biology T.M.H.
6. John W. Saunders Jr: Developmental Biology, Macmillan Publishing Co.Inc.N.Y.

8. Verma, P.S. and Agarwal, V.K.: Chordate Embryology, S. Chand & Co. Ltd., New Delhi.
9. T.W. Sadler: Langman"s Medical Embryology, 11th Edn. 2010. Lippincott, Williams & Wilkins
10. Principles of Development, Wolpert, Beddington, Brockes, Jessell, Lawrence, Meyerowitz, (3rd Ed., 2006), Oxford University Press, New Delhi, INDIA.
11. Analysis of Biological Development, Kalthoff, (2nd Ed., 2000), McGraw-Hill Science, New Delhi, INDIA.

[***All the books shall be of latest editions***]

ZOO-506
(LAB BASED ON ZOO-504 & ZOO-505)

No. of Credits: 04
Total Marks: 100

Biostatistics, Computational Biology and Bioinformatics **40 marks**

1. Construction of frequency distribution tables and diagrammatic and graphic representation of data.
2. Practical application of probability laws and goodness of fit test for binomial and poisson probability distributions in biology.
3. Computation and tests of significance for correlation and regression coefficients.
4. Sequence analysis using BLAST and result analysis.
5. Translate a nucleotide sequence and select the correct reading frame of the polypeptide from the output sequences.
6. Predict the structure of protein from its amino acid sequence.
7. Phylogenetic analysis using software/Phylogenetic tree generation.

Developmental Biology **40 marks**

1. Study of different types of eggs (of fish, frog, lizard and bird).
2. Study of permanent slides of different developmental stages of frog.
3. Study of chick embryo of different hours of incubation (24, 36, 40, 48, 55 and 72 hours).
4. Study of life cycle and developmental stages of Drosophila melanogaster.
5. Identification and study of larval and pupal wing, leg and eye antennal imaginal discs of Drosophila.

Laboratory Record Book **10 marks**

Viva Voce **10 marks**

SEMESTER II

ZOO-507
(BIOCHEMISTRY AND IMMUNOLOGY)

COURSE LEARNING OBJECTIVES

- To comprehend the fundamental principles of chemistry that govern complex biochemical reactions.
- To review the laws of thermodynamics and the quantitative relationships among free energy, enthalpy, and entropy.
- To gain knowledge about the energy cycle in cells and the special role of ATP as the energy currency.
- To understand the rate of a reaction catalyzed by enzymes and to know how the reaction changes in response to changes in experimental parameters, i.e. enzyme kinetics.
- To learn the basic energetic principles that govern metabolic pathways by which cells obtain energy from the oxidation of various fuels and also to know how cells use the energy in ATP to produce carbohydrates, lipids, amino acids, etc. from simpler precursors.
- To apprise the working mechanism of the immune system of the body, how it fights the disease and how it contributes to disease.
- To comprehend the insight of immuno-haematology for safe blood transfusions, organ transplants, and the management of immune-related blood disorders.
- To explore how the body naturally detects and eliminates abnormal cells including tumour cells.
- To understand the recent developments in immunology for disease control and treatment.

COURSE LEARNING OUTCOMES

On completion of this course, students will be able to:

- Gain knowledge about the fundamentals of molecules, chemical bonds, energy transformations, energy generations, and energy utilizations in cells.
- Understand how enzymes catalyze reactions with the mathematical idea.
- Comprehend knowledge of metabolic pathways for the oxidation of food stuffs along with the generation and utilization of energy in the cell and the regulatory mechanisms.
- Know the mechanism of body defense system by producing antibodies and activated lymphocytes.
- Learn about the role of Major Histocompatibility Complex in body immune system and concepts of complement system, cytokines, and allergic reactions.
- Understand how lymphocytes are matured, activated and differentiated.
- Know the structure and functions of antibodies and antigens along with their unique properties.
- Have a clear knowledge about human blood groups, compatibility of blood groups for transfusion, and complicacies in case of incompatible blood transfusion and haemolytic disease of new born.
- Know how body immune system defends tumors and also able to learn various immune related diseases.
- Explore the recent advances in immunology for the control and treatment of various diseases.

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: **10 lectures/20 marks**

1. Chemical bonds in Biochemistry: Electrostatic interactions, Hydrogen bonds, Van der Waals interactions, and Hydrophobic interactions.
2. Bioenergetics and Thermodynamics: Laws of Thermodynamics, Standard Free-Energy Change and Actual Free-Energy Change.
3. Phosphoryl Group Transfers and ATP; Biological Oxidation-Reduction Reactions.

Unit 2: **20 lectures/30 marks**

1. Enzymes: Enzyme kinetics, Regulatory Enzymes, and Enzyme Inhibition.
2. Carbohydrate metabolism: Glycolysis, Oxidative decarboxylation, Citric acid cycle and its regulation, Glycogenesis, Glycogenolysis, Gluconeogenesis, Coordinated regulation of glycolysis and gluconeogenesis, Coordinated regulation of glycogen synthesis and breakdown, and Pentose Phosphate Pathway; Fates of pyruvate under anaerobic conditions.
3. Metabolism of amino acids: Transamination, Deamination and Urea cycle; Metabolism of fats: β-Oxidation and ω-Oxidation of fatty acids, formation and utilization of ketone bodies, and biosynthesis of fatty acids.
4. Electron transport chain and oxidative phosphorylation.

Unit 3: **15 lectures/25 marks**

1. Introduction to cells and organs of Immunity; Types of Immunity: Cell mediated immunity and Humoral immunity.
2. Maturation, activation, and differentiation of B- & T- lymphocytes.
3. Antibody: Fine structure, Classes, Allotypes and Idiotypes; Functional properties of antibodies; Generation of antibody diversity: Molecular mechanism.
4. Antigen: Classes, Epitopes and Paratopes; Acquired immunological tolerance; Major Histocompatibility Complex (MHC): MHC gene, Structure and Functions of MHC; Complement system: Pathways, Biological activities of Complement components; Cytokines: Types, Structure and Functions; Hypersensitivity reactions.

Unit 4: **15 lectures/25 marks**

1. Immuno-hematology: ABO blood group, Rh blood group & HDN, and Clinical aspects of blood transfusion.
2. Transplantation immunology: Immunologic basis of graft rejection, Clinical manifestation of graft rejection, Tissue typing, Immune suppressive drugs.
3. Tumor immunology: Tumor antigen, Immunity against cancer, Cancer immunotherapy; Immunodeficiency diseases: Primary, Severe Combined Immunodeficiency disease, Secondary Immunodeficiency disease, Acquired immunodeficiency disease.
4. Recent development in antibody and immunotherapy; Immunization: Active and Passive, Recent approaches to vaccine production.

Recommended Books:

1. Stryer, L: *Biochemistry*, W.H. Freeman & Co, New York, 2012.
2. Michael M. Cox and David L. Nelson: *In Lehninger Principles of Biochemistry*, 5th Edn.2010; W.H. Freeman and Company, New York
3. Victor W. Rodwell, David A. Bender, Kathleen M Botham, Peter J. Kennelly, P. Anthony Weil: Harper's

   Illustrated Biochemistry, 30th Edn. 2015; Mc Graw Hill Education.
4. Satyanaraya, U: Biochemistry, 3rd Edn. 2006; Books and Allied (P) Ltd., Kolkata
5. Vasudevan DM, Sreekumari S: Text Book of Biochemistry, 5th Edn.2007; Jaypee Brothers, New Delhi
6. A.C. Dev: Text Book of Biochemistry
7. Bruce Alberts, A. Johnson, J. Lewis, D. Morgan, M. Raff, K. Roberts, P. Walter: In *Molecular Biology of the cell*, 6thEdn, 2015; Publisher: Garland Science, Taylor & Francis Group, New York
8. Roitt, I.M.: *Essential Immunology*, ELBS Edition
9. Paul, W.E.: *Fundamentals of Immunology*, Lippincott-Raven Pub., Philadelphia, New York.
10. Kuby: *Immunology*, W.H. Freeman, USA
11. Lal, S.S.: *Immunology*, Rastogi Pub., Meerut, India (3rd ed., 2012).
12. Tizzard, I: Immunology

[***All the books shall be of latest edition***]

ZOO-508
(LAB BASED ON ZOO-507)

No. of Credits: 04
Total Marks: 100

Biochemistry **40 marks**

1. Measurement of glucose concentration from any unknown given sample/blood by Anthrone/Somogi method.
2. Measurement of total protein from any unknown given sample/blood by Folin-Lowry's /Bradford's method.
3. Measurement of total cholesterol from any unknown given sample/blood.
4. Determination of enzyme activity of acid phosphatase.
5. Effect of pH and temperature on enzyme kinetics.
6. Separation of amino acids by Paper Chromatography.

Immunology **40 marks**

1. Study of permanent slides of sections/photographs of mammalian spleen, thymus, lymph node and tonsil.
2. Precipitation of Ouchtlerlony's double immuno-diffusion method.
3. Demonstration of assay of serum antibodies by ELISA/Chemiluminescence.
4. ABO and Rh blood grouping with proper demonstration of agglutination/haemagglutination reactions.
5. Minor and major Cross matching for human blood transfusion.
6. Detection of complement activity using haemolysis of antibody coated SRBC and standard serum.

Laboratory Record Book **10 marks**

Viva Voce **10 marks**

ZOO-509
ANIMAL PHYSIOLOGY AND ENDOCRINOLOGY
(*With special reference to mammal/human*)

COURSE LEARNING OBJECTIVES

- To comprehend a systematic knowledge pertaining to various functions of the body such as digestion, respiration, circulation, excretion, integration, coordination, etc.
- To understand the insights of hydrolysis of food stuffs and their absorption in the body.
- To acquire knowledge about the mechanics of respiration and its regulation.
- To know about the prevention of intravascular clotting and mechanism of blood coagulation.
- To comprehend the concept of urine formation, muscle contraction, importance of cerebrospinal fluid, control of visceral and other involuntary functions of the body.
- To acquire knowledge about the mechanism of vision, smell, and taste.
- To understand various integrating and coordinating functions of the body through the study of nerve impulse conduction, hormone actions, hormone functions, etc.

COURSE LEARNING OUTCOMES

On completion of this course, students will be able to:

- Have a clear knowledge on the understanding of advanced concepts of body functions.
- Comprehend how complex foods are converted into smaller and simpler forms in gastrointestinal tract and their regulatory mechanisms.
- Learn the mechanism of inspiration and expiration of air and how the respiratory gases are transported in blood.
- Understand the functions of heart and regulation of blood pressure.
- Know the physiology of urine formation and the idea of muscle contraction and nerve impulse conduction.
- Recognize and explain how the nervous system and endocrine system coordinately perform functions to maintain homeostasis in the body.

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1:

20 lectures/30 marks

1. Digestion and absorption of carbohydrates, proteins, lipids and nucleic acids in gastrointestinal tract; Absorption of water, minerals and vitamins in gastrointestinal tract; Regulation of gastrointestinal functions.
2. Mechanism of Inspiration and Expiration; Mechanism of O_2 and CO_2 transport in blood; Regulation of respiration.
3. Blood anti-clotting system and Mechanism of blood coagulation; Cardiac conduction system, Cardiac cycle and Electrocardiogram; Regulation of blood pressure.

Unit 2:

10 lectures/20 marks

1. Physiology of urine formation and its regulation.
2. Mechanism of Micturition; Regulation of Acid-Base Balance.
3. Mechanism of skeletal muscle contraction; Neuro-muscular junction and its role in muscle contraction; Cori cycle.

Unit 3: **10 lectures/20 marks**

1. Cerebrospinal Fluid: Formation, Composition, Flow, Absorption and Physiological functions.
2. General organization and physiological functions of Autonomic Nervous System.
3. Mechanism of conduction of action potential/nerve impulse in a nerve fibre; Transmission of action potential to next order neuron through synapse.
4. Photochemistry and neurophysiology of vision; Physiology of hearing, smell and taste.

Unit 4: **20 lectures/30 marks**

1. Mechanism of action of hormones (epinephrine/peptide/protein and steroid).
2. Hypothalamic-Pituitary Axis; Physiological functions of hypothalamic and pituitary hormones.
3. Physiological functions of hormones of thyroid, parathyroid, thymus, adrenal, pancreas, and gonads.
4. Endocrine disorders and diseases: Aetiology and Clinical features.

Recommended Books:

1. Guyton and Hall Text book of Medical Physiology: John E. Hall, PhD & Michael E. Hall, MD, MS; 14th Edition, 2021; Elsevier Saunders.
2. Ganong's Review of Medical Physiology: Kim E. Barrett, Scott Boitano, Susan M. Barman and Heddwen L. Brooks; 23rd Edition, 2010; Tata McGraw Hill Education Private Limited, New Delhi.
3. Williams Text book of Endocrinology: Edited by Shlomo Melmed, Richard J. Auchus, MD, PhD, Allison B. Goldfine, MD; 15th Edition, 2024; Saunders Elsevier.
4. Endocrinology: Mac E. Hadley; 5th Edition, 2004; Pearson Education, Delhi.
5. Best and Taylor's Physiological Basis of Medical Practice: OP Tondon & Y Tripathi; 13th Edition, 2021; Lippincott, Williams and Wilkins.
6. Text book of Physiology: A.K. Jain Vol. I & II, 4th Edition, 2011; Avichal Publishing Company, New Delhi.
7. Essentials of Medical Physiology: Sembulingam, K. & Sembulingam, Prema; 7th Edition, 2016; The Health Sciences Publisher, New Delhi, London, Philadelphia, Panama.

[All the books shall be of latest editions]

ZOO-510
(LAB BASED ON ZOO-509)

No. of Credits: 04
Total Marks: 100

Animal Physiology **45 marks**

1. Study of effect of temperature and pH on the activity of salivary amylase.
2. Determination of metabolic rate in amphibian/bird/rodent.
3. Demonstration of muscle contraction/heart beat by kymograph.
4. Enumeration of total erythrocytes in human blood by haemocytometry.
5. Enumeration of total leucocytes in human blood by haemocytometry.
6. Differential Leucocyte Count in human blood.
7. Bleeding Time and Clotting Time in human blood.
8. Measurement of blood pressure using sphygmomanometer.

Endocrinology **35 marks**

1. Hypophysectomy, thyroidectomy and adrenalectomy in birds/rodents.
2. Study of permanent slides of sections of mammalian endocrine glands (pituitary, thyroid, parathyroid, adrenal, pancreas, testis and ovary).
3. Assay of human serum TSH/T4/T3 by ELISA/Chemiluminescence.

Laboratory Record Book **10 marks**

Viva Voce **10 marks**

SEMEESTR III

ZOO-611
(ENVIRONMENTAL BIOLOGY AND APPLIED ZOOLOGY)

COURSE LEARNING OBJECTIVES

- To understand the structure and function of ecosystems.
- To acquire foundational knowledge required to conserve biodiversity, predict the impacts of climate change, and manage ecosystems.
- To Understand how species survive in increasingly fragmented habitats.

COURSE LEARNING OUTCOMES

On completion of this course, students will be able to:

- Explain ecological principles and ecosystem dynamics.
- Implement Conservation and Restoration strategies.

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: **15 lectures/25 marks**

1. Community Ecology: concept, structure, attributes, keystone species and control of community structure
2. Ecosystem: structure, function, and processes
3. Bioaccumulation, biomagnification, biotransformation of xenobiotic biomedical and hazardous work.

Unit 2: **15 lectures/25 marks**

1. Sericulture: Scope and prospect of sericulture in India
2. Apiculture: Prospect and problems of apiculture in India.
3. Lac culture: Cultivation and extraction of lac.
4. Insect as bio indicator
5. Entomophagism: Present and future prospect.

Unit 3: **15 lectures/25 marks**

1. **Clinical Parasitology:** General Introduction of medical parasitology; spectrum of symbiosis; types of parasites; types of hosts.
2. **Food-Borne Zoonotic Diseases:** General account and global public health significance; major causative parasitic pathogens; modes of transmission, epidemiology and integrated strategies for prevention and control.

3. **Vector Biology:** General account, morphology, and medical importance of key arthropod vectors and ectoparasites: mosquitoes, lice, fleas, bed bugs, ticks and mites; mechanisms of disease transmission and vector management.

Unit 4: **15 lectures/25 marks**

1. **Advanced production systems & Species selection**: Global and National Fisheries landscape, selection of culturable species, high-density aquaculture technologies, integrated & ecological aquaculture.
2. **Breeding & Hatchery Management:** Induced breeding & hypophysectomy, modern hatchery engineering, seed logistics & stress management.
3. **Limnology, pond ecology & nutrition:** Pre-stocking management of ponds, water quality hydrodynamics, feed formulation & nutritional biochemistry, live feed production.
4. **Aquatic pathology & biosecurity:** Bacterial & Viral pathogenesis, parasitic & fungal outbreaks, environmental & nutritional stressors, aquaculture biosecurity & prophylaxis.
5. **Post-Harvest processing & enterprise economics:** Post-mortem biochemistry of fish, preservation & processing technologies, industrial value-addition & by-products.

Recommended Books:

1. Foodborne Parasites (Food Microbiology and Food Safety) by Ynés R. Ortega and Charles R. Sterling.2nd Edition, Kindl Edition
2. Parasitology Protozoology And Helminthology 13Ed by CHATTERJEE KD
3. Parasitology (Protozoology & Helminthology) by Sood,R. CBS Publishers & Distributors.
4. General Parasitology by Cheng, T.C.: Academic Press College Division, Harcourt Brace Javanovich, Publishers Orlando, Florida (2nd Edition, 1986).
5. Medical Entomology – A handbook of Medically important insects and other arthropods by B.K. Tyagi; Scientific Publishers
6. Parasitology and Vector Biology by William C. Marquardt, Richard S. Demaree and Robert B. Grieve, Second Edition; Academic Press Inc.

[All the books shall be of latest editions]

ZOO-612
(LAB BASED ON ZOO-611)

No. of Credits: 04
Total Marks: 100

Environmental Biology **30 marks**

1. Studies on the population density in a natural community and estimation of diversity index.
2. Estimation of minerals (Na, Ca, K, Mg, Fe, etc.) in water.
3. Detection of heavy metals (Pb, Cd, Hg) in animal tissues.
4. Detection of microplastics in animal tissues and water.

Parasitology **20 marks**

1. Collection and examination of some medically important arthopods (5 nos).
2. Examine and identification of permanent slide for some food borne zoonotic parasites.

Fishery **30 marks**

1. Morphometric and Meristic identification of culturable species viz. Indian Major Carps (*Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*), exotic carps, and commercially important prawns/shrimps.
2. Isolation and extraction of fish pituitary gland.
3. Estimation of Dissolved Oxygen (DO) of pond water by Winkler's Method.
4. Assessment of soil and water chemistry: Measuring pH, total alkalinity, hardness, and primary nutrients (ammonia, nitrates) using water testing kits and spectrophotometry.
5. Field Visit & Industry Exposure Checklist

   Hatchery Visit: A 1-day trip to a commercial fish or shrimp hatchery during the breeding season to observe stripping, spawning pools, and larval rearing units.

   Modern Systems Inspection: A visit to a functional Biofloc facility or an RAS plant to observe automated feeders, aeration networks, and biofilter maintenance.

Laboratory Record Book **10 marks**

Viva Voce **10 marks**

ZOO-621
ENTOMOLOGY I
(SYSTEMATICS AND MORPHOLOGY OF INSECTS)

COURSE LEARNING OBJECTIVES

- To develop a thorough understanding of the modern phylogenetic classification and diversity of insects, including diagnostic features of major economically important orders and families.
- To apply principles of insect taxonomy and systematic identification using dichotomous keys and diagnostic morphological characters.
- To examine the structural organization and functional significance of insect integument, head, thorax, abdomen, and their appendages in relation to adaptation and survival.
- To analyze the comparative morphology and modifications of insect mouthparts, wings, legs, sensory organs, and genitalia in relation to feeding, locomotion, and reproduction.
- To evaluate classical and modern approaches in insect taxonomy, including morphological, molecular, numerical, behavioural, and chemotaxonomic methods used in insect classification and identification.
- To develop analytical, observational, and scientific interpretation skills relevant to entomological research, taxonomy, and insect biodiversity studies.

COURSE LEARNING OUTCOMES

At the end of the course, students will be able to:

- Explain the modern phylogenetic classification of insects and identify economically important insect orders and families based on diagnostic characteristics, biology, habits, and habitats.
- Construct and employ dichotomous keys for identifying major insect groups accurately and systematically.
- Describe the structure, composition, and functions of insect integument and cuticular appendages, demonstrating understanding of their adaptive roles.
- Illustrate and differentiate various types of insect mouthparts, sensory organs, thoracic structures, wings, and legs with reference to their structural modifications and functional adaptations.
- Analyze the morphology and functional organization of thoracic and abdominal appendages, including wing-coupling mechanisms, locomotory adaptations, and external genitalia.
- Evaluate the significance of classical and contemporary taxonomic approaches, including morphological, behavioural, numerical, molecular, and chemotaxonomic methods in insect systematics.
- Demonstrate research-oriented skills in insect taxonomy, scientific observation, comparative analysis, and entomological documentation.

COURSE CONTENT

No. of credits: 04
Total Marks: 100

Unit 1: **14 Lectures / 25 Marks**

1. Modern phylogenetic classification of insects.
2. Diagnostic characters, biology, habits, and habitats of economically important insect orders and families.
3. Principles and applications of dichotomous keys in insect taxonomy and identification.

Unit 2: **14 Lectures / 25 Marks**

1. Integument - Structure, composition, and functions of the insect integument and cuticular appendages.
2. Head- segmentation of the head capsule, cephalic appendages, structural modifications of mouthparts, and sensory organs in insects.

Unit 3: **18 Lectures / 30 Marks**

1. Thorax- Morphology; structure and modifications of wings, wing venation, wing-coupling mechanisms; structure and modifications of legs and mechanisms of locomotion.
2. Abdomen- Abdominal segmentation and appendages; structure and modifications of external genitalia.

Unit 4: **14 Lectures / 20 Marks**

1. Classical and modern taxonomic approaches in insects: Morphological, behavioural, numerical, molecular, and chemotaxonomic methods including cuticular hydrocarbon profiling for insect identification and classification.

ZOO-622
ENTOMOLOGY II
(INSECT ECOLOGY, DEVELOPMENT & PHYSIOLOGY)

COURSE LEARNING OBJECTIVES

- To provide in-depth understanding of ecological factors influencing insect diversity, population dynamics, behavioural ecology and insect–plant interactions.
- To familiarize students with post-embryonic development in insects, including larval and pupal forms, metamorphosis, diapause, and modes of reproduction.
- To develop knowledge of the structure and function of insect physiological systems involved in digestion, reproduction, and excretion.
- To impart insights into the organization and regulation of nervous, endocrine, respiratory, and circulatory systems in insects.
- To enhance analytical, observational, and research-oriented skills in interpreting developmental, physiological and ecological adaptations of insects to environmental and evolutionary contexts.

COURSE LEARNING OUTCOMES

At the end of the course, students will be able to:

- Explain the principles of insect ecology, including population dynamics, behavioural mechanisms, and plant–insect interactions.
- Analyze feeding, reproductive, and communication behaviours in insects and interpret their ecological significance.
- Evaluate and analyze the influence of ecological and chemical cues in host-plant selection, communication, and co-evolutionary relationships between insects and plants.
- Differentiate and illustrate larval and pupal forms, types of metamorphosis, and hormonal regulation of insect development, diapause, and reproduction.
- Describe and compare the functional organization of the digestive, reproductive, excretory, nervous, endocrine, respiratory, and circulatory systems of insects.
- Evaluate and integrate ecological, developmental, and physiological processes to explain insect adaptation, survival strategies, and research-related entomological problems.

COURSE CONTENT

No. of credits: 04
Total Marks: 100

Unit 1: Insect Ecology **15 Lectures/25 marks**

1. Insect diversity, distribution, and population ecology.
2. Abiotic and biotic factors influencing insect populations.
3. Feeding, reproductive, and communication behaviours in insects.

4. Ecological and functional aspects of insect–plant interactions.
5. Theories of co-evolution, host-plant selection mechanisms in phytophagous insects, and the role of allelochemicals in host plant recognition and mediation.

Unit 2: Post embryonic development **15 Lectures/25 marks**

1. Morphology of larval and pupal forms.
2. Diapause and its physiological significance.
3. Types and mechanisms of metamorphosis.
4. Role of neuropeptides and hormones in the neuroendocrine regulation of moulting and metamorphosis.
5. Polyembryony and modes of parthenogenesis in insects.

Unit 3: Insect Physiology I **12 Lectures/20 marks**

1. Structure and physiology of the digestive system.
2. Structure and physiology of the excretory system.
3. Structure and physiology of the reproductive system.

Unit 4: Insect Physiology II **18 Lectures/30 marks**

1. Structure and physiology of the Respiratory system.
2. Structure and physiology of the circulatory system.
3. Structure and physiology of the nervous system.
4. Structure and physiology of the endocrine system.
5. Mechanoreceptors and chemoreceptors in insects.

Recommended Books:

1. David, B. V. and Ananthakrishnan, T. N. (2013): General and Applied Entomology, Tata McGraw Hill, New Delhi.
2. Dungston Ambrose (2004): The insects: Structure, function & biodiversity, Kalyani Publications, New Delhi.
3. Tembhare, D. B. (2006). Modern Entomology, Himalaya Publishing House, New Delhi, himpub@vsnl.com pp.623
4. Chapman, R. F.: The insect structure and function, English Language Book Society, New Delhi.
5. Fenemore, P. G. and Alka Prakash (2006): Applied Entomology, New Age International Pvt. Ltd., New Delhi.
6. Ananthakrishnan, T. N. and Douglas Whitman (2005) Insect Phenotypic Plasticity, Diversity of Responses, Science Publishers, Inc., Enfield (NH), USA, Printed in India, sales@scipub.net pp.213.
7. Ananthakrishnan, T. N. (2010): Insect Biodiversity: Functional dynamics and Ecological Perspectives. Scientific Publishers (India).
8. Ananthakrishnan, T. N.: Dimensions of Insect Plant Interactions, Oxford Books and Periodicals, New Delhi.
9. Snodgrass, R. E.: Principles of Insect Morphology, Tata McGraw Hill, New Delhi.
10. William S. Romoser and John G Stoffolano (1994): The Science of Entomology, Win C Brown Publishers, England.
11. Richards and Davies (1993): Imm's General Textbook of Entomology, Volume I & II, Chapman & Hall, London. (B. I. Publication, Pvt. Ltd., 54-Janpath, New Delhi)

12. Roeder, K. S.: Insect Physiology, (Indian Print – 1994): International Books and Periodicals Service, 24B/5, Karol Bagh, New Delhi – 5.
13. Wigglesworth, V. B.: Principle of Insect Physiology, Chapman & Hall, English Language Book Society.
14. Larry P. Pedigo (1999): Entomology and Pest Management, Third Edition, Prentice Hall, New York (Indian print available from MacMillan Publishing Company) 691 pp.

[All the books shall be of latest editions]

ZOO-623
ENTOMOLOGY LAB
(LAB BASED ON ZOO-621 & ZOO-622)

No. of Credits: 04
Total Marks: 100

Experiments: **60 marks**

1. Permanent slide preparation of insect/insect body parts (antennae, mouthparts, legs, wings, tentorium, empodium, arolium and pollen basket) and drawing of the parts using Camera lucida.
2. Estimation and identification of chitin in insect integument.
3. Study of Haemocytes: Types, structures and counting using Neubauer's Haemocytometer.
4. Dissection of reproductive system, nervous system and neuro-endocrine organ of selected insect species.
5. Food preference and quantification of food intake by insects.

Collection and Preservation of Insects **20 marks**

Field collection of important insect pests of crops, stored grain pests and haematophagous insects & submitting them in a well-preserved manner.

Laboratory Record Book **10 marks**

Viva Voce **10 marks**

ZOO-631
FISHERY I
(ICHTHYOLOGY: SYSTEMATICS, PHYSIOLOGY, AND BEHAVIOUR)

COURSE LEARNING OBJECTIVES

- **Impart taxonomic and anatomical knowledge:** To teach classical and modern fish taxonomy, focusing on Northeast Indian freshwater biodiversity and the evolutionary significance of fish skeletal anatomy.
- **Explain functional physiology and adaptations:** To introduce internal physiological systems (respiration, osmoregulation, reproduction) and explore how fishes adapt to environmental stresses.
- **Develop analytical skills for Fishery Management:** To equip students with quantitative tools for measuring and modeling fish growth dynamics, age structures, and overall physiological health.
- **Explore behavioural ecology and sensory biology:** To foster an understanding of fish environmental interactions, focusing on biomechanical locomotion, specialized sensory systems, and complex behaviours.

COURSE LEARNING OUTCOMES

Upon successful completion of this course, students will be able to:

- Classify fishes using classical and modern taxonomy, with an emphasis on Northeast Indian biodiversity and the evolutionary significance of skeletal anatomy.
- Explain internal physiological systems and how fishes functionally adapt to environmental demands for survival, growth, and reproduction.
- Apply quantitative skills to measure and model growth dynamics, age structure, and the physiological condition of fish populations.
- Analyze fish behavioral ecology, including biomechanical movement, sensory perception, and complex environmental interactions.

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: Fin Fish Taxonomy and Anatomy **15 lectures/30 marks**

Freshwater fish taxonomy: General characters and classification of major fish groups (extent & extinct); identification of fishes of northeast India; Modern techniques of fish taxonomy- DNA barcoding; Freshwater ecoregions, drainage basins and distribution, status of freshwater fishes of northeast India.

Exo-Endoskeleton: Integuments, types of scales; Pigmentation, colouration, and their significance.

Endoskeleton: Skeletal system: cranium, visceral arches, vertebral column, fins, and skeleton and caudal vertebrae; Importance of osteology in fish classification.

Unit 2: Fin Fish functional biology **25 lectures/40 hours**

Food and feeding habits: Alimentary canal and its modification in relation to food and feeding habits, classification based on food and feeding habits, index of preponderance.

Respiration in fishes: Respiratory organs in fishes, gill ventilation and its mechanism; Air breathing: Conditions for air breathing, structural adaptations of air breathing fishes; Swim bladder and its types, composition of gas and hydrostatic control.

Excretion and Osmoregulation in fishes: Kidney- glomerular and aglomerular, excretion of nitrogenous wastes, water and ion balance; Stenohaline and euryhaline teleosts; Osmoregulation in migratory teleosts.

Fish Reproduction: Modes of reproduction, reproductive cycle, gonad maturity stages, fecundity; Hormonal regulation of gonadal development, activity of Gonadotropin-releasing hormone, and modes of spawning; Environmental factors controlling reproduction and factors affecting development. Induced breeding: hypophysation, natural and synthetic hormones, bundh breeding.

Unit 3: Age and growth of Fish **10 lectures/15 marks**

Growth, morphometric indices viz., length-weight relationships, condition factors, gonado-somatic index, Hepato-somatic index, index of preponderance and bioenergetics index, variation in growth rate, age determination.

Unit 4: Fish behaviour **10 lectures/15 marks**

Fish migration, courtship and parental care; Adaptation of fishes to hill stream mode of life; Locomotion, role of fins in locomotion, factors affecting locomotion; Electroreception and Sound production and reception.

Suggested Readings:

- **Nelson, J. S., Grande, T. C., & Wilson, M. V. H. (2016).** *Fishes of the World* (5th Ed.). John Wiley & Sons. *(The global gold standard for fish taxonomy, classification, and evolutionary relationships of extant and extinct groups).*
- **Jayaram, K. C. (2010).** *The Freshwater Fishes of the Indian Region* (2nd Ed.). Narendra Publishing House. *(Crucial for the identification and taxonomy of Indian freshwater fishes, including drainage basins).*
- **Talwar, P. K., & Jhingran, A. G. (1991).** *Inland Fishes of India and Adjacent Countries* (Vols 1 & 2). Oxford & IBH Publishing. *(A classic and comprehensive guide for the taxonomic identification of Indian fishes).*
- **Vishwanath, W. (2002).** *Fishes of North East India: A Field Guide to Species Identification*. NATP. *(Highly recommended specifically for the Northeast Indian biodiversity component of the syllabus).*
- **Vishwanath, W. (2021).** *Freshwater fishes of the Eastern Himalayas*. Academic Press, London, United Kingdom, 411 pp.
- **Lagler, K. F., Bardach, J. E., Miller, R. R., & May Passino, D. R. (1977).** *Ichthyology* (2nd Ed.). John Wiley & Sons. *(An excellent foundational text for fish anatomy, covering exo- and endoskeletons, scales, and osteology).*

- **Evans, D. H., Claiborne, J. B., & Currie, S. (2013).** *The Physiology of Fishes* (4th Ed.). CRC Press. *(The definitive textbook on fish physiology; perfectly covers gill ventilation, osmoregulation, nitrogenous waste, and endocrinology).*

- **Bone, Q., & Moore, R. H. (2008).** *Biology of Fishes* (3rd Ed.). Taylor & Francis. *(Brilliant coverage of functional biology, including the swim bladder, buoyancy, respiration, and alimentary canal modifications).*
- **Khanna, S. S., & Singh, H. R. (2014).** *A Textbook of Fish Biology & Fisheries*. Narendra Publishing House. *(A staple in Indian universities; covers food and feeding habits, respiration, excretion, and induced breeding/hypophysation very clearly).*
- **Hoar, W. S., & Randall, D. J. (Eds.).** *Fish Physiology* (Series). Academic Press. *(A multi-volume reference series. Excellent for deep dives into specific topics like the reproductive cycle and gonadotropins).*
- **Biswas, S. P. (1993).** *Manual of Methods in Fish Biology*. South Asian Publishers. *(An absolute must-have for Unit 3. It provides step-by-step methodologies for calculating the index of preponderance, condition factors, GSI, HSI, and length-weight relationships).*
- **Bagenal, T. B. (1978).** *Methods for Assessment of Fish Production in Fresh Waters* (3rd Ed.). Blackwell Scientific Publications. *(A classic text detailing age determination techniques, growth rates, and morphometric indices).*
- **King, M. (2007).** *Fisheries Biology, Assessment and Management* (2nd Ed.). Wiley-Blackwell. *(Provides excellent context on how growth parameters and age structures are used in practical fishery management).*
- **Pitcher, T. J. (Ed.). (1993).** *Behaviour of Teleost Fishes* (2nd Ed.). Chapman & Hall. *(The most comprehensive book on fish behavior, detailing migration, courtship, parental care, and sensory reception).*
- **Moyle, P. B., & Cech, J. J. (2004).** *Fishes: An Introduction to Ichthyology* (5th Ed.). Prentice Hall. *(Features excellent chapters on fish locomotion, the mechanics of fins, and adaptations to extreme environments like hill streams).*
- **Sloman, K. A., Wilson, R. W., & Balshine, S. (2006).** *Behaviour and Physiology of Fish*. Elsevier. *(Great for understanding the intersection of environmental stressors, electroreception, sound production, and behavioral adaptations).*
- Carl, B.E. Biology of Fishes. Saunders.
- Fretter, V. & Graham A.. The functional anatomy of vertebrates. Academic Press Inc. (Lon.) Ltd.
- Kurian, C.V. & Sabastian V.O. Prawns and Prawn Fisheries of India.
- Moyle Peterb. Fishes: An Introduction to Ichthyology. Prentice Hall.
- Brown E and Margret. 1957. Physiology of Fishes Vol I & II (Academic Press, Inc. Publishers).
- Love, M.S. & Cailiet, G.M. Readings in Ichthyology. Prentice Hall Publications, 1979.
- Pandey. Fish and Fisheries. Rastogi Publications.

ZOO-632
FISHERY II
(LIMNOLOGY AND INLAND FISHERIES)

COURSE LEARNING OBJECTIVES

- **Explore Inland Fishery Resources:** To overview India's inland capture fisheries (riverine, estuarine, cold-water) and examine the ecological impacts of dams on fish migration.
- **Teach Aquaculture Management Principles:** To teach fish farm design, pond ecosystem management (water/soil chemistry), and principles of fish nutrition and feed formulation.
- **Introduce Diverse Culture Techniques:** To introduce diverse aquaculture systems (integrated farming, RAS) and the culture techniques for commercially important finfishes and shellfishes.
- **Detail Seed Procurement and Hatchery Operations:** To educate on the procurement, handling, and transport of fish seeds/broodstock, and the functional design of modern hatcheries.
- **Objective 5: Integrate Limnology with Health Management:** To explain vital limnological parameters, plankton ecology, and methods for identifying, preventing, and treating aquatic diseases.

COURSE LEARNING OUTCOMES

Upon successful completion of this course, students will be able to:

- **Assess Inland Fisheries and Anthropogenic Impacts:** Evaluate the status of inland capture fisheries and analyze the ecological impacts of dams on fish migration.
- **Design and Manage Aquaculture Ponds:** Apply biological and engineering principles to design fish farms, manage pond properties, and formulate fish feeds.
- **Implement Advanced Aquaculture Techniques:** Implement diverse aquaculture methodologies (e.g., cage culture, RAS) and evaluate the ecological impacts of exotic species.
- **Manage Fish Seed and Hatchery Operations:** Manage fish seed collection and transport, and explain the operational mechanics of various hatchery systems.
- **Analyze Water Quality and Manage Aquatic Diseases:** Analyze limnological parameters for fish health, culture live feed, and diagnose or treat major aquatic diseases.

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: Inland capture fishery **5 lectures/10 marks**

Inland capture fisheries resources of India: Riverine fishery resources, regulation and exploitation; Dams and its effect on fish migration and remedies; Lake reservoir; Estuarine fishery: management, development and exploitation; Cold water fishery and its resources in north east India; Fish species and prospects for culture; Mahseer fishery.

Unit 2: Aquaculture management **20 lectures/30 marks**

Fish farm construction: Basic principles of fish farm construction, design and layout of different types of ponds; Biological principles for selection of species for culture.

Pond management: Physico-chemical properties of pond water and soil and their maintenance; Pre-stoking and post-stocking management of Nursery, rearing and stocking ponds along with control of weeds, pest and predator.

Fish nutrition: Nutritional requirements of fish; larval nutrition: importance of live feed and artificial feed, different types of feed available for larvae.

Feed formulation: General principles, different types of feed formulation, classification of feed ingredients.

Unit 3: Inland fish culture techniques **15 lectures/25 marks**

Sewage-fed fish culture, cage culture, pen culture, raft and raceway fish farms; Exotic fish culture: selection of fish species, invasive species and its impacts on natural fisheries; Integrated fish culture: Paddy cum fish culture, composite fish culture, integrated fish culture; Recirculation aquaculture system (RAS): Aquaponics and its operation.

Freshwater prawn culture; shrimps and Crab culture, Lobster culture, Mussel culture; Pearl oyster culture; Edible oyster culture.

Unit 4: Fish seed resources **5 lectures/10 marks**

Procurement and transportation of seed from natural resources; methods of Fish seed collection; Transport of brood fishes; Fish hatcheries: types and functional significance, Glass jar and Chinese hatchery.

Unit 5: Limnology and health management **15 lectures/25 marks**

Limnology: Physiochemical factors of freshwater fish habitat, relationship between environment and fisheries, water pollution and its impacts on fisheries; Fish food organisms: Ecological classification of freshwater organisms, Zooplanktons, phytoplankton and their role in fisheries; Culture of fish food organisms.

Aquatic health management: Diseases in aquaculture, parasitic and non-parasitic— bacterial, viral and fungal pathogens of fish; Fish pathology: prophylaxis and therapy.

Suggested Readings:

- **Jhingran, V. G. (1991).** *Fish and Fisheries of India.* Hindustan Publishing Corporation. *(Crucial for Unit 1 and Unit 4. It is the gold standard for Indian riverine, estuarine, cold-water, and Mahseer fisheries, as well as seed collection).*
- **Pillay, T. V. R., & Kutty, M. N. (2005).** *Aquaculture: Principles and Practices.* Blackwell Publishing. *(Essential for Units 2 and 3. Covers farm construction, pond management, cage/pen culture, and integrated fish farming in detail).*
- **ICAR (Indian Council of Agricultural Research). (latest edition).** *Handbook of Fisheries and Aquaculture.* Directorate of Knowledge Management in Agriculture, ICAR. *(A comprehensive guide covering all modern Indian aquaculture practices, including RAS, seed production, and shellfish culture).*

- **Rath, R. K. (2011).** *Freshwater Aquaculture.* Scientific Publishers. *(Great for Unit 2 and Unit 3. Highly recommended for pond management, pre/post-stocking management, and composite fish culture).*
- **Srivastava, C.B.L. (2006).** *A Textbook of Fishery Science and Indian Fisheries.* Kitab Mahal. *(A good general textbook for undergraduate/postgraduate Indian fishery concepts).*
- **Halver, J. E., & Hardy, R. W. (2002).** *Fish Nutrition.* Academic Press. *(The global standard text for understanding the biochemical nutritional requirements of fish).*
- **De Silva, S. S., & Anderson, T. A. (1995).** *Fish Nutrition in Aquaculture.* Chapman and Hall. *(Excellent for the practical application of feed formulation and artificial vs. live feed).*
- **Athithan, S., et al. (2016).** *Fish Nutrition and Feed Technology.* New India Publishing Agency. *(A practical guide tailored to Indian feed ingredients and formulation techniques).*
- **Wetzel, R. G. (2001).** *Limnology: Lake and River Ecosystems.* Academic Press. *(The definitive, most comprehensive textbook on freshwater ecology, physicochemical factors, and aquatic environments).*
- **Cole, G. A., & Weihe, P. E. (2015).** *Textbook of Limnology.* Waveland Press. *(A highly readable text for understanding water pollution, phytoplankton, and zooplankton dynamics).*
- **Welch, P. S. (1952/Reprint).** *Limnology.* McGraw-Hill. *(A classic text detailing the fundamentals of freshwater environments).*
- **Roberts, R. J. (2012).** *Fish Pathology.* Wiley-Blackwell. *(The ultimate reference for fish diseases, covering everything from bacterial and viral infections to parasitic diseases and therapy).*
- **Woo, P. T. K., & Bruno, D. W. (2011).** *Fish Diseases and Disorders (Vol 1-3).* CABI. *(Comprehensive volumes focusing on different types of pathogens and prophylactic measures in aquaculture).*
- **Nandi, S. (2016).** *Fish Health Management.* New India Publishing Agency. *(A good resource focusing specifically on health management practices, prophylaxis, and therapeutics in the Indian aquaculture context).*
- **Schaperclaus, W. (1991).** *Fish Diseases.* A.A. Balkema. *(A classic, detailed reference for parasitic and non-parasitic fish diseases).*
- **FAO study materials (latest updated information).**

ZOO-633
FISHERY LAB
(LAB BASED ON ZOO-631 & ZOO-632)

No. of Credits: 04
Total Marks: 100

Section A **40 marks**

1. Identification and classification of freshwater fishes of Northeast India using morphometric and meristic characters, use of key characters, description.
2. Identification of eggs, fries and fingerlings of commercially important fishes.
3. Preparation of fish skeleton and study: cranium, visceral skeleton, vertebrae, girdles, fins and caudal skeleton.
4. Study of food and feeding habits of fishes, Bucco-pharynx of economically important fishes, Pharyngeal teeth.
5. Examination of gut contents, qualitative and quantitative.
6. Dissection and examination of gills.
7. Dissection and examination of accessory respiratory organs.
8. Dissection of Weberian Ossicles.
9. Study of gonads, gonado-somatic index, determination of absolute and relative fecundity of fishes
10. Determination of Age: removal of scales and different parts of skeleton, spines, otolith. Preparation and examination.
11. Study of Length- Weight relationship of fishes and determination of condition factor.
12. Histology: Slide preparation and study of skin, gills liver, stomach, intestine, testis, ovary, pituitary.

Section B **40 marks**

1. Water and soil sampling from fish farms. Physicochemical analysis of water – turbidity, temperature, dissolved oxygen, carbon dioxide, alkalinity, pH, BOD.
2. Identification of weed fishes, predatory fishes and predatory insects in fish pond.
3. Eradication of predatory insects: Calculation of water surface area, preparation of soap – oil emulsion and application.
4. Manuring of ponds, calculation of quantity, methods of application and effects of water quality and biota.
5. Setting up of an aquarium and its maintenance.
6. Identification of exotic and invasive fish species.
7. Planktons: Identification of common zoo and phyto-planktons of the freshwater ponds. Plankton counting using Sedgwick-Rafter scale.
8. Identification of common fish parasites.
9. Study of adaptation of fishes to hill stream mode of life.
10. Induce breeding: location and removal of pituitary, preservation, preparation of injectable materials and administration.

11. Study of fishing Crafts and gears, indigenous fishing techniques.
12. Case study related to fisheries and report submission.

Laboratory Record Book **10 marks**

Viva Voce **10 marks**

Suggested study materials:

- Jhingran, V.G.: Fish and Fisheries of India3rd. En Today and Tomorrow Book agency, New Delhi.
- Pillay, T.V.R. 1990 : *Aquaculture, Principles and Techniques*. Fishing News Bk. Ltd.
- Edmonson, W.I.: *Freshwater Biology*, Ward and Weipel.
- Abidi, R.: *Fish Pathogen & Diseases in India*.
- Amlacher, E.: *Text Book of Fish Diseases*.
- S.K. Gupta & P.C. Gupta : General and Applied Ichthyology (*Fish and Fishery*) , S. Chand & Co. Ramnagar, New Delhi, 110055.
- Wedmeyer, A.F.S.*: Fish hatchery and management*.
- Von Brandts: *Fish catching techniques of the world*. Blackwell Pub.
- George Borgstrom Elsevier: *Fish as Food*, Vol. I & II
- Chonder, S.L. 1994*: Induce carp breeding*. CBS publishers and Distributors, New Delhi -110002.

[***All the books shall be of latest editions***]

ZOO-641

ANIMAL PHYSIOLOGY AND ENDOCRINOLOGY I [GENERAL PHYSIOLOGY]

(*With special reference to mammal/human*)

COURSE LEARNING OBJECTIVES

- To understand the role of nervous and endocrine system in the regulation of gastrointestinal movement and secretion.
- To comprehend the knowledge about various gut microbes, probiotics, prebiotics, and synbiotics.
- To know the idea of pulmonary volume and capacities, and also regulatory mechanism of respiration.
- To comprehend the electrophysiology of heart and circulation of blood in specific regions of the body.
- To understand the in-depth concept of haemoglobin and haemopoiesis.
- To know the role of kidney in the regulation of extracellular fluid concentration electrolytes.
- To comprehend the mechanism of muscle contraction, nerve impulse conduction, and physiology of vision, smell, and taste.
- To understand the eye movement and its control.

COURSE LEARNING OUTCOMES

On completion of this course, students will be able to:

- Have a clear concept about the role of hormones and nervous system in the regulation of gastrointestinal movement and secretion.
- Comprehend the importance of various microorganisms found in our gut and also the role of probiotics, prebiotics, and synbiotics in the gut.
- Know about the amount of atmospheric air we inhale and we exhale during respiration. Also able to understand various lung capacities and regulation of respiration.
- Know other functions of the lungs apart from respiratory functions.
- Understand the properties of heart that can perform electrical functions by which the heart can pump the blood.
- Understand how the blood circulates in specific regions of the body and also able to know the idea of haemoglobin and haemopoiesis.
- Know about the details of body fluid and electrolytes.
- Comprehend the molecular mechanism of muscle contraction and nerve impulse conduction.
- Understand the insights of vision, smell and taste.

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: Gastrointestinal and Respiratory Physiology **20 lectures/30 marks**

1. Neural and endocrine regulation of gastrointestinal movement and secretion; Regulation of food intact and thirst.
2. Human Gut Microbiomes; Probiotics, Prebiotics and Synbiotics.
3. Pulmonary Volumes and Capacities; Neural and Chemical regulation of respiration.
4. Non-respiratory functions of lungs: Filtration, Defensive function, Endocrine function, and Immune function.

Unit 2: Cardiovascular and Renal Physiology **20 lectures/30 marks**

1. Electrical activity of heart: Ionic basis of action potential, Conduction of action potential and Role of neurohormones.
2. Regional circulation: Cerebral, Coronary, Portal and Foetal circulation.
3. Chemistry, synthesis and catabolism of haemoglobin; Haemopoiesis; Basal Metabolic Rate.
4. Control of Extracellular Fluid Osmolarity and Sodium concentration; Renal regulation of Potassium, Calcium, Phosphate, and Magnesium.

Unit 3: Muscle and Nerve Physiology **10 lectures/20 marks**

1. Mechanism of Skeletal and Smooth muscle contraction.
2. Molecular aspect of development of action potential and conduction in a nerve fibre.
3. Molecular mechanism of release of neurotransmitters and their actions in synaptic transmission and neuromuscular junctions.

Unit 4: Physiology of Special Senses **10 lectures/20 marks**

1. Photochemistry and neurophysiology of vision.
2. Eye movement and their control; Accommodation of eye.
3. Neural and molecular mechanism of sensory transduction of smell and taste.

ZOO-642
ANIMAL PHYSIOLOGY AND ENDOCRINOLOGY II [ENDOCRINE PHYSIOLOGY]
(*With special reference to mammal/human*)

COURSE LEARNING OBJECTIVES

- To comprehend the knowledge about the coordinating functions of nervous and endocrine systems.
- To understand the structure and functions of pineal gland.
- To know the functions of pituitary hormones and pituitary hormone disorders.
- To know the biosynthesis, functions, and metabolism of hormones secreted by thyroid, adrenal, and gonads.
- To understand the role of parathyroid in calcium homeostasis.
- To know the details of pancreatic hormones and diabetes mellitus.
- To comprehend the functions of hormones produced by other tissues of the body.

COURSE LEARNING OUTCOMES

On completion of this course, students will be able to:

- Have a clear concept about the neurosecretory cells, neurohormones and neurotransmitters.
- Comprehend the knowledge about the hormonal feedback system.
- Know about the endocrine function of hypothalamus and pineal gland.
- Know the functions of pituitary hormones and pituitary hormone disorders.
- Understand the biosynthesis, functions and metabolism of hormones of thyroid, adrenal, and gonads.
- Know how the parathyroid plays role in the regulation of calcium in the body.
- Understand the involvement of insulin and glucagon in the regulation blood glucose concentration and also able know about diabetes mellitus.
- Comprehend the endocrine functions of gastrointestinal tract, kidney, heart, placenta, etc.

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: Neuroendocrinology **10 lectures/20 marks**

1. Neurosecretory cells and Neurotransmitters.
2. Hormonal Feedback and its control mechanism.
3. Structure of Pineal gland; Biosynthesis of melatonin and its regulation; Physiological functions of melatonin.
4. Structure and endocrine functions of hypothalamus.

Unit 2: Pituitary, Thyroid, Parathyroid and Adrenal **25 lectures/40 marks**

1. Physiological functions of pituitary hormones; Abnormalities of pituitary hormone secretion.
2. Biosynthesis of thyroid hormones and its regulation; Transport, physiological functions and metabolism of thyroid hormones; Pathophysiology of thyroid.
3. Role of parathyroid gland in calcium homeostasis.
4. Biosynthesis of catecholamines in adrenal gland and its regulation; Physiological functions of epinephrine, nor-epinephrine and dopamine;
5. Biosynthesis, transport, physiological functions and metabolism of adrenocortical hormones; Pathophysiology of adrenal gland.

Unit 3: Endocrine Pancreas and Gonads **15 lectures/20 marks**

1. Synthesis and chemistry of glucagon and insulin; Mechanism of insulin action; Role of insulin and glucagon in glucose homeostasis.
2. Diabetes: Types, Etiology, and Signs & Symptoms.
3. Biosynthesis and physiological functions of estrogen, progesterone and testosterone.

Unit 4: Hormones of other tissues **10 lectures/20 marks**

1. Physiological functions of gastrointestinal hormones.
2. Physiological functions of hormones of heart, kidney, adipose tissues, and placenta.
3. Non-classical hormones: EGF, IGF, TGF, FGF, Anti-Mullerian hormone, Inhibin, & Activin.

Recommended Books:

1. Guyton and Hall Text book of Medical Physiology: John E. Hall, PhD & Michael E. Hall, MD, MS; 14th Edition, 2021; Elsevier Saunders.
2. Ganong's Review of Medical Physiology: Kim E. Barrett, Scott Boitano, Susan M. Barman and Heddwen L. Brooks; 23rd Edition, 2010; Tata McGraw Hill Education Private Limited, New Delhi.
3. Williams Text book of Endocrinology: Edited by Shlomo Melmed, Richard J. Auchus, MD, PhD, Allison B. Goldfine, MD; 15th Edition, 2024; Saunders Elsevier.
4. Endocrinology: Mac E. Hadley; 5th Edition, 2004; Pearson Education, Delhi.
5. Best and Taylor's Physiological Basis of Medical Practice: OP Tondon & Y Tripathi; 13th Edition, 2021; Lippincott, Williams and Wilkins.
6. Text book of Physiology: A.K. Jain Vol. I & II, 4th Edition, 2011; Avichal Publishing Company, New Delhi.
7. Essentials of Medical Physiology: Sembulingam, K. & Sembulingam, Prema; 7th Edition, 2016; The Health Sciences Publisher, New Delhi, London, Philadelphia, Panama.

[All the books shall be of latest editions]

ZOO-643
ANIMAL PHYSIOLOGY AND ENDOCRINOLOGY LAB
(LAB BASED ON ZOO-641 & 642)

No. of Credits: 04
Total Marks: 100

General Physiology **40 marks**

1. Determination of platelet count in human blood.
2. Determination of packed cell volume (PCV)/haematocrit value.
3. Effect of acetylcholine and adrenaline on intestinal motility in amphibians/birds/rodents.
4. Demonstration of compound action potential in a toad's/frog's sciatic nerve.
5. Determination of the effect of posture on blood pressure.
6. Effect of adrenaline, acetylcholine and atropine on heart of amphibian/bird/rodent.
7. Recording of simple muscle twitch and effect of temperature on it in an animal model.

Endocrinology **40 marks**

1. Study of permanent slides of sections of mammalian endocrine glands (hypothalamus, pituitary, pineal, thyroid, parathyroid, pancreas, adrenal, testis, ovary).
2. Assay of human serum TSH by ELISA/Chemiluminescence.
3. Assay of human serum T4/T3 by ELISA/Chemiluminescence.
4. Surgical procedures in birds/rodents:
   a. Hypophysectomy
   b. Thyroidectomy
   c. Adrenalectomy
   d. Pancreatectomy
   e. Castration
   f. Ovariectomy

Laboratory Record Book **10 marks**

Viva Voce **10 marks**

ZOO-651
PARASITOLOGY I
(GENERAL PARASITOLOGY)

COURSE LEARNING OBJECTIVES

- Understand the basic concepts and terminology in parasitology
- Explain host-parasite relationships and adaptations
- Identify modes of transmission and epidemiological patterns
- Evaluate the impact of parasitic diseases on public health and agriculture
- Promote awareness of ethical and biosafety practices in parasitological research

COURSE LEARNING OUTCOMES

By the end of this unit, students will be able to:

- Define key concepts and terminology in parasitology
- Understand host-parasite interactions and adaptations
- Identify modes of transmission and epidemiological patterns
- Assess the consequences of parasitic diseases and their management
- Practice ethical and biosafety standards in parasitological research

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: Introduction to Parasitology **15 lectures/20 marks**
Different types of animal associations; Definitions; Phoresis, Commensalism, Parasitisim, Mutualism, Hyperparasitism, Origin of parasitism, adaptation to multiple hosts, some evolutionary patterns of parasites.

Unit 2: Parasite host specificity **10 lectures/20 marks**
Parasite - host specificity, specificity factors related to infection and growth, host specificity of protozoa and helminth parasites.

Unit 3: Parasite transmission **10 lectures/20 marks**
Introduction, types of transmission; Mechanism of host mechanism for penetration the host, circadian rhythm.

Unit 4: Epidemiology and Preventive measures **25 lectures/40 marks**
Basic epidemiology of parasitic infections: General and Landscape Epidemiology; epidemiology of Kala-azar, Echinococcoses, Filariasis and Malaria; Preventive measures and control of viral, bacterial, fungal and parasitic disease.

ZOO-652
PARASITOLOGY II
(BIOLOGY OF PARASITES)

COURSE LEARNING OBJECTIVES

- Understand the biology and classification of medically and economically important parasites
- Describe the morphology, life cycles and transmission strategies of parasites
- Evaluate the pathogenicity and clinical manifestations of parasitic diseases
- Apply laboratory techniques for parasite identification and *in vitro* cultivation techniques for protozoan parasites: principles, media requirements, and challenges
- Compare the structural adaptations of soil-dwelling, free-living, and predatory nematodes against plant parasites
- Integrate parasitological knowledge with public health and veterinary relevance
- Develop scientific reasoning and research skills in parasitology
- Promote ethical and biosafety practices in parasitological research

COURSE LEARNING OUTCOMES

By the end of this unit, students will be able to:

- Classify and differentiate major groups of parasites based on taxonomy and morphology
- Explain transmission mechanisms of medically and economically important parasites
- Evaluate the pathogenicity, clinical manifestations, epidemiology and diagnostic methods of parasitic infections
- Assess the impact of parasitic diseases on public health, veterinary science, and agriculture
- **Evaluate** protocols for *in vitro* protozoan culture and discuss their applications in drug discovery and research
- Demonstrate scientific reasoning and research skills in parasitology
- Practice ethical and biosafety standards in parasitological research

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: Protozoology **15 lectures/25 marks**

Classification of parasitic protozoa; General account of medically important parasites in kinetoplastida, Coccidia, Piroplasmia and Microspora (for example Leishmania sp., *Encephalitozoon* sp., *Babesia* sp., *Cryptosporidium* sp., etc.), Culture of protozoan parasites in vitro.

Unit 2: Helminthology **17 lectures/30 marks**

Classification of parasitic helminthes; General characteristics of the Cestoda, Trematoda and Nematoda and diseases caused by them. Morphology, life history, and pathogenicity of *Paragonimus westermani, Taenia saginata, Dracunculus medinensis.* General accounts of Lymphatic filarial parasites and Zoonotic lymphatic filariasis.

Unit 3: Acanthocephala **13 lectures/20 marks**

General characteristics of Acanthocephala. Morphology, life history and pathogenicity of *Acanthocephalus bufonis* and *Moniliformes moniliformes.*

Unit 4: Phytonematology **15 lectures/25 marks**

General morphology, classification, symptoms and economic importance of some major phytonematodes; morphological variations of soil / free living and predatory nematodes. Morphology, life history and pathogenicity / damage caused by *Anguina tritici*, and *Meloidogyne incognita*. Control methods of some important plant parasitic nematodes.

Recommended Books:

1. Cox, F.E.G. : A Text book of Modern Parasitology - Blackwell Scientific Publications, London 1993.
2. Cheng ,T.C.: General Parasitology, Academic Press College Division, Harcourt Brace Javanovich, Publishers Orlando, Florida (2nd Edition 1986).
3. Smyth, J.D. : Animal Parasitology, Cambridge University Press(3rd Edition 1993).
4. J. Joseph Marr , T.W. Nilsen and R.W. Komuniecki (Eds.) : Molecular Medical Parasitology, Academic Press. An Imprint of Elsevier Science , U.K. 2003.
5. Garcia, L. S. Diagnostic Medical Parasitology 4th Ed. ASM Press, Washington DC, (2001).
6. Chandler A.C. & Read, C.P., Introduction to Parasitology, John Wiley, London (1961).
7. Smyth, J.D., Introduction to Animal Parasitology, Hodder & Stoughton, London (2005).
8. Chappell, L.H., Physiology of Parasites, Blackie, Glasgow & London (1979).
9. Cheng, T.C., General Parasitology, Academic Press, London (1973).
10. Sood,R. Parasitology (Protozoology & Helminthology) CBS Publishers & Distributors,

[All the books shall be of latest editions]

ZOO-653
PARASITOLOGY LAB
(LAB BASED ON ZOO-651 & ZOO-652)

No. of Credits: 04
Total Marks: 100

Experiments **70 marks**

I. **Protozoa**
   a) Permanent stained preparation of *Amoeba, Euglena, Paramecium and Vorticella*.
   b) Prepared slides of *Amoeba, Trypanosoma, Euglena, Paramecium* (binary fission), *Paramecium* (conjugation), *Opalina, Vorticella, Balantidium, Coccidia*

II. **Platyhelminthes**
   1. Specimens : *Planaria, Dugesia, Fasciola, Taenia*, and Echinococcus.
   2. Permanent Slides: F*asciola* (miracidium, sporocyst, redia and cercaria), scolex and proglottids of *Taenia* (Mature and gravid L.S. & T.S.).
   3. Stained preparation: Trematode, proglottid or scolex of cestode.

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

IV. Dissection and examination for the presence of endoparasites in animal host (fish, amphibians, reptiles, birds, mammals)

V. Examination for the presence of ectoparasites in animal host (fish, amphibians, reptiles, birds, mammals).

VI. Study the digenetic trematode larvae from the snails.

VII. Extraction of nematodes from soil sample.

Submission of specimens and slides **5+5=10**

i. Submission of parasites-specimens of Nematodes, Cestodes, Trematodes and Acanthocephalan (at least 5 in numbers)

ii. Submission of 10 prepared slides.

Laboratory Record Book **10 marks**

Viva Voce **10 marks**

ZOO-661
GENETICS AND MOLECULAR BIOLOGY I
(TECHNIQUES IN GENETICS AND MOLECULAR BIOLOGY)

COURSE LEARNING OBJECTIVES

- To apprehend the knowledge on DNA expression at RNA and protein level through microarray mutagenesis etc.
- To understand the insights of genome editing methods like homologous recombination, TALENs, Zinc finger, CRISPER-CAS 9 and generation of gene knockout and knock organism.
- To acquire knowledge about the methods of nucleic acids, and downstream works like RAPD, RFLP, SNPs etc.
- To know about the DNA fingerprinting and foot printing, DNA barcoding, Gene therapy: Principles, methods and applications
- To comprehend the concept of Centrifugation types (density gradient, ultracentrifugation), Micronucleus and Comet assay. Cytotoxicity test of certain chemicals/radiation in animal model, end point of toxicity.
- To acquire knowledge about introduction to Omics, Next Generation Sequencing, Strategies of genome sequencing like Human Genome Project and Genome India Project.
- To understand chromosome evolution in human, Screening and identification of modifier genes.
- To know about Quantitative Trait locus (QTL) mapping and physical mapping

COURSE LEARNING OUTCOMES

On completion of this course, students will be able to:

- Have a clear knowledge of basics gene expression and methods to study.
- Comprehend how complex the mechanisms of gene editing and pathways.
- Learn the DNA polymorphisms and its endpoints.
- Understand the working principles of centrifugation and consequent types and genotoxicity tests.
- Know the Omics, Next Generation Sequencing, Strategies of genome sequencing like Human Genome Project and Genome India Project.
- Recognize and explain how the chromosome evolution in human, Screening and identification of modifier genes.
- Understand QTL and physical mapping to understand genome organisation

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: **20 lectures/30 marks**

Analysis of gene expression at RNA and protein level; DNA microarray technique of largescale gene expression; *in vitro* site-directed mutagenesis techniques; genome editing methods: homologous recombination, TALENs, zinc finger nuclease technology (ZFNs), CRISPR-CAS 9; generation of gene knock-out and gene knock-in organisms; antisense and ribozyme technology.

Unit 2: **15 lectures/20 marks**

Isolation and purification of nucleic acids; advanced PCR techniques; RAPD, RFLP, AFLP, SSR, SNPs, ESTs, and DNA fingerprinting and footprinting; DNA barcoding; gene therapy: principles, methods and applications.

Unit 3: **10 lectures/20 marks**

Centrifugation: basic principles and types (density gradient, ultracentrifugation); micronucleus and comet assay; **c**ytotoxicity test of certain chemicals/radiation in animal model, end point of toxicity.

Unit 4: **20 lectures/30 marks**

Introduction to Omics; next generation sequencing (NGS); strategies of genome sequencing; recognition of coding and non-coding regions and annotation of genes; screening and identification of modifier genes; human genome project and genome India project; human karyotyping; QTL mapping and Physical mapping.

Recommended books:

1. Alberts B, et al (2015), Molecular Biology of the Cell, 6th ed. Garland Science.
2. Brown TA (2010), Gene cloning and DNA analysis, 6 th ed. Wiley Blackwell.
3. Divan A and Royds J (2013), Tools and Techniques in Biomolecular Science, Oxford University Press.
4. Lodish H, Berk A, Kaise CA, et al (2008), Molecular Cell Biology, 6 th ed. New York: WH Freeman.
5. Southern EM (2001), DNA microarrays: History and Overview. Methods Mol Bio 170:1-15.
6. Weissman J, Guthrie C and Fink GR (2010), Guide to Yeast Genetics and Molecular Biology, Methods Enzymol, 2 nd ed. Elsevier
7. A.J.F Griffiths (2000), Modern genetic analysis, 3rd edition, W.H. Freeman and Company
8. Krebs J.E. et al (2011), Lewin's Genes X, International edition, Jones and Bartlett Publishers.

[All the books shall be of latest editions]

ZOO-662
GENETICS AND MOLECULAR BIOLOGY II
(CYTOGENETICS, RADIATION AND CANCER BIOLOGY)

COURSE LEARNING OBJECTIVES

- To provide a comprehensive understanding of the structural and functional dynamics of chromosomes.
- To strengthen the understanding of the methodologies employed in chromosomal studies.
- To provide the conceptual understanding on how to analyse the evolutionary mechanics of sex chromosomes and the concept of dosage compensation.
- To comprehend the patterns of inheritance, genetic imprinting, and their clinical applications in genetic counselling.
- To evaluate advanced genetic tools and mutations.
- To provide insights on various aspects of ionizing radiations and its biological impacts.
- To comprehend the precise cellular and molecular mechanisms that drives the process of cellular ageing and different cell death mechanisms.
- To understand the pathophysiology and the genetic basis of carcinogenesis; mechanism of tumour development, role of tumour markers and cancer stem cells, and molecular approaches to targeted cancer therapy.

COURSE LEARNING OUTCOMES

On completion of the course, the students will be able to:

- Clearly understand the dynamics of chromosome structure and functions.
- Demonstrate the working knowledge of metaphase chromosomal methodologies.
- Know how to analyse the evolutionary mechanics of sex chromosomes and the diverse mechanisms of dosage compensation.
- Differentiate between monogenetic and multifactorial inheritance patterns, explain genetic imprinting, and apply these concepts to clinical genetic counselling.
- Evaluate and apply advanced genetic tools in model organisms like*Drosophila*.
- Identify the sources, types, units of ionizing radiation, and distinguish between the direct and indirect actions of radiationand evaluate radiation-induced effects on biological processes.
- Comprehend and describe the precise cellular and molecular mechanisms of cellular ageing and different pathways of cell death.
- Outline the different stages of carcinogenesis, analyse the genetic basis of cancer, describe the cellular and molecular dynamics of tumour development, identify clinical tumour markers and have a good knowledge of the modern molecular approaches in targeted cancer therapy.

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: **20 Lectures/30 Marks**

Chromosomal proteins: condensation and decondensation; metaphase chromosomal studies: types, metaphase arrester, hypotonic solution, fixatives; banding types and mechanisms; concerted events of sex chromosome evolution, and dosage compensation in *Drosophila;* isolation of X linked and autosomal conditional mutations in *Drosophila,* enhancer trap and UAS-GAL4 in *Drosophila*; monogenetic and multifactorial inheritance; genetic imprinting; genetic counselling.

Unit 2: **15 Lectures/20 Marks**

Sources and types of ionizing radiations; radiation dose and units, dosimetry, direct and indirect actions of radiation; radiation induced chromosomal aberrations; effect of radiation on synchronously dividing culture cells; reactive oxygen species (ROS) and oxidative stress; natural antioxidants in human health and diseases; radio sensitizers, application of radiobiology.

Unit 3: **15 Lectures/20 Marks**

Ageing: cellular and molecular mechanism of ageing; apoptosis: caspases, intrinsic and extrinsic pathways of programmed cell death, autophagy and necrosis.

Unit 4: **20 Lectures/30 Marks**

Carcinogenesis: cancer initiation, promotion, progression and termination; factors responsible for carcinogenesis; genetic basis of cancer: proto-oncogenes, viral oncogenes, tumour suppressor genes; mechanism of proto-oncogene activation; tumour development: angiogenesis, invasion and metastasis; tumour marker, biology of cancer stem cells; molecular approaches in targeted cancer therapy; pharmacogenomics.

Recommended Books:

1. E .J. Hall & A.J. Giaccia: Radiobiology for the Radiologists, Wolters Kluwer/ Lippincott, 2012.
2. Radiation Biology: A handbook for Teachers and Students, IAEA, Vienna,2010.
3. J .Kie : Biological Radiation Effects, Springer Verlag, 1990.
4. B. Halliwell& J.M.C. Gutteridge : Free Radicals in Biology and Medicine, Oxford University Press, 2000.
5. C von Sonntag: The Chemical Basis of Radiation Biology, Taylor & Francis, 1987.
6. T. Alper : Cellular Radiobiology , Cambridge University Press , 1979.
7. R.A. Fleck and A. Hollaender : Genetic Toxicology , Plenum press, 1982.
8. A.C. Upton, et al. : Radiation Carcinogenesis , Elsevier , 1986.
9. Bruce Alberts, A. Johnson, J. Lewis, D. Morgan, M. Raff, K. Roberts, P. Walter: In Molecular Biology of the cell, 6thEdn, 2015; Publisher: Garland Science, Taylor & Francis Group, New York
10. H. Lodish, D. Baltimore & others: In Molecular Cell Biology, 5th Edn, 2006, Publisher: W.H. Freeman and Company, New York
11. Stryer, L: Biochemistry, W.H. Freeman & Co, New York, 2012.
12. Michael M. Cox and David L. Nelson: In Lehninger Principles of Biochemistry, 5th Edn.2010; W.H. Freeman and Company, New York
13. Lewin, B: Genes IX, Oxford University Press, 2012.

14. Principles of Genetics, 8th Ed, Gardner, M. J. Simmons, D. P. Snustad. Publisher: John Wiley & Sons

[All the books shall be of latest editions]

ZOO-663
GENETICS AND MOLECULAR BIOLOGY LAB
(PRACTICAL BASED ON ZOO-661 & ZOO-662)

No. of Credits: 04
Total Marks: 100

EXPERIMENTS — **80 Marks**

1. Preparation of buffer and reagents
2. Demonstration of RAPD/RFLP/DNA finger printing
3. Web based tools for sequence searches and homology screening
4. Data mining for sequence analysis
5. Preparation of human karyotype and study of chromosomal aberrations with respect to number, translocation, deletion, etc. from the photomicrographs/pictures
6. Irradiation of DNA model system
7. *In vitro* study of cell apoptosis and necrosis
8. Isolation of DNA and quantification
9. Human Leukocyte Antigen (HLA) typing using PCR
10. MTT test/Micronucleus/Trypan blue test
11. Mitosis and Meiosis from male testis of rat/grasshoppers/spiders
12. Metaphase harvestation from bone marrow cells of rat through colchicine and hypotonic solution by flame-dry method
13. Banding from aged slides: C-, G-, and Q-banding
14. Mutant analysis from *Drosophila*
15. Barr body detection from human female cheek cells

Laboratory Record Book — **10 Marks**

Viva-Voce — **10 Marks**

SEMESTER IV

ZOO-613
(ANIMAL BIOTECHNOLOGY, PRINCIPLES OF GENE MANIPULATION AND BIOINFORMATICS II)

COURSE LEARNING OBJECTIVES

- To provide a foundational understanding of the environment, tools, and methodologies required for maintaining animal cells in a laboratory setting.
- To explore sophisticated techniques for producing transgenic, cloned, and knock-out animals
- To master the molecular tools and strategic workflows involved in recombinant DNA (rDNA) technology.
- To study the production of human insulin and monoclonal antibodies.
- To explore the roles of biotechnology in molecular diagnostics and gene therapy.
- To introduce the computational tools and databases necessary for managing and analysing biological data.
- To acquire knowledge about analyzing, visualizing, and predicting protein 3D structures.
- To predict conformations by applying homology modelling, threading, and *ab initio* prediction methods.
- To execute structure-based drug design and implementing ligand-based drug design.

COURSE LEARNING OUTCOMES

On completion of this course, students will be able to:

- Identify and discuss the use of equipment, reagent and culture media essential for cell or tissue culture.
- Explain Good Laboratory Practices (GLP) in handling cell cultures and the sterilization methods.
- Distinguish between different culture types, including primary culture, cell lines, monolayer, suspension, stem cell cultures and tissue culture.
- Understand the principles of cryopreservation and the diverse applications of animal cell culture in research and industry
- explain the technologies used to produce transgenic animals, knock-out animals, and cloned animals.
- Describe the industrial production of human insulin (via rDNA technology) and monoclonal antibodies (via Hybridoma technology).
- Evaluate the role of biotechnology in molecular diagnosis and the implementation of gene therapy.
- Categorize the enzymes used in rDNA technology and differentiate between various cloning vectors (such as plasmids, BACs, and YACs) and expression vectors.
- Explain gene cloning strategies, including methods for transforming bacteria and techniques for screening and selection.
- Understand the construction and screening processes for cDNA and genomic libraries.
- Have a clear knowledge of basics and understanding of advanced concept to solve structural biology problems, predict unknown protein shapes, and design targeted therapeutic molecules computationally.

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: **15 lectures/25 marks**

1. Equipment, culture media and reagents used in animal cell culture; Good Laboratory Practices (GLP).
2. Sterilization methods and techniques; Primary culture and cell lines; Types of cell culture: monolayer, suspension, clonal and stem cell culture.
3. Tissue/organ culture; Cryopreservation of cell lines; Applications of Animal Cell Culture.

Unit 2: **15 lectures/25 marks**

1. Transgenic technology: Gene transfer technology for production of transgenic animals; Knock-out animals; Production of cloned animals.
2. Production of human insulin using rDNA technology; Production of monoclonal antibodies using Hybridoma technology.
3. Biotechnology in molecular diagnosis and gene therapy.

Unit 3: **15 lectures/25 marks**

1. Enzymes used in recombinant DNA technology; Cloning vectors (plasmids, bacteriophages, cosmids, phagemids, phasmids, BACs & YACs), and expression vectors.
2. Gene cloning strategies: methods of transforming bacteria with rDNA, methods of selection and screening of transformed bacteria.
3. Construction of screening of cDNA and genomic library.

Unit 4: **15 lectures/25 marks**

1. Databases of structure-based classification: CATH and SCOP, Protein structure prediction, Classification and comparison of protein 3D structures, 3-D structure visualization.
2. Basic concepts in molecular modelling, homology/comparative modelling, fold recognition, threading approaches, and ab initio structure prediction methods.
3. *In silico* drug designing: Structure-based drug design, Ligand based drug design.

Recommended books:

1. Primrose, S. B. and Twyman, R.M.: Principles of Gene Manipulation and Genomics, (7th Ed. 2006), Blackwell Publishing, West Sussex, UK.
2. Bernard R. and Jack: Molecular Biotechnology: Principles and application of recombinant DNA, ASM Press, Herndon, USA.
3. Watson et al: Recombinant DNA: Genes and Genomics – a short course, W.H. Freeman and Company, New York, USA.
4. B.D. Singh: Biotechnology (4th Ed. 2012), Kalyani Publications, Kolkata. 5. Gupta, P.K.: Elements of Biotechnology, Rastogi Publications, Meerut.
5. J. Paul: Animal cell culture.
6. Freshney, R. Ian: Culture of animal cells: a manual of basic technique and specialized applications (7th volume, 2016), Publisher Hoboken, New Jersey: Wiley-Blackwell
7. Jin, Xiong: Essential of Bioinformatics, Cambridge University Press, 2007
8. David W. Mount. Bioinformatics: sequence and Genome Analysis, Cold Spring Harbor Laboratory Press; 2nd edition

9. Prakash, S. Lohar: Bioinformatics, MJP Publishers, Chennai, 2015.
10. S.C.Rastogi,N. Mendiratta and P. Rastogi: Bioinformatics-Methods and Applications, PHI Learning Private Limited, Delhi, 2013.
11. Sharma,V, Munjal,A. and Shanker, A.: A Text Book of Bioinformatics, Rastogi Publications, Meerut- 2008.
12. C.S.V. Murthy: Bioinformatics: Himalaya Publishing House Pvt. Ltd. Mumbai, 2008.
13. Molecular Modelling Principles and Applications (2nd Ed.) by Andrew R. Leach., Prentice Hall, USA. 2001 2.
14. Principles of Protein Structure by G. E. Schulz., Springer 2009
15. Molecular Modelling for Beginners, (2nd Edition) by Alan Hinchliffe., John Wiley & Sons Ltd.2008
16. Computational Medicinal Chemistry for Drug Discovery, edited by Patrick Bultinck., Marcel Dekker Inc. 2004

[*All the books shall be of latest editions*]

ZOO-614
(LAB BASED ON ZOO- 613)

No. of Credits: 04
Total Marks: 100

Animal biotechnology &principles of gene manipulation **50 Marks**

1. Isolation of plasmid DNA.
2. Quantification and checking purity of DNA.
3. Digestion of plasmid DNA by Restriction enzyme.
4. Demonstration of different Sterilization methods: autoclaving, filter sterilization of heat-sensitive liquids, and aseptic techniques
5. Preparation of animal tissue culture media.
6. Isolation of primary cells from animal tissue (e.g., fibroblasts from skin) and initiation of primary culture.
7. Cryopreservation and Recovery of Animal Cell Lines
8. Amplification of target genes using PCR for diagnostic markers.
9. Preparation of competent cells and storage.
10. Calculation of transformation efficiency from the data provided.
11. Perform antibiotic/ blue-white screening for recombinant colonies

Bioinformatics II **30 Marks**

1. Advanced Visualization Software and 3D representations.
2. Prediction and validation of protein structure using homology modeling (use of Swiss model)
3. Molecular docking using AutoDock

Laboratory Record Book **10 marks**
Viva Voce **10 marks**

ZOO-624
ENTOMOLOGY III
(AGRICULTURAL ENTOMOLOGY, BIONOMICS, PEST MANAGEMENT & APPLIED ENTOMOLOGY)

COURSE LEARNING OBJECTIVES

- To provide advanced knowledge of economically important insect pests affecting agricultural, medical, veterinary, and stored-product systems, including their biology, bionomics, nature of damage, and management strategies.
- To develop critical understanding of integrated pest management (IPM) approaches, including cultural, physical, biological, hormonal, chemical, and biotechnological methods of pest suppression.
- To impart comprehensive knowledge of insecticides, pesticide resistance mechanisms, toxicological concerns, and sustainable approaches for minimizing environmental and health hazards.
- To familiarize students with the principles and applications of biological control, mass rearing of natural enemies, insect cell culture, and baculovirus expression vector systems in applied entomology.
- To enhance analytical and research skills related to forensic, medical, and veterinary entomology, including vector biology, disease transmission, and insect-based forensic investigations.
- To strengthen scientific communication, problem-solving ability, and research aptitude through the interpretation and application of contemporary entomological concepts and technologies.

COURSE LEARNING OUTCOMES

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

- Classify and evaluate major agricultural, stored-grain, medical, and veterinary insect pests based on their economic importance, biology, and nature of infestation.
- Analyze the concepts of injury level, economic injury level, and economic threshold level for designing scientifically sound pest management strategies.
- Compare and critically assess different pest management tools, including legislative, cultural, mechanical, biological, hormonal, chemical, and biotechnological approaches within the framework of integrated pest management (IPM).
- Explain the classification, mode of action, and ecological implications of major groups of insecticides, and evaluate mechanisms underlying pesticide resistance and resistance management strategies.
- Apply knowledge of biological control agents, mass rearing techniques, conservation strategies, and insect cell culture systems for sustainable pest management programmes.
- Interpret the role of insects in forensic investigations and evaluate the industrial and economic importance of insects as bioresources.

- Examine the biology, vectorial capacity, disease transmission, and management of medically and veterinary important insects, including mosquitoes, flies, and other disease vectors.
- Demonstrate research-oriented thinking, scientific communication skills, and the ability to integrate modern entomological techniques and analytical approaches in solving applied biological problems.

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: **14 lectures/25marks**

1. Economically important pests and their status, nature of damage and control measures of pest of cereals (paddy and maize), fibre crops (cotton), vegetables (cabbage and potatoes), fruits (banana and citrus), plantation crops (tea and sugarcane), spices (ginger and chillies) and stored grains (grains and pulses).

Unit 2: **16 lectures/30 marks**

1. Concept of injury level: Economic injury level, and economic threshold level.
2. Tools of pest management: Legislative, cultural, physical, mechanical methods, and biological control.
3. Chemical control: Classification of insecticides based on mode of entry, mode of action, and chemical nature; organochlorines, organophosphates, carbamates, pyrethroids, and botanical insecticides.
4. Development of pesticide resistance and methods to minimize the toxic effects of pesticide.
5. Enzyme inhibitors and biotechnological intervention methods.
6. Hormonal control: Concepts and applications of juvenoids, ecdysteroids, and insect growth regulators (IGRs).
7. Use of pheromones in pest management.

Unit 3: **14 lectures/20 marks**

1. Mass Production and Conservation of Natural Enemies: Conservation, mass rearing, and field release of important biological control agents, including predators, parasitoids, and entomopathogens.
2. Insect Cell Culture: Principles of insect cell culture and its applications, with special reference to baculovirus expression vector systems (BEVS).

Unit 4: **16 lectures/25 marks**

1. Forensic Entomology: Role of Entomology in forensic science.
2. Insects as bio resources from the industrial point of view.
3. Medical & Veterinary Entomology: Biology, disease dissemination and management of Mosquitoes (Aedes, Anopheles, Culex); flies (housefly, horsefly, tsetse fly and sandfly).
4. Study of viral diseases – Dengue, Japanese Encephalitis, Chikungunya, Zika.

Recommended books:

1. David, B. V. and Ramamurthy, V. V. (2012): Elements of Economic Entomology, Namrutha Publications, Chennai.

2. David, B. V. and Ananthakrishnan, T. N. (2011): General and Applied Entomology, Tata McGraw Hill, New Delhi.
3. Atwal, A. S.: Agricultural Pests of India and South East Asia, Kalyani Publishers, New Delhi.
4. Dhaliwal, GS and Opendra Koul (2007): Biopesticides and Pest Management, Kalyani Publishers, New Delhi.
5. Ananthakrishnan, T. N. (1996): Biotechnological perspectives in chemical ecology of insects, Oxford & IBH Publishing Co. PVT. LTD., New Delhi.
6. Ananthakrishnan, T. N. (1998): Technology in Biological Control, Oxford IBH Publishing Co. PVT. LTD., New Delhi.
7. Nair, M.R.G.K.: Insect and Mite Pests of crops in India, ICAR Publications, New Delhi.
8. Tyagi (2000): Medical Entomology, Scientific Publishers (India), Jodhpur.
9. Rathnaswamy, G.K. (1986): A handbook of medical entomology and elementary parasitology, Viswanathan (Printers & Publishers), Chennai.
10. Fenemore, P. G and Alka Prakash (2006): Applied Entomology, New Age International (P) Ltd., New Delhi.
11. Ignacimuthu, S. and David, B. V. (2009): Ecofriendly Insect Pest Management, Elite Publishing House Pvt. LTD., New Delhi.
12. Muraleedharan, N. (1991): Tea Pest Management, UPASI Tea Research Institute, Valparai, Coimbatore.
13. M.L. Thakur (2000): Forest Entomology (Ecology and Management), Sai Publishers, Dehra Dun.
14. C.F.C. Beeson (1993): The Ecology and Control of the Forest Insects of India and the neighbouring countries, Shiva offset Press, Dehra Dun.
15. Martin, C. R., Hollins-Martin, C., Preedy, V. R., & Rajendram, R. (Eds.). (2021). *Zika Virus Biology, Transmission, and Pathways, Volume 1: The Neuroscience of Zika Virus*
16. Higgs, S., Vanlandingham, D. L., & Powers, A. M. (Eds.). (2018). *Chikungunya and Zika viruses: Global emerging health threats*. Academic Press (1st ed.).

[All the books shall be of latest editions]

ZOO-634
FISHERY III
(APPLIED FISHERIES AND TECHNOLOGY)

COURSE LEARNING OBJECTIVES

- **Ornamental Fishery:** Teach the principles of ornamental fish culture, including aquarium design, maintenance, and breeding techniques.
- **Post-Harvest & By-products:** Explain biochemical post-mortem changes, preservation methods, and the commercial utilization of fish by-products.
- **Genetics & Biotechnology:** Introduce fish genetic inheritance, chromosomal manipulations, transgenics, and modern feed biotechnologies.
- **Fishing Techniques:** Describe indigenous and modern fishing crafts/gears and highlight the ecological impacts of destructive fishing.
- **Marketing & Extension:** Overview fisheries economics, domestic/export marketing channels, rural extension, and the legal frameworks governing Indian fisheries.

COURSE LEARNING OUTCOMES

Upon successful completion of this course, students will be able to:

- **Manage Ornamental Fisheries:** Design aquariums, manage aquatic plants, and breed ornamental fishes.
- **Apply Post-Harvest Tech:** Apply preservation techniques and formulate commercial fish by-products.
- **Implement Biotechnology:** Apply fish genetics and evaluate biotechnologies like transgenics and cryopreservation.
- **Identify Fishing Gears:** Classify fishing crafts/gears and assess the impacts of destructive fishing.
- **Analyze Fishery Economics:** Evaluate fish marketing strategies, rural extension programs, and Indian fishery laws.

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: Ornamental fishery **10 lectures/15 marks**

Ornamental fish culture; Ornamental aquarium fishes; Construction of aquarium and its maintenance; Breeding and care of Freshwater aquarium fishes.

Aquarium keeping—Design and construction of tanks; species-wise tank size requirement; heating, lighting, aeration and filtration arrangements;

Decorations: common aquarium plants and their propagation; Maintenance of Natural colour of fishes in Aquarium.

Unit 2: Post-harvest technology **15 lectures/30 marks**

Post-harvest technology: Chemical composition and nutritive value of fish; Rigor mortis and post-

mortem changes, Methods of preservation of both finfish and shellfish preservation: refrigeration and freezing, drying, salting, Smoking, canning, pickling; Handling and packaging of fish for marketing; product stability and shelf-life.

Fish by products: Fish oils, Fish Proteins, Fish manure, Fish glue, Fish flour, Isinglass, Fishmeal, Fish Silage, Fish guano, Bone meal; Fish fermentation in South East Asia: Production of fish sauce by lactic acid fermentation.

Unit 3: Fish genetics and biotechnology **10 lectures/15 marks**

Inheritance in fishes, sex determination; hybridization, gynogenesis, androgenesis, polyploidy and production of mono-sex population; transgenic fish and its merits and demerits; Cryopreservation techniques; Feed Biotechnology: Probiotics, single cell proteins, Nutraceuticals.

Unit 4: Fishing techniques **10 lectures/15 marks**

Different types of fishing crafts and gears, their operation and maintenance; Indigenous fishing techniques; Modern equipment for fishing. Destructive fishing– its impact on fish diversity.

Unit 5: Fish marketing and extension **15 lectures/25 marks**

Exclusive Economic Zone (EEZ) and its strategy; Fish marketing and economy: Modern marketing methods and channels; Role of fisheries in Indian economy; Domestic and export marketing of fish and fish products.

Fisheries co-operatives and their role in fish production and marketing; Aquaculture and rural development in India; Role and status of women in fisheries.

Fishery education, training and extension; Fishery research Institutes in India.

Fishery legislation and their role in fishery development.

Suggested Readings

- **Axelrod, H. R., & Schultz, L. P. (1990).** *Handbook of Tropical Aquarium Fishes*. TFH Publications. *(The global standard reference for identifying, breeding, and caring for ornamental aquarium fishes).*
- **Dey, V. K. (1997).** *Hand Book on Aquafarming: Ornamental Fishes*. MPEDA, India. *(An excellent practical guide specifically tailored to the Indian ornamental fish trade and breeding setup).*
- **Jameson, J. D., & Santhanam, R. (1996).** *Manual of Ornamental Fishes and Farming Technologies*. Fisheries College and Research Institute, TNVASU. *(Covers tank design, filtration, and the specific propagation of aquarium plants).*
- **Balachandran, K. K. (2001).** *Post-harvest Technology of Fish and Fish Products*. Daya Publishing House. *(The most comprehensive Indian textbook covering everything from rigor mortis to canning, freezing, and by-products like fish meal and fish oil).*
- **Sen, D. P. (2005).** *Advances in Fish Processing Technology*. Allied Publishers. *(Great for modern preservation techniques, product stability, and shelf-life analysis).*
- **Gopakumar, K. (2002).** *Textbook of Fish Processing Technology*. ICAR. *(A standard ICAR textbook detailing the biochemical composition of Indian fishes and traditional preservation methods like drying and smoking).*

- **Reddy, P. V. G. K., et al. (2005).** *Fish Genetics and Aquaculture Biotechnology*. ICAR. *(Covers hybridization, polyploidy, gynogenesis, and androgenesis specifically in the context of aquaculture).*
- **Lakra, W. S., Abidi, S. A. H., Singh, S. P., & Pandey, A. K. (2004).** *Fisheries Biotechnology*. Narendra Publishing House. *(Excellent chapters on transgenic fish, cryopreservation techniques, and the use of probiotics/nutraceuticals in feed).*
- **Pandian, T. J. (2013).** *Genetic Sex Differentiation in Fish*. CRC Press. *(A highly specialized text perfect for understanding sex determination and the production of monosex populations).*
- **Sreekrishna, Y., & Shenoy, L. (2001).** *Fishing Gear and Craft Technology*. ICAR. *(The definitive Indian textbook on various types of indigenous and modern fishing crafts, gears, and their operations).*
- **Brandt, A. V. (1984).** *Fish Catching Methods of the World*. Fishing News Books. *(A classic text exploring global fishing techniques and the evolution of modern equipment, useful for assessing destructive fishing impacts).*
- **Subba Rao, N. (2006).** *Fisheries Development and Management in India*. Concept Publishing Company. *(Covers EEZ strategies, fishery legislation, and the role of fisheries in the Indian economy).*
- **Kumar, B. G. (2004).** *Fisheries Economics and Marketing*. ICAR. *(Essential for understanding modern marketing channels, domestic/export marketing, and fishery co-operatives).*
- **Srivastava, P. N., et al. (2006).** *Fisheries Extension*. Concept Publishing Company. *(Details rural development, the status of women in fisheries, and the role of various fishery research institutes and training programs in India).*
- **FAO Study materials.**

ZOO-644
ANIMAL PHYSIOLOGY AND ENDOCRINOLOGY III
[REPRODUCTIVE PHYSIOLOGY]

(*With special reference to mammal/human*)

COURSE LEARNING OBJECTIVES

- To understand the hormonal control of spermatogenesis, oogenesis, and menstrual cycle.
- To know the mechanism of ovulation and fertilization.
- To learn the neural and hormonal control of adolescence and puberty.
- To comprehend the knowledge about implantation, post-implantation and problems during implantation.
- To know the hormonal regulation of pregnancy and associated events.
- To comprehend the neural and hormonal control of parturition and lactation.
- To understand about reproductive health, birth control, and Assisted Reproductive Technology.

COURSE LEARNING OUTCOMES

On completion of this course, students will be able to:

- Have a clear concept about the hormonal control of spermatogenesis, oogenesis, and menstrual cycle.
- Comprehend the mechanism of ovulation and fertilization.
- Know about the successive changes during adolescence and puberty and their neuroendocrine control.
- Know all the mechanisms of implantation, post-implantation and problems during implantation.
- Understand how hormones control pregnancy.
- Understand how parturition and lactation are controlled by neuroendocrine orchestra.
- Know about the reproductive health, birth control, and Assisted Reproductive Technology.

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: General account on Reproductive Physiology **20 lectures/30 marks**

1. Hormonal control of spermatogenesis and oogenesis; Mechanism of menstrual cycle.
2. Mechanism of ovulation: hormonal and molecular changes during preovulatory period and factors involved in follicular rupture.
3. Molecular mechanism of fertilization and prevention of polyspermy in human female.
4. Neuroendocrinology of adolescence and puberty.

Unit 2: Embryo implantation and Foetal-Placental Physiology **20 lectures/30 marks**

1. Implantation window and mechanism of embryo implantation.
2. Mechanism embryo implantation failure; Recurrent abortions; Preeclampsia; Gestational diabetes.
3. Post-implantation decidualization and placenta formation.
4. Structure and functions of Placenta.

Unit 3: Physiology of pregnancy, parturition and lactation **8 lectures/15 marks**

1. Hormonal regulation of pregnancy; Cessation of ovulation and menstruation during pregnancy.
2. Physiological changes during pregnancy.
3. Role of hormones in the regulation of immune system during pregnancy.
4. Neuroendocrinology of parturition and lactation.

Unit 4: Reproductive Health, Birth control and Assisted Reproductive Technology

12 lectures/25 marks

1. Reproductive Health Knowledge and menstrual hygiene practices; Common reproductive health concerns for women.
2. Chemical, immunological, and surgical interferences in male fertility.
3. Oral Contraceptive Pills: Types, Mechanism of action, and Adverse effects; Intrauterine Devices (IUD): Types, Working mechanism, Advantages and side effects.
4. Assisted Reproductive Technology: Introduction, Types, and Procedures.

Recommended Books:

1. Guyton and Hall Text book of Medical Physiology: John E. Hall, PhD & Michael E. Hall, MD, MS; 14th Edition, 2021; Elsevier Saunders.
2. Ganong's Review of Medical Physiology: Kim E. Barrett, Scott Boitano, Susan M. Barman and Heddwen L. Brooks; 23rd Edition, 2010; Tata McGraw Hill Education Private Limited, New Delhi.
3. Langman"s Medical Embryology: T.W. Sadler; 11th Edition, 2010. Lippincott, Williams & Wilkins.
4. Endocrine and Reproductive physiology: Bruce A. White and Susan P. Porterfied; 4th Edition, 2013; Elsevier Inc.
5. The Physiology of Reproduction: Ernst Knobil and Jimmy D. Neil; 2nd Edition, 2014; Raven Press.
6. Reproductive Endocrinology: Physiology, Pathophysiology, and Clinical Management: Samuel S. C. Yen, Robert B. Jaffe, Robert L. Barbieri. Saunders publisher.
7. Reproductive Physiology: Nalbandov, A.V., W.H. Freeman and Company.
8. Williams Text book of Endocrinology: Edited by Shlomo Melmed, Richard J. Auchus, MD, PhD, Allison B. Goldfine, MD; 15th Edition, 2024; Saunders Elsevier.
9. Endocrinology: Mac E. Hadley; 5th Edition, 2004; Pearson Education, Delhi.
10. Best and Taylor's Physiological Basis of Medical Practice: OP Tondon & Y Tripathi; 13th Edition, 2021; Lippincott, Williams and Wilkins.
11. Text book of Physiology: A.K. Jain Vol. I & II, 4th Edition, 2011; Avichal Publishing Company, New Delhi.
12. Essentials of Medical Physiology: Sembulingam, K. & Sembulingam, Prema; 7th Edition, 2016; The Health Sciences Publisher, New Delhi, London, Philadelphia, Panama.

[All the books shall be of latest editions]

ZOO-654
PARASITOLOGY III
(ADVANCES IN PARASITOLOGY)

COURSE LEARNING OBJECTIVES

- Comprehend molecular foundations of parasitology
- Apply molecular techniques in parasitology
- Understand immunological aspects of host–parasite interactions
- Integrate immunodiagnostic tools and serological assays
- Design experiments and analyze molecular/immunological data
- Link molecular and immunological insights to parasite control and therapeutics
- Uphold biosafety, ethics, and quality standards in molecular parasitology
- Cultivate critical thinking and literature engagement

COURSE LEARNING OUTCOMES

By the end of this unit, students will be able to:

- Demonstrate conceptual understanding of molecular parasitology
- Apply molecular biology techniques in parasitological research
- Explain the immunological basis of host–parasite interactions
- Employ immunological techniques for diagnosis and research
- Integrate molecular and immunological knowledge in disease control
- Design and analyze experimental research in molecular and immuno-parasitology
- Demonstrate ethical, biosafe, and responsible scientific conduct
- Develop critical thinking and lifelong learning skills

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: Parasite Genomics **15 lectures/25 marks**

Introduction to parasite genomes, genetic structures in *Plasmodium vivax*. Parasite Antigens, Antigenic Variation in Protozoan parasites, Molecular mimicry in Helminthes.

Unit 2: Drug and Vaccines **15 lectures/25 marks**

Characteristics of an ideal drug, chemotherapy in relation to parasites, drug delivery methods, drug resistance in parasites; Vaccines, types of vaccines, development and designing; Adjuvants, immune-potentiality of Adjuvants.

Unit 3: Immuno-parasitology **15 lectures/25 marks**

Immunity, types of immunity and immune response, concomitant immunity; Evasion of immune response by parasites; Host's immunity against parasites like *Plasmodium, Trypanosoma, Schistosoma, Giardia* and *Ascaris*.

Unit 4: Molecular parasitology **15 lectures/25 marks**

Molecular analysis of parasitic systems: Isolation of DNA and RNA from protozoan and helminth parasites, Hybridization, ELISA, DNA sequencing, Blotting techniques, Amplification of DNA by Polymerase Chain Reaction.

Recommended Books

1. Immunology of Infection by Kaufmann, Academic Press (1999).
2. A.G. Maule and N.J. Marks : Parasitic Flatworms – Molecular Biology , Biochemistry , Immunology and Physiology. CABI , UK, USA. 2006.
3. J. Joseph Marr , T.W. Nilsen and R.W. Komuniecki (Eds.) : Molecular Medical Parasitology, Academic Press. An Imprint of Elsevier Science , U.K. 2003
4. Immunology of Infection by Kaufmann, Academic Press (1999).
5. Kuby, J. (1997) Immunology. 3rd Edition, W.H. Freeman and Company, New York.
6. Luis M. de Pablos, Javier Sotillo (2022) Parasite Genomics: Methods and Protocols, Humana New York, NY

ZOO-664
GENETICS AND MOLECULAR BIOLOGY III
(HUMAN GENETICS, GENOMICS AND MOLECULAR BIOLOGY)

COURSE LEARNING OBJECTIVES

- To understand genetic disorders through Drosophila as model organisms
- To learn the diagnostic techniques of molecular cytogenetic
- To acquire knowledge on antibody diversity and autoimmune diseases
- To learn about the mechanism of homologous recombination
- To understand regulation of transcription by certain DNA sequence binding proteins
- To understand mRNA surveillance
- To gain knowledge on protein folding and proteomics

COURSE LEARNING OUTCOMES

On completion of this course, students will be able to:

- Know *Drosophila* model for understanding varied human genetic disorders.
- Know key molecular cytogenetic diagnostic techniques
- Know the mechanism of homologous recombination and site-specific recombination and how precursors of RNA are processed.
- Have an insight of different proteins interacting with specific DNA sequences and with each other in regulating transcription
- Understand mRNA surveillance's role in regulation of damaged mRNA
- Unfold how functional proteins must undergo proper folding
- Have a clear concept about the field of proteomics, their types and practical applications.

COURSE CONTENT

No. of Credits: 04
Total Marks: 100

Unit 1: **20 lectures /30marks**

Molecular genetic analysis; *Drosophila* as a model for the study of human genetic disorders; Identification of human disease genes and aetiology of selected human genetic disorders; Human genetic diversity; Molecular cytogenetic diagnostic techniques.

Unit 2: **20 lectures /30marks**

Genetic basis of antibody diversity and HLA; Autoimmune diseases: Genetic factors, pathogenesis and aetiology, Diagnosis, prognosis and treatment of autoimmune diseases; Genetic control of immune responses.

Unit 3: **15 lectures/20 marks**

Super-coiling of DNA; Processing of RNA precursors; Mechanism of homologous recombination in prokaryotes and eukaryotes; Site-specific recombination.

Unit 4: **15 lectures/20 marks**

Control of transcription by sequence-specific DNA-binding proteins; Quality control to prevent translation of damaged mRNAs; Mechanism of protein folding; Proteomics: Definition, complexity, limitations, and practical applications.

Recommended Books:

1. Bruce Alberts, A. Johnson, J. Lewis, D. Morgan, M. Raff, K. Roberts, P. Walter: In Molecular Biology of the cell, 6th Edn, 2015; Publisher: Garland Science, Taylor & Francis Group, New York.
2. Watson, James D., Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, and Richard Losick. Molecular Biology of the Gene. 7th ed.; 2013; San Francisco: Pearson.
3. Snustad, D. Peter, and Michael J. Simmons. Principles of Genetics. 7th ed. 2015.; Wiley
4. Stryer, L: Biochemistry, W.H. Freeman & Co, New York, 2012.
5. Michael M. Cox and David L. Nelson: In Lehninger Principles of Biochemistry, 5th Edn.2010; W.H. Freeman and Company, New York.
6. Lewin, B: Genes IX, Oxford University Press, 2012.
7. H. Lodish, D. Baltimore & others: In Molecular Cell Biology, 5th Edn, 2006, Publisher: W.H. Freeman and Company, New York.
8. Geoffrey, M. Cooper: The Cell – A Molecular Approach, (2nd Ed.) ASM Press, Wahsington,
9. D.C. Freifelder, D.: Molecular Biology, Jones & Bartleth Pub. Inc.

[All the books shall be of latest editions]

ZOO-RM
(RESEARCH METHODOLOGY)

COURSE LEARNING OBJECTIVES

- **Introduce** students to the systematic process of planning, executing, and reporting research.
- **Familiarize** students with various research designs, sampling methodologies, and data collection techniques.
- **Train** students in using foundational descriptive and inferential statistics to test hypotheses and draw valid conclusions.
- **Inculcate** strong ethical values in research practices, including the prevention of plagiarism and awareness of intellectual property rights.
- **Develop** proficiency in academic writing, reference management, and the structure of scientific papers/theses.

COURSE LEARNING OUTCOMES

By the end of this course, students will be able to:

- **CLO 1 (Formulate):** Identify research gaps and formulate clear research questions and testable hypotheses.
- **CLO 2 (Design):** Select and justify appropriate research designs and sampling methods for a study.
- **CLO 3 (Analyze):** Collect, process, and analyze data using appropriate descriptive and inferential statistical tests.
- **CLO 4 (Evaluate):** Apply research ethics strictly, avoiding plagiarism and scientific misconduct.
- **CLO 5 (Communicate):** Write structured scientific papers and research proposals with accurate academic citations.

COURSE CONTENT

No. of Credits: 02
Total Marks: 50

Unit 1: Foundations of Research & Design **10 lectures/17 Marks**

- **Introduction to Research**: Definition, objectives, characteristics, and types of research (Fundamental vs. Applied, Qualitative vs. Quantitative).
- **Formulating the Research Problem:** How to identify a research gap, define research questions, and formulate testable hypotheses.
- **Literature Review Strategies:** Methods for searching literature, using academic databases (Scopus, Google Scholar, PubMed), and critical appraisal of existing research.

- **Research Design Frameworks:** Exploratory, descriptive, and experimental research designs. Independent, dependent, and confounding variables.
- **Sampling Designs & Techniques:** Probability vs. non-probability sampling methods; determining sample size and minimizing sampling errors.

Unit 2: Data Collection, Measurement & Analysis **10 lectures/16 Marks**

- **Methods of Data Collection**: Primary data collection (surveys, interviews, experiments) vs. secondary data collection (census, historical records, open-source datasets).
- **Measurement and Scaling:** Levels of measurement (Nominal, Ordinal, Interval, Ratio) and ensuring data validity and reliability.
- **Introductory Data Processing:** Data editing, coding, classification, and tabulation. Graphical representation of data.
- **Descriptive Statistics:** Measures of central tendency (mean, median, mode) and dispersion (standard deviation, variance, range).
- **Inferential Statistics & Hypothesis Testing:** Understanding *p*-values, Type I and Type II errors. Overview of parametric (t-test, ANOVA) and non-parametric tests (Chi-square).

Unit 3: Intellectual Property, Ethics & Scientific Writing **10 lectures/17 Marks**

- **Research Ethics & Plagiarism:** The philosophy of ethics in research, fabrication, falsification, and plagiarism (FFP). Use of similarity-detection tools (Turnitin, Urkund).
- **Intellectual Property Rights (IPR):** Introduction to patents, copyrights, trademarks, and the process of technology transfer.
- **Anatomy of a Research Paper:** Structuring a scientific article: IMRAD format (Introduction, Methods, Results, and Discussion), Abstract, and Title formulation.
- **Referencing and Citation Styles:** Mechanics of referencing (APA, MLA, IEEE, Chicago). Use of reference management software (Mendeley, Zotero).
- **Thesis Writing & Funding Proposals:** Structuring a postgraduate thesis, mechanics of writing a research grant proposal, and responding to peer review comments.

Core Textbooks

- C.R. Kothari & Gaurav Garg: Research Methodology: Methods and Techniques (4th Edition).
- John W. Creswell & J. David Creswell: Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (5th Edition)
- Ranjit Kumar: Research Methodology: A Step-by-Step Guide for Beginners (5th Edition).
- Andy Field: Discovering Statistics Using IBM SPSS Statistics

- Barbara Illowsky & Susan Dean: OpenStax: Introductory Statistics
- Barbara Gastel & Robert A. Day: How to Write and Publish a Scientific Paper (9th Edition).
- Richard A. Posner: The Little Book of Plagiarism.

Digital Tools & Software Essentials

- Reference Management: *Zotero* or *Mendeley* (Free, open-source tools for organizing citations and generating bibliographies automatically).
- Literature Search: *Google Scholar*, *Scopus*, and *Dimensions.ai* (For advanced keyword and citation searching).
- Data Analysis: *R/RStudio* (Free/Open-source) or *Jamovi / JASP* (Excellent, free, user-friendly graphical alternatives to SPSS).

Free Online Courses & Video Lectures (MOOCs)

- SWAYAM / NPTEL (India): *Introduction to Research Methodologies* or *Academic Writing* courses (Excellent, free semester-long video lecture series curated by top-tier universities).
- Coursera: *Understanding Research Methods* (University of London) or *Quantitative Research Methods* (University of Amsterdam).