

Cotton University

Syllabus for Postgraduate Program in Zoology



**DEPARTMENT OF ZOOLOGY
COTTON UNIVERSITY,
GUWAHATI-781001, ASSAM**

Programme Learning Outcomes (PLO):

The programme outcomes (specific skills, generic skills and attributes) that a post-graduate student of Zoology will have at the end of the completion of M.Sc. degree in Zoology are as follows

- PLO1. Subject knowledge:** Apply knowledge of Zoology, Life Sciences, and related subjects to comprehend complex life processes and phenomena.
- PLO2. Problem solving:** Identify, review, and analyze complex situations involving living forms. Design processes/strategies that meet the specified needs while taking into account public health and safety, as well as cultural, societal, and environmental factors.
- PLO3. Investigating complex problems:** To provide valid conclusions, apply research-based knowledge and research methods such as experiment design, data analysis and interpretation, and information synthesis.
- PLO4. Social responsibility:** Apply reasoning informed by contextual knowledge to evaluate societal, health, safety, legal, and cultural issues, as well as the responsibilities that come with them, in the context of professional engineering practise.
- PLO5. Understanding the environment:** Understanding the impact of natural and anthropogenic activities in societal and environmental contexts, as well as demonstrating knowledge of, and need for, sustainable development Identify and justify the conservation of a variety of invertebrates and vertebrates.
- PLO6. Ethics:** Apply ethical principles and commit to professional ethics, responsibilities, and work/research practise norms.
- PLO7. Project management:** Demonstrate knowledge and understanding of Zoology and management principles, and apply them to one's own work as a team member and leader.

Programme Specific Outcomes (PO):

The knowledge, techniques and skills acquired after the completion of M.Sc, Degree in Zoology will have the following programme specific outcomes:

- PSO1.** Procedural knowledge that leads to the development of various types of professionals in the fields of Zoology and related fields such as apiculture, aquarium fish keeping, fishery extension studies leading to self-employment as fish farmers, integrated fish farming, medical diagnostics, and sericulture, among others. (iii) abilities relating to Zoology specialized areas as well as subfields within Zoology, including broader interdisciplinary subfields (Chemistry, Physics and Mathematics).
- PSO2.** Application of study concepts to the principles and theories related with animal behavior and its management and understanding scientific principles and its application in human and animal health, medicines and drug discoveries,

Matrix for OPE and SEC papers

SN	PLOs	Papers		
		OPE 1	OPE 2	SEC
1.	Subject knowledge	✓	✓	✓
2.	Problem solving	✓	✓	✓
3.	Investigating complex problems	✓	✓	✓
4.	Social responsibility	✓	✓	✓
5.	Understanding the environment	✓	✓	✓
6.	Ethics	✓	✓	✓
7.	Project management	✓	✓	✓

P.G.1stSemester

Paper: ZOO701C (Core)BiosystematicsofNon- Chordates

Credits:4=4+0+0(64Lectures)

Learning Objectives:

This course provides an understanding of the existence of various life forms on Earth, as well as detailed knowledge of biosystematics and taxonomic classifications. It will assist the student in comprehending the functional biology of non-chordates as well as the systematic organization of animals based on evolutionary relationships, structural and functional affinities.

Learning Outcomes:

Upon completion of this course, students should be able to

- LO1. Have a thorough understanding of the subjects of systematics, taxonomy, and structural organization of animals, particularly non-chordates, along with their functional biology.
- LO2. They will be able to understand the evolutionary history and relationships of different non-chordates through functional and structural affinities.
- LO3. They can comprehend the economic importance of non-chordates, their interaction with the environment and their role in the ecosystem.

Unit1:BiosystematicsandTaxonomy:

16L

1. Basic concept of Biosystematics, taxonomy and classification; classical and recent

taxonomic parameters 2. Newer trends in biosystematics- chemo, cyto and molecular taxonomy (DNA barcoding in explaining 3. Taxonomic key, its types and their role in classification 4. Taxonomic characters and significance, ICZN, 5. Introduction of Species concept, biological and evolutionary species concept, difficulties in application of biological species concept, Supra and infra-specific and sibling species categories.

Unit 2: Biological classification: 18L

1. Theories of biological classification, 2. Phylogenetic types of classification, systematic of animals and hierarchic classification, Zoological nomenclature-basic knowledge of naming of genus and species; Modern scheme of classification into sub-kingdom, division, section, phyla and minor phyla. 3. Phenetic method of classification, numerical phonetics and numerical taxonomy, preparation of data matrix and similarity matrix using distance method (Manhattan distance and Euclidian distance), 4. Cladistic method of classification, difference in application of phonetic and cladistic classification, Cladogram, Cladistic methods.

Unit 3: Functional biology of non-chordates: 18L

1. Osmoregulation in protozoa; 2. Colonial protozoans and theories of origin of metazoans; 3. Feeding pattern and digestion in lower metazoans, 4. Life history pathogenicity and control of *Fasciola hepatica*, 5. Exocrine gland (Lac, Wax, Silk and Labial gland), 6. Larval forms of echinoderms, metamorphosis and phylogenetic significance, 7. Structure and function of digestive organs in insect-pleotropic membrane and filter chamber 8. Hydrostatic movement in Echinodermata and Annelids 9. Mechanism of respiration by gills, book lung and trachea 10. Respiratory pigments in non-chordates 11. Mechanism of Excretion and excretory organs in Annelids and Arthropods.

Unit 4: Minor phyla 12L

Salient features and affinities of- 1. Placozoa, 2. Mesozoa, 3. Ctenophora, 4. Rotifera, 5. Phoronida, 6. Sipuncula, and 7. Bryozoa (Ectoporecta).

Books recommended:

1. Barnes: Invertebrate Zoology (Holt-Saunders International, 4th edition, 1980)
2. Barnes: The Invertebrates – A synthesis, 3rd edition, Blackwell, 2001
3. Hunter: Life of Invertebrates, Collier Macmillan Pub. 1979
4. Marshall: Parker & Haswell Text Book of Zoology, Vol. I, 7th edition, Macmillan, 1972
5. Moore: An Introduction to the Invertebrates, Cambridge University Press, 2001
6. Jordan & Verma: Chordate Zoology (1998, S. Chand)
7. Sinha, Adhikari & Ganguly: Biology of Animals (Vol. II, 1998, New Central Book Agency)
8. Chapman: The Insects: structure and function, 1998
9. Srivastava: A text book of applied entomology Vol I & II Kalyani Publishers, New Delhi, 1988, 1993
10. Kapoor V. C.: Principles of Taxonomy
11. Parker and Haswell: A Textbook of Zoology Vol. I (Revised)

Paper: ZOO702C
(Core)BiochemicalandBiophysical
Science

Credits:4=4+0+0(64Lectures)

Learning Objectives:

This course will provide a thorough understanding of general biochemistry and bioenergetics, as well as their biological significance. The core conceptual framework can also help students understand enzyme kinetics and metabolism. As a result, this course will lay the groundwork for further research into micro and macromolecular interactions in biological systems.

Learning Outcomes:

Upon completion of this course, students are able to understand

LO1. The basic structural and functional chemistry of biomolecules.

LO2. The relationship of energetics with biological systems.

LO3. Kinetics of enzyme action and metabolism

A. Biochemicalscience:

Unit-1:Generalbiochemistry

4.1 Waterandbiomolecules: 14L

1. Biological importance of water, PH, PK and acid-base balance, Henderson-Hasselbachequation **2.** Types of Buffers and Biological importance **3.** Electrolyte and water

balance,Acidosis,Alkalosis**4.**Conceptofchemicalbonding,istypesandbiologicalapplicat ion

5. Role of Carbon in life and its variety of functional group/ variety of functional groups ofcarbon and its biological role **6.** Natural products, their physiological & pharmacologicalimportance

4.2 Proteinchemistryandfunction: 14L

1. Protein structure and significance- Primary structure: peptide bond. Secondary structure(α helix, β pleated sheet and bends) **2.** Ramachandran plot. **3.** Tertiary structure: forcesstabilizing tertiary structure, domain and motifs. Quaternary structure **4.** Protein-proteininteraction **5.** Ligand and types of biological ligands. Ligand formation between protein andnucleicacid**6.**Lipidand its roleinbiomembrane.

Unit-2:Functionalbiologyofnucleicacid 8L

1. Structure, folding motifs, conformational flexibility and supercoiling of DNA **2.** Mechanism ofDNAreplication**3.**RNA-Transcriptionandpost-translationalmodification

B. Biophysicalseience:

Unit-3: Bioenergetics

16L

1. Forces between molecules (electrostatic, van der Waals forces - hydrophobic and hydrophilic) and their biological importance.
2. Laws of thermodynamics (zeroth, first, second laws)
3. Concept of free energy (Gibbs), entropy and calculation based on free energy change, Endothermic and exothermic reactions.
4. Biological applications of thermodynamics (open and closed systems).
5. Third law of thermodynamics - significance of hydrophobicity and entropy in biological reaction system. Free energy and equilibrium constant of reactions, coupled reaction.
6. Bioenergetics of muscle contraction.

Unit-4: Enzyme kinetics and metabolism

12L

4.1 Enzyme action

4L

1. Mechanism of enzyme action (active site, substrate binding site, transition state analogue)
2. Concept of regulation of enzyme activity.
3. Ribozyme, abzyme and isoenzyme and their biological and medico-significance.

4.2 Metabolism

4L

1. Concept of metabolic pathway and their regulation.
2. Energy transduction - glucose and fatty acids as energy sources/metabolic fuel
3. Respiratory chain and oxidative phosphorylation
4. Metabolic disorder.

4.3 Enzyme Kinetics

4L

1. Kinetic analysis of enzyme catalyzed reaction, Derivation Michaelis-Menten equation and related calculations (Lineweaver-Burk plot).
2. Lowering of activation energy.

Books recommended:

1. Albert et al.: Molecular Biology of the Cell (4th Ed.), Garland Publishing Inc., 2002
2. Lodish et al.: Molecular Cell Biology (5th Ed.), Freeman and Company, 2004
3. Berg et al.: Biochemistry (5th Ed.), Freeman and Company, 2002
4. Murray et al.: Harper's Biochemistry (26th Ed.), Appleton & Lange, 2003.
5. Bose, S. Elementary Biophysics. Jyoth Books, 1982.
6. Bums, D.M. and MacDonald, S.G.G.. Physics for Biology and Pre-medical students. ELBS and Addison-Wesley Publishers Ltd., London, 1979.
7. Casey, E.J. Biophysics concepts and Mechanism. Affiliated East-West Press Pvt. Ltd., New Delhi, 1962.
8. Das, D. Biophysics and Biophysical Chemistry. Academic Publishers. New Delhi, 1982.
9. Epstein, H.T.. Elementary Biophysics, selected topics. Addison - Wesley Publishing Company Inc. London, 1963
10. Das, D. Biophysics and Biophysical Chemistry. Academic Publishers. New Delhi, 1982

Paper: ZOO703C
(Core) Computational and Quantitative Biology

Credits: 4=4+0+0 (64 Lectures)

Learning Objectives:

This course is designed so that students can practice the various important skills related to biological data science that are important in the research and development sector. This course will teach computer-based programming for biological data, as well as a detailed overview of data types and statistical procedures for experiment design, data collection, and analysis of results.

Learning Outcomes:

By studying this course, students will be able to

- LO1.** Perform the data analysis and data presentation using several statistical tools available on various computer programs.
- LO2.** Handle high throughput proteomic and genetic data.
- LO3.** Understand the maintenance of computers, servers and big data files.
- LO4.** Acquire the necessary knowledge to pursue jobs in biological data science, particularly in scientific academics, funding agencies, and educational institutions.

A. Computational Biology

Unit 1: Computational biology & bioinformatics

1.1: Computational biology 10L

1. Computational biology - definition & different branches and application
2. Biometrics - identification system, accuracy and technologies, fingerscan & facial scan and application
3. Bioinformatics - brain of biotechnology.

1.2: biological databases 18L

1. Introduction to Genomic Data and Data Organization. **2.** Sequence Data Banks – Introduction to sequence data banks: protein sequence data bank, NBRF-PIR, SWISSPORT, UNIPROT **3.** Nucleic Acid sequence data bank – GenBank, EMBL. **4.** Structural data bank – protein data bank, PDB and SCOP, The Cambridge Structural database (CSD), **5.** Sequence Analysis – Analysis tools for sequenced data banks, **6.** Pair-wise alignment – NEEDLEMAN AND WUNSCH ALGORITHM, **7.** SMITH WATERMAN **8.** Multiple alignments – CLUSTAL, BLAST, FASTA algorithm to analyze sequence pattern, motifs and profiles Sequence retrieval system (SRS), Protein identification resource (PIR); **9.** File formatting – FASTA, GCG and ClustalW.

Unit 3: Quantitative biology-1 **18L**

1. Variance, standard deviation, standard error, **2.** measure of skewness and Kurtosis,

3. coefficient of variance & calculation. 4. Basics of Probability – Concept of probability, addition and multiplication laws of probability and application to the problems of biology; 5. Probability distribution – Definition, Types (Bernoulli, binomial, Poisson and normal distributions), properties and applications.

Unit 4: Quantitative biology-2

18L

1. Sampling- a) Concept of sampling and sampling methods, b) Test of significance for large sample (Z-test) and for small sample (t-test). c) Hypothesis formulation and testing of Hypothesis 2. Chi-square analysis (goodness of fit, f-test). 3. Correlation: a) Definition types of correlation, b) Methods of studying correlation, Karl Pearson coefficient of correlation, Rank correlation method. 4. Regression analysis. 5. Analysis of variance.

Books recommended:

1. Barnes & Gray (ed): Bioinformatics for geneticists, Wiley (2003)
2. Lesk: Bioinformatics, Oxford (2003, Indian ed)
3. Westhead et al: Bioinformatics Instant Notes, Viva Books (2003, Indian ed)
4. Bruning J.L. and B.L. Kintz Computational Handbook of Statistics, Scott, Foresman and Company (1977).
5. Daniel W. W. Biostatistics: A Foundation for Analysis in Health Sciences, John Wiley (2000).
6. Milton J. S. and J. O. Tsokos Statistical Methods in the Biological and Health Sciences, McGraw Hill Book Co. (1983)
7. Quinn G.P. and Keough M.J. (2002) Experimental Design and Data Analysis for Biologists, Cambridge Univ. Press.
8. Techniques in life sciences – by Tembhare
9. Practical Biochemistry By Plummer
10. Principles and techniques of Practical Biochemistry Ed. B.L. Williams & K. Wilson, Arnold Publishers

Paper:ZOO704C(Core)
Parasitology and Vector Biology,
Immunological Sciences &
MicrobiologyCredits:4=4+0+0(64Lectures)

Learning Objectives:

This course is divided into two parts: advanced parasitology and immunological science.

There is an enormous diversity of parasites in nature, and knowing and understanding them well becomes critical in terms of effectively controlling and managing the parasites. The economic impact of these organisms is frequently enormous, making it all the more important to study them. Parasitology will allow us to correctly diagnose parasites, understand their life cycles, and control them effectively, as well as use some of them as biocontrol agents. Parasitology, particularly the study of parasite life cycles, has aided in breaking down stigmas and religious taboos in many societies, liberating many people from superstition and illness. Developing countries, such as ours, where the majority of the population is engaged in agricultural activities and lives in poverty, can benefit from parasitology research. The course will undoubtedly teach students to recognize, appreciate, and comprehend the various types of parasites found throughout the study of life.

The immunology section is designed to teach students the fundamentals of immunology so that they can develop an understanding of the subject, such as how the immune system works. What are the molecular and cellular components, as well as the pathways, that protect an organism from infectious agents or cancer? This comprehensive course answers these questions by delving into the structure, function, and genetics of the immune system's components.

Learning Outcomes:

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

LO1.

Understand the variation amongst parasites, parasitic invasion in both plants and animals; applicable to medical and agriculture aspects.

LO2. Help to know the stages of the life cycles of the parasites and the respective infective stages.

LO3. identify the cellular and molecular basis of immuneresponsiveness and understand how the innate and adaptive immuneresponses coordinate to fight invading pathogens.

LO4.

Understand the immunomodulatory strategies essential for generating or suppressing immuneresponses as required in hypersensitivity reactions, transplantation, autoimmune diseases and cancer.

LO5. Learn to review the literature to determine the strengths and weaknesses of

the data published in immunology and its novelty.

LO6. Design new methods to improve existing vaccines and other immunotherapeutic strategies.

Advanced Parasitology and Vector Biology

25L

Unit 1: Parasitology

17L

1.1 : General consideration of parasites:

1. Types of parasites, Type of hosts, parasite relationship-Symbiosis and commensalism
2. Distribution of diseases and Zoonosis caused by animal parasites 3. Molecular interaction between host & parasites and evasion of immunity 4. Biochemical adaptations of parasites & parasites of veterinary importance.

1.2 : Protozoan parasite

1. Distribution, habit and habitat, structure, life cycle and diseases caused by selected pathogenic protozoan parasites of man: a) Entamoeba histolytica, b) Trypanosoma gambiense, c) Leishmania donovani, 2. Physiology of parasitic amoebae of man.

1.3 : Helminth parasites

1. General characters, organization and larval forms of Platyhelminthes and Nematelminthes 2. Distribution, habit and habitat, structure and life cycle of economically important helminth parasites of man and domesticated animals: a) Echinococcus granulosus, b) Schistosoma haematobium, c) Trichinella spiralis, d) Wuchereria bancrofti

Unit 2: Vector biology

8L

1. Vectors – insect vectors, mosquito, housefly, bedbug, head louse; 2. Biology of different mosquito; 3. Vector borne diseases – human diseases and their control measures 4. Vector borne viral disease – Dengue and Japanese encephalitis 5. Vector control – Biological, chemical and physical methods

B. Immunological sciences and microbiology

39L

Unit 3: Immunology

24L

1. Cells of the immune system: T-cell generation, activation and differentiation, B-cell-generation activation and differentiation; 2. Antibody: types, structure, function, production and diversity; 3. Epitopes and haptens; 4. Major Histocompatibility Complex (MHC)- general organization and inheritance of the MHC, MHC molecules and genes; 4. Complement system

- classical, alternative and lectin pathways, regulation of complement system, biological consequences of complement activation; 5. Cytokine receptors- properties of cytokines, cytokine receptors, cytokine 6. Hypersensitivity reactions- types, mechanisms of type I to IV hypersensitivity reactions; 7. Autoimmunity and Organ specific autoimmune diseases (Rheumatoid arthritis, Grave's disease and treatment); 8. Transplantation immunology- blood antigens, transplantation rejection, graft rejection, immunosuppression.

1. Structureandgrowthofbacteria;2.Structureofvirus&reproduction(Lyticcycle ,Lysogeniccycle&Roleoflambdarepressor);2.Pathogenicmicrobes-Rabies,3.Viraldisease-, Zika, Nipah, HIV, H1N1.;4. Antibiotics: Chemistry their mode of action 5. Vaccine:Types,Vaccinepreparation.

Booksrecommended:

1. Animalparasitology–J.D.Smyth(CambridgeUniv.Press.,1976).
2. Foundations of parasitology 6 ed. – L. S. Roberts & J. Janovy Jr (McGraw Hill Publ.,2000).
3. Parasitism–A.O.Bush,J.C.Fernandez&J.R.Seed(CambridgeUniv.Press,2000).
4. Helminthology–Eds.N.Chaudhury&I.Tada(NarosaPublg.House,1994).
5. Helminthes, Arthropods, & Protozoa of domesticated animals 6 ed. – E.J.L Soulsby(ELBS,1976).
6. Introductiontoparasitology–B.E.Matthews(CambridgeUniv.Press.1998).
7. EcologicalAnimalParasitology–C.R.Kennedy(BlackwellScientificPubl.,1975).
8. Immunology,Kuby,W.F.Freeman,U.S.A
9. FundamentalsofImmunology,W.Paul

Paper: ZOO705L(Lab)
Lab1: Zoology Core Course
Laboratory Credits: 4=0+0
+4

(i) : Practical on Biosystematics of non-chordates

1. Taxonomic hierarchical classification invertebrate specimens of non-chordates by local, binomial nomenclature (at least 3 representatives of museum specimen from each phyla) & 2 minor phyla
2. Identification of at least one specimen from each typological species (supra, infra & sub species categories)
3. Permanent mounting (any three)
 - a) Protozoa (cilia-*Paramecium*, flagella-*Euglena*)
 - b) Porifera-freshwater sponges spicules, Coelenterata-*Obelia* colony
 - c) Cockroach-salivary gland and trachea, Daphnia, Cyclops
4. Study of permanent slides: Zoa, Megalopa (crustacean larvae), Glochidium, Echinoderm larvae
5. Study of Invertebrate fossils
6. Dissection: a) Mouth parts of Cockroach, Housefly, Mosquito; b) Reproductive system of cockroach c) Nervous system of cockroach

(ii) : Biochemical and biophysical sciences

1. Construction of model of biomolecules by wire and bits.
2. Preparation of different buffers and determination of pH by pH meter.
3. Chromatographic separation of amino acid and protein (in body fluid and tissue)/phytochemical by TLC.
4. Enzyme kinetics-
In vitro detection of salivary amylase activity from cockroach maltose standard/pepsin or tripsin (from stomach of toad).
5. Quantitative estimation of protein by SDS-PAGE electrophoresis (Demonstration)
6. Quantitative estimation of glucose and protein.
7. Separation of nuclei, cell debris, mitochondria by differential centrifugation.

(iii) : Biostatistics, bioinformatics and tool technique

1. Data processing and graphical presentation of data (bar diagram, histogram, pie chart) using excel sheet.
2. Calculation of measure of central tendencies (mean and median), dispersion (standard deviation, coefficient of variance) from the data collected/provided.
3. Computation of test of significance (T-test) from the data collected/provided.
4. Computation one-way ANOVA in computer by using suitable software/Excel.
5. Download protein and nucleotide sequences through browsing suitable databases and report to be submitted (Protein sequence: Hb, Myoglobin, TATA/box binding protein. Nucleotide sequence: Cry1AC, BC12/HSP70 gene etc).
6. Design of a primer for gene amplification (offline and online for forward and reverse) and annotation, ORF finder for eukaryotic gene use of ARTEMIS or any other suitable software.

7. Construction of phylogenetic tree (through Clustal W, Megablast 7/PHYLIP) for DNA and protein for any five suitable vertebrate and invertebrate animals and their interpretation.

(iii) : Biostatistics, bioinformatics and tool technique

1. Data processing and graphical presentation of data (bar diagram, histogram, pie chart) using excel sheet.
2. Calculation of measure of central tendencies (mean and median), dispersion (standard deviation, coefficient of variance) from the data collected/provided.
3. Computation of test of significance (T-test) from the data collected/provided.
4. Computation of one-way ANOVA in computer by using suitable software/Excel.
5. Download protein and nucleotide sequences through browsing suitable databases and report to be submitted (Protein sequence: Hb, Myoglobin, TATA/box binding protein. Nucleotide sequence: Cry1AC, BCl2/HSP70 gene etc).
6. Design of a primer for gene amplification (offline and online for forward and reverse) and annotation, ORF finder for eukaryotic gene use of ARTEMIS or any other suitable software.
7. Construction of phylogenetic tree (through Clustal W, Megablast 7/PHYLIP) for DNA and protein for any five suitable vertebrate and invertebrate animals and their interpretation.

(iv) : Advanced parasitology and vector biology, immunological and microbial science Parasitology:

1. Identification of dipteran vectors and study of different stages of the life history of Anopheles Cul ex, Aedes, housefly, sand fly (through slides/chart).
2. Preparation of permanent slide of insect leg, antennae, wings of mosquito/housefly/cockroach.

Vector biology:

1. Surveillance and writing a report on breeding habitat of mosquito/cockroach. Study of mosquito/housefly diversity species. 1. Histological identification: Primary and secondary lymphoid organs through prepared slide.
2. Preparation of single cell suspension from bone marrow and spleen of mice. Cell viability assay and cell counting from spleen (splenocyte)/thymus.
3. Preparation and study of phagocytosis from splenic/peritoneal macrophages. Performing the agglutination or precipitation test in ABO blood group

Immunology:

1. Histological identification: Primary and secondary lymphoid organs through prepared slide.
2. Preparation of single cell suspension from bone marrow and spleen of mice. Cell viability assay and cell counting from spleen (splenocyte)/thymus.
3. Preparation and study of phagocytosis from splenic/peritoneal macrophages. Performing the agglutination or precipitation test in ABO blood group

Microbial science:

1. Media preparation for microbial culture. Gram staining of bacteria (*Lactobacillus*).

Viva-

**VocePractical
Records**

**Paper:ZOO706S(SEC)
Seri biology & Sericulture
PracticesCredits:2=
2+0+0(32Lectures)**

Learning Objectives:

The course will educate students on the importance of sericulture as a profitable business. It

will assist students in comprehending the biology of silkworms and their nutritional requirements in order to secrete high-quality silk. The course would explain silkworm rearing techniques, silk reeling techniques, and various measures to be taken to maximize the benefits. It would also assist students in learning about the various applications of silk and developing the entrepreneurial skills required for self-employment in the sericulture and silk production sectors.

Learning Outcomes:

Upon completion of the course, students should be able to:

- LO1.** Learn about the history of sericulture and the silk route.
- LO2.** Recognize various species of silk moths in India and exotic and indigenous races.
- LO3.** Be aware about the opportunities and employment in the sericulture industry - in public, private and government sectors.
- LO4.** Gain thorough knowledge about the techniques involved in silkworm rearing and silk reeling.
- LO5.** Develop entrepreneurial skills necessary for self-employment in mulberry and seed production and be apprised about practicing sericulture as a profit-making enterprise.
- LO6.** Enhance collaborative learning and communication skills through practical sessions, teamwork, group discussions, assignments and projects.

Unit1:Introduction	6L
1. Sericulture: Definition, history and present status; Silk route 2. Types of silkworms, Distribution and Races 3. Exotic and indigenous races Mulberry and non-mulberry Sericulture	
Unit2:BiologyofSilkworm	6L
1. Lifecycle of Bombyx mori 2. Structure of silk gland and secretion of silk	
Unit3:RearingofSilkworms	8L
1. Selection of mulberry variety and establishment of mulberry garden 2. Rearing house and rearing appliances 3. Disinfectants: Formalin, bleaching powder, RKO 4. Silkworm rearing technology: Early age and Late age rearing 5. Types of mountages, Spinning, harvesting and storage of cocoons	
Unit4:PestsandDiseases	6L
1. Pests of silkworm: Uzi fly, dermestid beetles and vertebrates 2. Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial 3. Control and prevention of pests and diseases	
Unit5:EntrepreneurshipinSericulture	6L

1. Prospectus of Sericulture in India: Sericulture industry in different states, 2. Employment, potential in mulberry and non-mulberry sericulture. 3. Visit to various sericulture centers.

Books recommended:

1. Manual on Sericulture; Food and Agriculture Organisation, Rome 1976
2. Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
3. Silkworm Rearing and Disease of Silkworm, 1956, Ptd. By Director of Ptg., Stn. & Pub. Govt. Press, Bangalore
4. Appropriate Sericultural Techniques; Ed. M.S. Jolly, Director, CSR&TI, Mysore.
5. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan 1972.
6. Manual of Silkworm Egg Production; M.N. Narasimhanna, CSB, Bangalore 1988.
7. Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
8. A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR&TI, Mysore 1989.

P.G.2nd Semester

Paper: ZOO801C (Core) Analytical Techniques and Molecular Biology Credits: 4= 4+0+0 (64 Lectures)

Learning Objectives:

This course is divided into two sections. The first section provides an understanding of chordate functional biology, as well as detailed knowledge of diversity and taxonomic classifications. It will assist the student in understanding the functional diversity of chordates as well as the systematic organization of animals based on evolutionary relationships, structural and functional affinities. The second part of the course will give you a thorough understanding of biodiversity and its conservation. This course also includes a detailed examination of the economic significance of biodiversity.

Learning Outcomes:

Upon completion of this course, students should be able to

LO1. Have complete insight into the subject of functional biology of chordates.

LO2. Understand the fundamentals of biodiversity conservation.

LO3. Comprehend the economic importance of biodiversity and its role in the ecosystem.

A. Functional biology of chordate

38L

Unit 1: Vertebrate body plan

12L

1. Mechanism of body support & movement
2. Ectothermic and exothermic mode of life;
3. Jaw suspension - functional & evolutionary significance, cranial kinetics, intra-cranial feeding mechanism
4. General plan of neurocranium & dermatocranium
5. Temporal regions of reptiles, evolutionary significance;
6. Dentition & dentition formula in mammals;
7. Modification in beak, feet, palates in birds

Unit 2: Functional diversity of chordates

14L

1. Aerial respiration in vertebrates;
2. Evolution of cerebrum, Association of CNS, information process, encephalisation in higher brain;
3. Nitrogen excretion in vertebrates;
4. Communication signals - bioluminescence, pheromones, coloration & mimicry;
5. Accessory respiratory organs in fish & air-sac in birds;
6. Adaptations to Stress - basic concept of environmental stress, acclimation, acclimatization, avoidance and tolerance, stress and hormones;
7. Body fluids - major types of body fluids & fluid compartments;
8. Bonding biodiversity - molecular diversity & cellular diversity in terms of functional diversity.

Unit 3: Receptors in vertebrates

12L

1. Characteristics of general receptors, receptor potential & sensory coding;
2. Sense organs & simple receptors - organs of olfaction & taste, lateral line system, electro-reception;
3. Adaptation

inorganic system for reception-chemo-receptors & electrical receptors.

B. Biodiversity and conservation

Unit 4: Biodiversity and conservation

(26L)

4.1: Introduction to biodiversity

8L

1. Definition & indices of biodiversity 2. Biodiversity hotspot with reference to NE region 3. Types of biodiversity 4. Levels of biodiversity-genetic, species & ecological diversity 5. measuring biodiversity; interrelationship between diversity measures; pattern of local and regional biodiversity. 6. Species interaction

4.2: Biodiversity conservation

10L

1. Biodiversity conservation- methods & strategy formation 2. Threats to biodiversity-vulnerability of species extinction; 3. Red data book; rarity, endemism, effective and minimum viable population, 4. Fragmentation of population and metapopulation

4.3: Economic importance of biodiversity

8L

1. Forest Biodiversity for medical use 2. Values and uses of biological diversity, 3. Invertebrate diversity as bioindicator; putting a price on biological diversity; pollinating insect diversity and their management and utilization in sustainable agriculture.

Books recommended:

1. Booloottian, R. A. and Stiles, K. A., College Zoology, 10th edition, Macmillan Publishing Co., Inc. New York, 1981.
2. Colbert, E. H., Morales, M. and Minkoff, E. C. Colbert's Evolution of the Vertebrates: A history of the backboned animals through time, 5th edition, John Wiley - Liss, Inc., New York, 2002.
3. Farner, D. S. and King, J. R., Avian Biology (in several volumes), Academic Press, New York, 1971.
4. Goodrich, E. S., Studies on Structure and Development of Vertebrates, Dover Publication, New York, 1958.
5. Hildebrand, M. Analysis of Vertebrate Structure, 4th edition, John Wiley & Sons, Inc., New York, 1995.
6. Jordan, E. L. and Verma, P. S., Chordate Zoology. S. Chand & Company Ltd, 1998.
7. Kotpal, R. L. The Birds, 4th edition, Rastogi Publications, Shivaji Road, Meerut, 1999.
8. Primark: A Primer of Conservation Biology (2nd ed. Sinauer Associates)
9. Odum, E. P. Fundamentals of Ecology. Nataraj Publishers, Dehra Dun, 1996.
10. Berwer, A. The Science of Ecology. Saunderson's college publishing, 1988.

Paper: ZOO802C
(Core)CellBiologyandG
enetics

Credits:4=4+0+0(64Lectures)

Learning Objectives:

This course will teach about the complex organization of the eukaryotic cell as well as the molecular mechanisms of the cellular processes found in all cell types. Genetics and Cytogenetics is a core course that teaches students the fundamentals of how organisms, populations, and species evolve. Aside from Mendel's laws and basic genetics, this course at the Master's level will provide some of the most incisive analytical approaches that are now being used across the spectrum of biological disciplines.

Learning Outcomes:

The students will:

LO1. Be able to understand how the cell functions as a unit of life.

LO2.

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

LO3.

Be able to draw parallels between the physiological processes at the cellular and organismic levels.

LO4.

Appreciate the importance of cell-cell adhesion and the extracellular matrix in the evolution of multicellular organisms.

LO5. Genetics and Cytogenetics course will open up several avenues for students in terms of research and employability.

LO6. Genetics has made extensive use of model organisms, many of which will be used to teach this course. By observing genetic mutations in *Drosophila*, students can correlate phenotype with genotype, understand genetic interaction and their molecular basis.

LO7. Students will be able to set their hands on genetic crosses to understand recessive and dominant, segregation, the pattern of inheritance and finally evaluating statistical significance by counting the progeny as statistical analysis provides crucial insight into many biological processes.

LO8.

Students will learn how genetic information is passed on in eukaryotes and prokaryotes, how genes work together in a complex manner in the biological system and any alteration can lead to a major phenotypic change.

A. Cell biology & Cellular dynamics(30L)

Unit1:Cellbiology

(20L)

1.1.Membranetransport: 10L

1.Structuralorganizationofcellmembrane;2.Transmembranetransportofionsandsmallmolecules (active,passive&bulktransport),Donnaneequilibrium;3.Membranetargetingofproteins;vesiculart raffickingbetweenmembranes,Post-translationalmodifications,proteinsorting;
4. Nuclear Transport –Import and Export of protein; Export of different RNAs; 5. Nucleo- cytoplasmicinteractions&theirrole.

1.2:Cellcycleandcelldeath 10L

1. Eukaryotic Cell cycle- phases & cell cycle control, cyclin&cyclin dependent kinase; 2. Check point ®ulation; 3. Apoptosis- cellular & molecular events; 4. Cancer – Phenotypic characters of cancercells; Genetic basis of cancers: Protooncogene, Oncogene, Tumor suppressor genes, Oncogenesis,Stemcells anddifferentiation.

Unit2:Cellulardynamics 10L

1. Cytoskeleton-Structure of a)microfilaments; b)microtubules; c)intermediate filaments; d) molecular motors; 2. Their role in cell shape and motility, cell structure and dynamics; 3. CellSignaling-theirrolein Cell-cellinteraction.

B. Cytogenetics&populationgenetics

Unit 3: Cytogenetics
(23L)

3.1:Chromatinstructure: 11L

1. Eukaryotic chromatin structure and chromosome organization; 2. Chromosomal proteins: histonesandtheirmodifications,non- histoneproteins,scaffold/matrixProteins;3.Levelsofchromatincondensationatinterphaseandmet aphasestages;4.Centromere,kinetochoreandtelomere;

3.2:Humancytogenetics&geneticdiseases 12L

1.Karyotypeandnomenclatureofmetaphasechromosomebands,2.Geneticcounseling,3.Common syndromes caused by aneuploidy, mosaicism, deletion and duplication 4. molecular basisfora)Hemophilia,b)Sicklecellanemia,d)Thalassemia,e)Xerodermapigmentosum,f)Cysticf ibrosis,
g)Duchennemusculardystrophy 11L

Unit4:Populationgenetics 11L

1. Hardy-Weinberg's law of equilibrium. 2. Forces of destabilization-mutation & mutation rates,natural selection- gamete, recessive & lethal selection, heterozygote advantages. 3. Factors changingallelic frequencies-mutation, selection, genetic drift, migration, meiotic drive
4. Variation- geneticpolymorphism,causesofgeneticvariation,populationvariation.5.Measureofgeneticvariati on
6. Optimumphenotypeselection,Fisher'spressure,genetichomeostasis,geneticload&death,muta tion load 7. Inbreeding: Measure of inbreeding. Inbreeding depression, heterosis; Gene &environmentinteraction

Booksrecommended:

1. Alberts et al., Molecular Biology of the Cell, Garland, 2002
2. Lodish et al., Molecular Cell Biology, Freeman, 2004
3. Rooney & Czepulkowski, Human Cytogenetics - A Practical Approach, IRL, 1987
4. Strachan & Read, Human Molecular Genetics, Wiley, 1999
5. Watson et al., Molecular Biology of the Gene, Pearson, 2004
6. General genetics by Winchester
7. Molecular Biology of gene by Watson et al. Vol I & II
8. Genetics by Strickberger
9. Molecular Biology by Friefelder
10. Genetics by P.K. Gupta

Paper:
ZOO803C Developmental Biology
Credits: 4+0+0 (64 Lectures)

Learning Objectives:

The primary goal of the Developmental Biology course is to provide students with a four-dimensional thinking approach that allows them to truly understand the patterns and processes of embryonic development, body plan, fate map, induction, competence, regulative and mosaic development, molecular and genetic approach for the study of developing embryo that is not necessarily shared with any other discipline in the biological sciences. The importance of Developmental Biology in the study of human disease will be demonstrated throughout by the use of various model organisms.

Learning Outcomes:

LO1. Developmental Biology enquires about the fundamental processes that underpin the fertilization of an egg cell and its step-by-step transformation into the fascinating complexity of a whole organism.

LO2. Students learn best by doing and by having the opportunity to put what they have learned into practice. Therefore, using various model organism as a learning tool in Developmental Biology, students will learn how a cell behaves in response to an autonomous determinant or an external signal depends on the combination of transcriptional and posttranscriptional regulators, signaling pathway components, cytoskeletal elements, and other proteins and RNA that it has synthesized earlier: i.e., on its developmental history.

LO3. Students will also understand that cells only express a proportion of their genome, and that differential gene expression underlies cell differentiation and any alteration in the entire process of development leads to devastating diseases.

A. Developmental biology

Unit 1: Gamete biology & early development

(18L)

1. Gametogenesis, 2. Fertilization in mammals: Isogamy & heterogamy, Recognition of gametes and acrosomal reaction, Prevention of polyspermy and gamete fusion, Activation of egg metabolism 3. Cryopreservation of gametes & embryo; 3. Cleavage pattern & chemical changes during cleavage, 4. Role of nucleus & cytoplasm during early development, 5. Morphogenesis - morphogenetic movement during development, 6. Gastrulation: Presumptive areas & Fate maps, cell movement and formation of germ layers in mammal, 7. General concept of potency, commitment, specification, induction (mesoderm development), competence & determination (imaginal discs of insects) 7. Axis & invertebrate.

Unit2:Organogenesis**20L**

1.Cell-

cellinteraction,2.Neurulation(neuraltubeformation)&primordialorganrudimentsformation, 3. Origin & fate of neural crest cells, 4. Trans-differentiation & its medical implication-Metaplasia®eneration;5.Homeoboxgenesinpatterning;6.insectimaginaldisc;8.Lateembryonic development- Vulva formation in Caenorhabditis; 9. Regeneration of Salamander limbs:PolarCoordinatemodel,10.Teratogenesis

B. Reproductivephysiology**Unit3:Reproductivephysiology****17L**

1.Implantation&pregnancy,placentalstructure&hormones,2.Endocrine,genetic&immunologicalfactorsinfluencingpregnancy;3.Parturition&lactation-recentconceptofphysiologicalmechanismofparturition,hormonalcontroloflactation&physiologicalimportance.

Unit4:Medicalembryology**9L**

1. Infertility;2.Gametemanipulation–a).MultipleovulationsandIn-vitrofertilization(IVF),b).Gamete Intrafallopian transfer (GIFT), c). Intra cytoplasmic sperm injection (ICSI),e). Chimeraformation, 3.Multiple ovulation & embryo transfer technology (MOET) 3. Embryonic stem cells-application,economical&clinicalsignificance,Surrogacy,Cryopreservationofgametes.

Booksrecommended:

1. AdashiandLeung(eds):TheOvary,Raven Press,1993.
2. Adashietal:Reproductiveendocrinology,SurgeryandTechnology,Lippincott-Ravenpublishers,1996.
3. Findlay,J.K.:MolecularBiology of theFemaleReproductiveSystem,Academic Press,SanDiego,1994.
4. Knobil&Neil(eds.):ThePhysiologyofReproduction,Vol.I&II,RavenPress,1994.
5. Lamming(eds.):Marshall'sPhysiologyofReproduction.Longman,Green&Co.,1984.
6. Mann&Lutwak-Mann:TheMaleReproductiveFunctionandSemen,Springer-Verlag,1981.
7. Paulsonetal(eds.):Andrology:MaleFertilityandSterility,AcademicPress,1986.
8. Yenetal(eds.):ReproductiveEndocrinology,W.B.Saunders,1999.
9. IntroductiontoembryologybyBalinsky
10. DevelopmentalBiologyS.Gilbert
11. DevelopmentalBiologybyBerryl

Paper:ZOO804C
Ecology and Environmental Science, Wildlife
Biology
Credits:4=4+0+0(64Lectures)

Learning Objectives:

The goal of this course is to raise awareness among young students about the environment, the impact of climate change and how to mitigate it, and biodiversity.

Learning Outcomes:

LO1. Students will be exposed to the fundamental aspects of ecology.

LO2.

They will get ideas about the impact of anthropogenic activities on the environment.

LO3. Students will get ideas about the natural resources and their conservation.

A. Ecology & population ecology

Unit 1: Ecology

(44L)

1.1: Principle of ecology

8L

1. Introduction to ecology, 2. Evolutionary ecology, environmental concepts – laws and limiting factors, ecological models. 3. Biotic potential & environmental resistance. 4. Soil, types & important soil for vegetation.

1.2 Pollution Ecology:

8L

1. Definition, sources, kind of pollutants, primary and secondary pollutants. 2. Definition, source, its effects and control of (a) air pollution, (b) Water, Pesticide, Soil pollution, (c) Sound pollution, (d)

Radioactive pollution, 6. Bioaccumulation, biomagnification, biotransformation of xenobiotic biomedical and hazardous work.

1.3: Population ecology & species interaction

12L

1. Characteristics of population, population size 2. Population dynamics- a) Intrinsic rate of natural increase; b) Population growth form (sigmoid curve, J curve and hyperbola), logistic equation and concepts relating to growth; c) life history pattern, fertility rate and age structure; d) Population fluctuations and cyclic oscillation; e) Population density and structures; f) r- and k- selections and carrying capacity; 3. Competition and coexistence, intra-specific and inter-specific interactions, 4. Scramble and contest competition model, mutualism and commensalism, prey-predator interactions; 5. Ecological genetics- Importance of genetics to ecological, reproductive system & genetic censures of different reproductive systems

1.4: Nature of ecosystem

8L

1. Nature of ecosystem, 2. Energy flow through ecosystem, 3. Biogeochemical cycles, 4. Resilience of ecosystem, 5. Ecosystem management. 5. The biosphere, biomes and impact of climate on biomes. 6. Types of ecosystem—freshwater, marine and terrestrial 7. Wetland—the kidney of nature.

1.5 : Concept of habitat

8L

1. Concept of habitat & niche-Definition & characterization of habitat niche determination, Gaussian principles 2. Species co-existence & community structure 3. Trophic levels & its organization with reference to energy transfer. 4. Ecotone concept and edge effect;

B. Environmental biology & Wildlife ecology

Unit 2: Environmental biology

7L

1. Introduction to environmental biology, 2. Concept of environment structure; 3. Environmental stresses and their management

Unit 3: Wildlife ecology

3L

1. Forest and wild life ecology- 2. Concept of indicator species and their environmental significance. 3. Wildlife biology as resource, food, nutrition, requirements etc.

Unit 4: Conservation biology

10L

1. Wildlife conservation and management; 2. Social forestry & tribal welfare of north. 3. National legislations for protecting biological resources— Biodiversity Act, 2002 and Biodiversity Rules, 2004, 4. Important wildlife sanctuaries & national parks in Assam & India in relation to specific conservation to wild lives. 5. Man-animal conflict in Assam-causes & their solution. 6. International bodies for conservation with reference to red data book.

Books recommended:

1. Harborne: Introduction to Ecological Biochemistry 4th Ed. Academic Press, 1993.
2. Schoonhoven et al.: Insect-Plant Biology, Chapman and Hall 1998.
3. Chapman and Reiss: Ecology-Principles and applications, Cambridge University Press, 1995.
4. Ricklefs and Miller: Ecology 4th ed. Freeman and Co. 2000.
5. Turk and Turk: Environmental Science, 4th ed. Saunders, 1993
6. Primark: A Primer of Conservation Biology, 2nd ed. Sinauer Associates
7. Calabrese: Pollutants and High-Risk Groups, John Wiley, 1978
8. Raven, Berg, Johnson: Environment, Saunders College Publishing, 1993
9. Sharma: Ecology and Environment, Rastogi Publication, 7th ed. 2000
10. Dasmann, R., 1981. Wildlife Biology, 2nd ed. John Wiley and Sons, NY
11. Dobson, A.P. 1996. Conservation and Biodiversity. Scientific American Library, New York, U.S.A.
12. Jeffries, M.J. 1997. Biodiversity and Conservation. Routledge, New York, New York, U.S.A.

Paper: ZOO805L(Lab)
Lab 2: Zoology Core Course
Laboratory Credits: 4=0+0+4

(i) : Functional biology of chordates and Biodiversity

1. Study of skull types with reference to jaw suspension - fish, frog, calotes, snake, rat/rabbit (guinea pig)
2. Dissection of accessory air-breathing organ from any one of marketed specimen (Anabus, Clarius, Heteropneustes/Chan nasp.).
3. Animal population study through quadrat analysis (ants)
4. Enumerate biological diversity (zooplanktons & birds) from large habitat (freshwater lake/w ater body) within the vicinity of the city
5. Study of Pungmarkoftiger.

(ii) : Cell biology and genetics

1. Study of structure of prokaryotic cell by staining preparation of Lactobacillus from curd
2. Study of structure of eukaryotic cell from the permanent preparation
3. Study of eukaryotic cell organelle by making preparation with suitable stain/permanent slides/ photographic model (nucleus, mitochondria, Golgi apparatus, liposome, centrioles, ER).
4. Study of polytene chromosome from Chironomous larva
5. Study of sex chromatin (Barr body) from buccal epithelia
6. Measurement of cell size by ocular & stage microscope
7. Identification of male & female Drosophila
8. Study of genetic frequency of human ABO blood group to see the validation of Hardy-Weinberg equation & its significance in population genetics

(iii) : Developmental biology

1. Estimation of LDH activity
2. Histological slides of reproductive organs
3. Study of different phases of estrous cycle from vaginal smear of rat/mouse
4. Study of different types of eggs on the basis of yolk content
5. Study of different developmental stages of amphibian & chick embryo (whole mount permanent slides)

6. Study of different types of mammalian embryo (already existing preserved embryo)

7. Study of developmental stages of human embryo (through already existing model)

(iv) : Ecology, Environmental Science and wildlife biology

1. Determination of pH, temperature, turbidity from collecting samples.

2. Analysis of types of phyto and zooplankton for the nearby sampling of water bodies.

3. Determination of primary productivity by dark and light bottle method.

4. Determination of relative humidity by hygrometer and anemometer.

5. Field visit to and submission of report.

PAPER:ZOO901C
MOLECULAR BIOLOGY AND ANIMAL BIOTECHNOLOGY
(Credits:3+0+1=4)

Learning Objectives:

This course will teach you about the complex organisation of the eukaryotic cell as well as the molecular mechanisms of the cellular processes found in all cell types. Genetics and Cytogenetics is a core course that teaches students the fundamentals of how organisms, populations, and species evolve. Aside from Mendel's laws and basic genetics, this course at the Master's level will provide some of the most incisive analytical approaches that are now being used across the spectrum of biological disciplines.

Learning Outcomes:

The students will:

LO1. Be able to understand how the cell functions as a unit of life.

LO2.

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

LO3.

Be able to draw parallels between the physiological processes at the cellular and organismic levels.

LO4.

Appreciate the importance of cell-cell adhesion and the extracellular matrix in the evolution of multicellular organisms.

LO5. Genetics and Cytogenetics course will open up several avenues for students in terms of research and employability.

LO6. Genetics has made extensive use of model organisms, many of which will be used to teach this course. By observing genetic mutations in *Drosophila*, students can correlate phenotype with genotype, understand genetic interaction and their molecular basis.

LO7. Students will be able to set hands on genetic crosses to understand recessive and dominant, segregation, pattern of inheritance and finally evaluating statistical significance by counting the progeny as statistical analysis provides crucial insight into many biological processes.

LO8. Students will learn how genetic information is passed on in eukaryotes and prokaryotes, how genes work together in a complex manner in biological system and any alteration can lead to major phenotypic change.

A. MOLECULAR BIOLOGY

Unit 1: Molecular biology (22L)

1. Structure of protein, Domains and motifs, 2. Transcription factor, 3. Protein folding, Ramchandran plot. 4. Molecular chaperons; 5. Genome organization in prokaryotes, eukaryotes & genome complexity. 6. Recombination, 7. Mobile genetic elements; 8. DNA damage & repair-types of DNA damages and repair systems. 9. Model organisms for molecular studies; 10. Somatic cell hybridization and chromosome mapping, Cell fusion and applications, 11. Construction of cDNA & genomic DNA libraries.

B. ANIMAL BIOTECHNOLOGY

Unit 2: General biotechnology (26L)

2.1 Use of animals as bioreactors; 2. Animal breeding & care; 3. Uses of animals in experiment: Selection rationale & cruelty. 4L

2.2: Cell culture 8L

1. Cell culture – a) Equipments and materials for cell culture technology, b) principle of sterile techniques and cell propagation, c) primary and established cell line cultures. 2. Mammalian cell lines & their characteristics. 3. Basic techniques of mammalian cell culture, disaggregating of tissue, maintenance of cell culture, cell separation, cell synchronization, cell cloning, micromanipulation, cell transformation.

Unit 3: Recombinant organisms and transgenic animals 5L

1. Transgenic animals; creation of transgenic mice, retroviral vector method, Microinjection, embryonic stem cell method – short gun, electroporation, lipofection, microinjection. 3. Production of other transgenic animals – cattle, sheep, pigs and fish.

Unit 4: Application of Biotechnology 9L

1. Application of RFLP in forensic science, 2. hybridoma technology and Production of monoclonal antibodies. 3. Environmental Biotechnology – biosensors in ecotoxicological screening; 4. Biofuels & biogas production 5. Biohazard & biosafety level – I, II, III, IV 6. Intellectual property right (IPR)

PRACTICAL: Molecular Biology and Applied biotechnology, Molecular techniques. Credit: 1

1. Study of colchicised metaphase chromosome in bone marrow of rodent species (mouse) by air flame dry method.
2. Study of sex chromatin in human female from hair bud cells.
3. Preparation of human karyotype.
4. Demonstration of culturing of E. Coli on solid and liquid medium.
5. Demonstration of bacterial transformation using suitable plasmid (with and without insert).
6. Identification and study of male and female drosophila, study of mutant variety of drosophila – eye and body colour, body pattern, wings development from the permanent slides.
7. Demonstration of SDS-PAGE for protein and visualization.
8. Demonstration of Agarose gel electrophoresis for DNA.
9. Estimation of cholesterol and LDH.
10. Demonstration of animal culture lab.

HISTOLOGY&HISTOCHEMISTRY,TOXICOLOGY

(Credits:3+0+1=4)

Learning Objectives:

This course will teach you the techniques used in histological studies, as well as the specifics of histopathology. The course will also teach you about histochemistry and toxicology.

Learning Outcomes:

Upon completion of this course students will

LO1. enable to use different histological techniques to study histopathology and histochemistry.

LO2. know how to use different bio-instruments along with their principles.

Unit1: Histology(19L)

1.1. Techniques of histology: 6L

1. Mechanism of Fixation and Fixatives-Types, Chemistry & Choice of Fixatives 2. Tissue Staining-Principle and Mechanism of histological staining, different types of dyes &, dye binding reactive groups, Histological stains; mordants & mordanting & histological lake, double staining technique 3. Tissue processing through microtomy technique- narcotization & excise the tissue sample, fixation processing, Dehydration, Clearing and Embedding, block making & trimming, sectioning & stretching.

1.2: Histopathology: 10L

1. Histological structure & functions of liver, kidney, & brain; 2.. Histological structure & functions of immunological organs thymus, spleen; 3. Cellular behaviour in pathological state; 4. Cell injury- definition, pathogenesis of reversible & irreversible cell injury, concept of free radicals, oxidative state & oxidative stress; 5. Thrombosis- definition, types & mechanism of thrombosis, 6. Healing- definition, mechanism & factors controlling cellular healing.

Unit 2: Histochemistry and toxicology: 8L

1. Principle and methods of histochemical reaction and localization of the following: Carbohydrate moieties: by PAS (Periodic Acid Schiff) method; 2. Protein by bromophenol blue method; 3. Lipid moieties by Sudan black B method, 4. Nucleic acid: by methyl green pyronin method. 5. Enzymes: alkaline phosphatase by metal precipitation method, cytochemical detection of calcium; 6. Basic concept and scope of toxicology, 7. Toxicity principle and methods, 8. Different types of toxicity test (chronic, subchronic, acute, subacute); 9. Dose response relationship, calculation of LD50, LC50, ED50, TI Index.; 10. Food toxicant and their control method; 11. Metal toxicity on animal.

Unit3: Bioinstrumentation-1

1. Principle, different types of centrifugation (differential, density gradient and ultra centrifugation) and biological applications. 2. IR and NMR spectroscopy. Principle and application in biology. GM tube and liquid scintillation counter, 3. Microscopy-a) principle of microscopy and application-Bright-field microscope, Dark-field microscope, b) Phase-contrast microscope, 4. Principle & application of a) Fluorescence microscope, Confocal microscope, b) electron microscopy (SEM & TEM), 5. Spectrophotometric techniques— principles and biological applications of UV, Atomic absorption and mass

spectroscopy , 6.Chromatographic techniques – principle and types, applications of Gel filtration, ion-exchange, column, TLC, GC, HPLC; affinity of chromatography 5. Principle and application of autoradiography techniques

Unit4:Bioinstrumentation-II(8L)

1. Electrophoresis techniques – principles and applications of Agarose- and polyacrylamide gel, Two-dimensional (2D), Isoelectrofocussing electrophoresis. 2. PCR techniques- RT-PCR & QPCR, principle & application. 3. Flowcytometry-principle & bio- application, 4. Microarray techniques, 5. ELISA, 6. Fluorescence in situ hybridization (FISH) technique.

PRACTICAL: Credit: 1

1. Preparation of commonly used fixative, stain, vital and supra vital stain.
2. Histological preparation of tissue for microtomy technique. Paraffin (Necrotization, fixation, dehydroxation, Clearing, paraffin embedding of tissues from any vertebrate specimen, sectioning of paraffin block, stretching and spreading sections on slides).
3. Histological staining of paraffin tissue section using H & E method.
4. Supravital staining of blood cells/spleen.
5. Histochemical detection of glycogen, acidic glycoprotein by PAS and Alcian blue (pH 2.5) techniques.
6. Histochemical detection of alkaline phosphatase in situ.
7. Histochemical/cytochemical detection of nucleic acid (DNA and RNA) by methyl green pyromin method
8. Detection of DNA by Feulgen method.
9. Cytochemical detection - SH group for blood sample
10. Study of histopathological and cytopathological changes. Cells or tissue samples from permanent slides or photographs (cytomorphology blood, carcinoma cell, tissue necrosis and degenerative changes, fatty infiltration, cytolysis).
12. Microscopic measurement of cell by ocular and stage micrometer.

Books recommended:

1. Bancroft, J. D. & Stevens, A. Theory and Practice of Histological techniques, Churchill-Livingstone, 2002
2. Casselman, W. G. B.: Histochemical techniques, John Wiley, 1959
3. Pearse, A. G. E.: Histochemistry; Theoretical and Applied (Vol. I, II & III), (4th ed.), Churchill-Livingstone, 1980-1993
4. Nelson et al.: Lehninger Principles of Biochemistry (3rd Ed.), MacMillan Worth, 2000
5. Berget et al.: Biochemistry (5th Ed.), Freeman, 2002
6. Mathew et al.: Biochemistry (3rd Ed.), Pearson, 2004
7. Principles of ecotoxicology- 3rd edition 2006, C H Walker, S P Hopkin, R N Sibly and D B Peakall (Eds.), Taylor and Francis, New York, NY.
8. Introduction to Environmental toxicology -3rd edition 2003, W.G.Landis and M.H.Yu. Lewis publishers, Florida.
9. Text Book of Modern Toxicology 2000 edition, Ernst Hodgson and Patricia Levi, McGraw –Hill International edition. Singapore.

PAPER:ZOO903C
ENDOCRINOLOGY AND BEHAVIORAL SCIENCE
(Credits:3+0+1=4)

Learning Objectives:

The endocrinology section is designed to provide a thorough understanding of non-mammalian and mammalian endocrinology, as well as the physiological roles of the endocrine system. The section on animal behaviour focuses on the fundamental concepts of animal behavioural patterns.

Learning Outcomes:

At the end of this course students should enable to

LO1. Understand the role of different hormones in human physiology along with their biosynthesis in the body.

LO2. Understand animal social behaviour.

A. ENDOCRINOLOGY

Unit1: Non-mammalian and mammalian endocrinology

1. Non-mammalian 2L

1. Endocrine control of molting & reproduction in insect, 2. Structure of Pineal gland & its functions.

1.2 : Mammalian endocrinology 12L

1. Introduction to endocrine system & classes of hormones-peptide, protein, steroid & prostaglandins, 2. Endocrine cells of pancreas, pancreatic hormones & its role in glucose homeostasis 3. Thyroid Gland-Biosynthesis of thyroid hormones, Control of secretion & their Physiological roles. 4. Adrenal gland- a) its secretion, physiological action of adrenal hormones b) Adrenal Medullary hormones-Catecholamine biosynthesis, release and its physiological roles, 5. Synthesis of steroid hormones & synthesis of corticosteroid hormones, 6. Role of parathormones in Calcium & phosphate homeostasis, Hormones as second messenger.

Unit2: Reproductive endocrinology 10L

1. Testis- Organization, Physiological roles of androgens & inhibin, Ovary- Organization, Physiological roles of Estrogen, Progesterone, Relaxin & Inhibin. 2. Human reproductive pheromones, role of pheromones in puberty, Physiological changes & hormonal regulation of onset of puberty 3. Placental hormones,

Unit3: Endocrine disorders 6L

1. Overview of endocrine disorders-a). Pituitary gland- Acromegaly & Diabetes insipidus b). Thyroid gland-Goiter & Myxoedema c). Parathyroid gland- Osteoporosis d). Islets of Langerhans- Diabetes mellitus e). Adrenal gland-Cushing's syndrome f). Ovary & female infertility- Polycystic ovarian disease g). Obesity

B. ANIMAL BEHAVIOUR

Unit4: Behavioural biology (18L)

4.1: Biological Rhythms & control: 6L

1. Definition & types of rhythms, Zeitgebers, circadian rhythms, Basic types of exogenous rhythms in the human and their significance, Photoperiodism, annual and lunar periodicity. 2. Role of melatonin & neurotransmitters in circadian control, Role of SCN in the human, photic

and non photic pathways, pacemaker function of the SCN.

4.2: Mimicry & coloration: 3L

1. Definition of mimicry & coloration, Types of mimicry, Batesian and Mullerian mimicry and significance.

4.3: Interspecific relationship: 2L

1. Definition of Interspecific relationship, Aggregations and social organization.

4.4 Animal behavior & pattern: 7L

1. Animal behavior - innate or inherent behavior, learned behavior, vision and behavior, sound and behavior, Social behaviour: mating, family, and group behavior, advantages of social behavior, Habitat selection and foraging behavior 2. Genetic, hormonal and evolutionary aspects of behavior. 3. Sexual conflict & Sexual selection: a) intra sexual selection (male rivalry), b) inter-sexual selection (female choice), c) infanticide, sperm competition, d) mate guarding, sexual selection in human, e) consequences of mate choice for female fitness, f) monogamous versus polygamous sexual conflict. 4. Parental care.

PRACTICAL: Non-mammalian and mammalian endocrinology and behavioral science Credit: 1

1. Dissection of pituitary gland from suitable marketed fish
2. Demonstration of thyroid, adrenal, pancreas & gonads of any suitable vertebrate specimen through dissection
3. Dissection of neuroendocrine complex in insect (cockroach)
4. Parabiosis (parabiotic behavior) in cockroach
5. Study of histological preparation of pituitary & thyroid gland
6. Study of pituitary, thyroid, parathyroid, pancreas, adrenal, testis & ovary of mammal through permanent slides
7. Castration & ovariectomy in rat
8. Identification of gonadotropin in human urine sample
9. Effect of insulin/adrenaline on blood glucose level in rats
10. Study of median threshold concentration of sucrose/glucose solution in eliciting feeding response in ants
11. Methylene blue visualization of sensory neurons in *Drosophila*
12. Recording & analysis of insect (cricket) & bird calls
13. Study of social insect colonies
14. Study of laboratory behavior in mice by using zigzag or T-shaped maze
15. To study the geotaxis behavior of worm
16. To study oriental responses of 1st instar larva of photostimuli

Books recommended:

1. Comparative Endocrinology of Invertebrates by Highman and Hill.
2. Comparative Vertebrate Endocrinology by P.J. Bentley, Cambridge Univ. Press.
3. General and Comparative Endocrinology by E.J.W. Barrington, Oxford Clarendon Press
4. Endocrinology Vol. 1-3 by DeGroot L.J. et al.
5. Text Book of Endocrine Physiology by C.R. Martin, Oxford Univ. Press, New York.
6. Text Book of Endocrinology by Turner and Bangnara (W.B. Sanders).
7. Vertebrate Endocrinology by Mc. Hadley.
8. Text Book of Comparative Endocrinology by Gorbman A, and Bern H.A., John Harley and Sous, New York.
9. Alcock: Animal Behaviour - An Evolutionary Approach. (7th ed.) Sinaur Associates, Inc. 2001.
10. Drickamer & Vessey: Animal Behaviour -

Concepts, Processes and Methods (2nd ed.), Wadsworth, 1986.

11. Gadagkar: Survival Strategies - Cooperation and Conflict in Animal Societies. Universities Press, 1998.

**(Special
Paper) PAPER: ZO
O904S
CELL & MOLECULAR BIOLOGY - I
(Credits: 3+0+2=5)**

Learning Objectives:

This course aims to provide a detailed understanding of cell biology covering all the basic structure and dynamicity of cell, cell communications, cell signaling and details about cancer cell and apoptosis. This paper is the part of the specialization in cell and molecular biology. Therefore, this paper aims to cover the foundation of the subject.

Learning Outcomes:

Upon completion of this course students should be able to-

- LO1.** Understand and interpret structure and dynamicity of cell.
- LO2.** Have clear knowledge about the cell communication and signaling.
- LO3.** Have understanding about protein sorting and transport.
- LO4.** Understand and get prepared for advanced cell and molecular biology.

A. CELL STRUCTURE & DYNAMICITY

Unit 1: Cell structure & Cell cycle (23L)

1.1: Cell cytoskeleton: 5L

1. Prime cytoskeletal proteins & functional roles 2. Assembly & disassembly of microtubules, dynamic stability of microtubule proteins, molecular motor, cargo protein 3. Actin structure, polymerization & actin binding protein 4. Intermediate protein (laminin) & role in evolution of cellular regulation.

1.2: Chromosome structure: 7L

1. Circular & linear chromosomes, Ultrastructure of chromosome based on different models (multiple strand, single strand, unine, molecular model, 2. Variations & abnormalities in chromosome structure & number (breakage, fusion-bridge cycle, deletion, duplication, translocation, aneuploidy, polyploidy) 3. Satellite chromosome & satellite DNA 4. Role of centromere & telomere in chromosome & Chromosome condensation 5. Nucleosome & its phasing 6. Sex determination & dosage compensation & Mitochondrial inheritance

1.2: Cell cycle, cancer & apoptosis: 5L

1. Cell cycle-molecular basis of mitosis & meiosis, mitotic inhibitors 2. Cyclins & CDKs in cell cycle phases & Molecular mechanism of M-CDK activation 3. Genetic regulation of cell cycle, deregulation led to cancer 4. Molecular basis of cellular checkpoints & their roles in cell 5. Synaptonemal complex & recombination molecule 6. Ageing: Cellular & molecular mechanism of ageing, genetic control, Oxidant as a major contributor to cancer & ageing.

1.3 Cancer & apoptosis- 6L

1. Epidemiology, causes, properties & types of cancer 2. Proto-oncogene & viral oncogene, mechanism of oncogene activation, Tumor marker & tumor suppressor genes 3. Molecular approaches in cancer therapy 4. Apoptosis & pathways (Caspases 5. Bcl2, P53, Bax & BAK gene activation pathways of apoptosis, Mitochondrial pathways of apoptosis).

Unit 2: Cell signaling & communication

(13L) 2.1: Cell signaling & receptors: 4L

1. Cell signaling molecules & forms of intracellular receptors, Surface receptors & cytokine receptors 2. Mechanism of signaling from plasma membrane to nucleus 3. Signal amplification & signal transduction pathways (JAK-STAT, MAP kinase, RTK & RAS, TGF signaling, Wnt

& Hedgehog pathways).

2.2: Cell communication 5L

1. Cell-cell adhesion by cadherin & selectin 2. Cell junction & organization (Tight junction, Gap junction, anchoring, 3. Cell-matrix interaction-integrin, collagen & fibronectin 4. Focal adhesion & desmosome, Extracellular matrix, 5. Compartmentalization of cell organelle & peroxisomes

2.3: Protein sorting & protein transport 4L

1. Insertion of protein in ER, intracellular & molecular mechanism of protein transport (Golgi trafficking, Calnexin Cop I & Cop II mediated transport), 2. Receptor mediated endocytosis & Regulatory protein transport (SNARE & Rab protein), Lysosomal assembly & function.

B. MOLECULAR CYTOLOGY

Unit 3: DNA damage & repair mechanism 5L

1. Free radicals & damage to DNA & nucleoprotein, DNA damage by photosensitization 2. High fidelity of DNA sequence & Concept of eukaryotic DNA repair system (Direct repair, mismatch repair, basic excision repair, recombinant repair) 3. Role of DNA polymerases in error correction of replication.

Unit 4: Human Molecular Genetics 7L

1. Basic attributes and polymorphic structures in human protein coding genes. 2. DNA polymorphism (Y-chromosome polymorphism and Single nucleotide polymorphism (SNP), Basic concept in Molecular phylogenetics) 3. Molecular biology in forensic science: (Protein comparisons, DNA comparisons, RFLPs, genetic fingerprinting, VNTRs) 4. Human genome projects & age of genomics.

PRACTICAL: Credit: 2

(Cell structure, Dynamicity, Molecular Cytology)

1. Total leucocyte, erythrocyte and differential count of leucocyte.
2. Preparation & study of effect of colchicine treatment on the behaviour of mitotic chromosome in onion root tip/ mouse bone marrow.
3. Preparation of sex chromatin (Barr body) from human buccal epithelium.
4. Preparation of chromosome bending pattern (G-C) from the mitotic chromosome preparation from the mammalian blood/bone marrow.
5. Supra-vital staining of living cell from blood/lining protozoan/spleen
6. Detection of localization (changes in epithelial cell, liver/kidney) of some cell organelle (mitochondria, Golgi -in situ) from the chick epithelial cell/liver/kidney cells by using specific stain.
7. Histochemical localization of lipid peroxidase granules.
8. Identification and localization of nucleolar organizer region (NOR) on polytene/bone marrow chromosome.
9. Preparation of cell suspension and assays (count of) viable cells by trypan blue exclusion.
10. Cell viability by MTT assays/ Assaying of phagocytosis in mouse macrophage.
11. Assaying of apoptosis in mouse thymus cell by acridine orange and propidium iodide staining.
12. Cytochemical/ histochemical detection of lipid granules by Sudan Black method from blood/animal tissue.
13. Study of behavioural response of erythrocyte cell to different concentrations of physiological saline.
14. Determination of oxidative stress enzyme SOD/LPO/Catalase.
15. Identification of different types of cancer cells from permanent slides
16. Study of mutant variety of *Drosophila*
17. Practical record book & viva voce.

Booksrecommended:

1. G.M.CooperandR.E. Hausman:TheCell,AMolecularApproach. 5thEd.ASM Press(2009)
2. Bostock&Sumner:EukaryoticChromosome (North-Holland,1987)
3. Karp:CellandMolecularBiology(JohnWiley&Sons, 2002)
4. Lewin, GenesVIII(Wiley,2004)
5. Lodish etal:MolecularCellBiology(Freeman, 2000)
6. Pollard& Earnshaw: Cell Biology(Saunders, 2002).
7. Albertsetal: MolecularBiologyof the Cell (4thEd.), Garland,2002
8. A.Paul:CellandMolecularBiology,BooksandAllied(P) 2nd Edn.(2009)
9. Lodish etal:MolecularCellBiology(5th Ed.), Freeman, 2004
10. DeRobertis&DeRobertis:Cell&Molecular Biology,Lea &Febriger,1987
11. Friefielder:MolecularBiology
12. Darnell,LodishandBaltimore:Molecular cellbiology(Scientific AmericanBooks)
13. H.D. Kumar:Molecularbiology
14. W.H. Elliotand D. C.Elliot: Biochemistryand molecular biologyby(OUPress)
15. G.Plopper,D.Sharp,E.Sikorski:Lewin's Cells,3rdEdn.JonesandBartlett Learning.

PAPER:ZOO905S

ECOLOGYANDWILDLIFE BIOLOGY– I

(Credits:3+0+2=5)

Learning Objectives:

The purpose of this course is to introduce students to abiotic and biotic interactions in ecosystems, with a focus on environmental variables and different levels of organisation in the ecological hierarchy. Starting with species diversity, this course delves into system stability, ecosystem productivity, and biogeochemical cycling. It also sheds light on various livelihood issues associated with tangible and intangible ecosystem services.

Learning Outcomes:

Upon completion of this course, students should be able to

- LO1.** Understand basic pattern of interaction between environmental variables and biota with special reference to limit of tolerance.
 - LO2.** They will be able to link the different levels of organization in ecology with the basic ecosystem functions.
 - LO3.** The understanding of the livelihood issues will make students more scientific in their approach while implementing conservation action plans at all scales.
-

Unit 1— Environmental variables and limits, Community

(14L)1.1— Environmental variables and limits (7L)

1. Organism and its environment: Limits of Tolerance, 2. Adjustment to tolerant limit, 3. Interaction between environmental variables, 4. Macro and micro environments.

1.2—Community (7L)

1. Community and ecosystem; community level organisation, 2. Analysis of food web design, nutrient flow within community, 3. Niche relationship, parallel and niche overlaps and competition, niche separation, 4. Population structure, population cycles in invertebrates.

Unit 2—Species diversity and coevolution, Stability (13L)

2.1—Species Diversity (7L)

1. Diversity as a descriptor of ecological community, 2. Measures of the diversity, factors promoting species diversity, 3. Co-evolution, plant-insect interaction, larger herbivores population, 4. Theories of diversities and factors promoting species diversity

2.2—Stability (6L)

1. Definition, stability of single species, two three species system, 2. Diversity and stability, May's paradox, 3. Stability of food web design, 4. Energetic of stable system

Unit 3: Ecosystem and its Productivity, Energy and Mineral cycle

(14L)3.1- Ecosystem and Its Productivity (7L)

1. Types of forests, wetland and grassland, 2. Ecosystem productivity, 3. Methods of Assessment of Ecosystem Productivity, 4. Ecosystem Goods and Services, Green India Mission

3.2 Energy and Mineral cycles (7L)

1. Energy flow model, application of law of thermodynamics, 2. Hydrological, mineral cycle, 3. Artificial inputs in ecosystem and its impact, 4. Soil: structure, characteristics and agricultural practices

Unit 4— Ecosystemserviceandlivelihoodissues(7L)

1.NTFP (Non timber forest product), Rural employment and ecosystem services, MGNREGA, 2. Forestright act, biodiversity act 2002, IPR, Ramsar conventions, 3. Wetland and forest ecosystem service, 4.Climate change- expectedimpact onecosystem service, pollinators

PRACTICAL:

1. Ecologicalsamplingandcensus techniques
2. Fieldequipments onpopulation studyand analysis,cameratrapping
3. Estimation of density, frequency and abundance of animals/ plants in a community using transect/quadratmethods.
- 4.Study of diversity index/ dominance index5.GIS,GPSand RStechonology.
- 6.PracticalRecordbook andViva voce

BooksRecommended:

1. Anathakrishnan:Bioresourcesecology, Taylor and Francis, 1982
2. Bouhey:Ecologyofpopulations,(2nd edition)Macmillan,1973.
3. Dowdoswell:Anintroduction toanimalecology,Methien, 1967.
4. Kormondy: Conceptsofecology,Prentice-Hill, 1984
5. May: StabilityandComplexityin Modelecosystems (Vol.6th). Princeton universitypress, 1974
6. Odum: FundamentalofEcology(5thedition),Thomas Brooks/Cole, 2005.
7. Pawlosuske:Physico-chemicalmethodsforwaterandwastewatertreatment (vol19)Elsvier,1982.
8. Wetzal:Limnology:LackandRiverEcosystem(3rd edition)Academicpress2001.
9. Arora : Fundamentals ofenvironmental biology
10. Anathakrishnan:Bioresourcesecology,Kalyani publishers1985.

PAPER:
ZOO906SENTOMO
LOGY-I
(Credits:3+0+2=5)

Learning Objectives:

Insects are considered as an important subject under phylum Arthropoda. Entomology comprises basic information relating to insect diversity, taxonomy. Also, different ethnozoological and ecological aspect relevant to medical and forensic entomology are being taught under this course.

Learning Outcomes:

Upon completion of the course students should be able to-

LO1. Understand the classification and identification of insects.

LO2. Understand various morphological characters of insects and its modifications.

LO3. Know the diversity and ecological correlates of insects.

LO4. Know the application of insects in various fields like medical and forensic science.

(INSECTSTRUCTURE ANDFUNCTION, ECOLOGY)

Unit 1 :5L

1. Modern scheme of classification of insects, distinguishing characters, general biology, habit and habitats of insect orders.

Unit2 :Insect morphology16L

1. Head – origin, structure and modification – types of mouthparts, antennae, tentorium and neck sclerites; 2. Thorax – areas and sutures of tergum, sternum and pleura, wings: structure and modifications; venation, wing coupling apparatus and mechanism of flight, legs: structure and modification – mechanism of walking; 3. Abdomen – segmentation and appendages; genitalia and their modifications.

Unit 3:5L

1. Structure and function of – the visual organs, the sense organs and the effector organs in insect.

Unit4:Insect diversity and ecology15L

1. Abundance and diversity of insects; reasons for success. Basic principles of abiotic factors and their generalized action on insects. Biotic factors – food as a limiting factor for distribution and abundance; 2. Life tables and their application to insect biology. Survivorship curves. Population dynamics – factors affecting abundance; environmental factors, dispersal and migration; 3. Insect plant interaction; host plant selection by phytophagous insects, signs of damage caused by forest insects.

Unit5 :Medical entomology7L

1. Insect of medical importance (Life cycle and control) – Mosquitoes (Aedes, Anopheles, Culex); flies (housefly, horsefly, tsetse fly and sandfly); 2. Study of viral diseases – Dengue, Malaria, Kala-azar, Japanese Encephalitis, chikungunya, zika; 3. Insect in forensic science.

PRACTICAL: Credit-2

1. Mounting of mouth parts of mosquito, cockroach, butterfly and honey bee
2. Mounting of legs, antennae and wings (at least of two types)

3. Preparation of ararium, empodium, tentorium and pollen basket.
4. Identification of medically important insects.
5. Study of insect collecting devices.
6. Study of methods of insect collection and preservation.
7. Field visit to Agricultural field/Wild life institute/National Park/Forensic lab visit and submission of field report.
8. Practical record book.
9. Vivavoce.

Books Recommended

1. *A general text book of entomology*, Imms, A. D., Chapman and Hall, UK
2. *Introduction to the study of insects*, Borror, D. J., Triplehorn, C. A., and Johnson, N. F., M Saunders College Publication, USA
3. *Principles of Insect Morphology*, Snodgrass, R. E., Cornell Univ. Press, USA
4. *Host Selection by Phytophagous insects*, Bernays, E. A., and Chapman, R. F., Chapman and Hall, New York, USA
5. *Insect Plant Biology*, Schoonhoven, L. M., van Loop, J. A., & Dicke. M. Pub. Oxford Univ. Press. USA
6. *Insects: Structure and Function*. Chapman RF. 1998. ELBSEd., London.
7. *The Insects: Structure, Function and Biodiversity*. Duntson PA. 2004. Kalyani Publ., New Delhi.
8. *Physiology of Insects*. Patnaik BD. 2002. Dominant, New Delhi.
9. *Entomology*. 10th Ed. Vol. 1. *Structure, Physiology and Development*. Chapman & Hall, New York.
10. *Entomology at a Glance*. Saxena RC & Srivastava RC. 2007 Agrotech Publ. Academy, Jodhpur.
11. *Ecology: Principles & Applications*. 2nd Ed. Chapman JL & Reiss MJ. 2006. Cambridge Univ. Press, Cambridge.
12. *Advances in Insect Biodiversity*. Gupta RK. 2004. Agrobios, Jodhpur.
13. *Insect Ecology*. 3rd Ed. Price PW. 1997. John Wiley, New York.
14. *Ecology of Insects: Concepts and Application*. Speight MR, Hunta MD & Watt AD. 2006. Elsevier Science Publ., The Netherlands.
15. *Modern entomology 2014*. Thembrae DB, Himalayan Publishing House
16. *Biology of Disease Vectors*, 2nd Ed; Marquardt WC, 2004, Elsevier Academic press
17. *Medical entomology : A textbook on Public Health and Veterinary Problems Caused by Arthropods*, Revised Edition, Edited by Bruce Eldridge and John Edman
18. *Medical and Veterinary Entomology* Mullen, G., Durden, L., A.

PAPER:
ZOO906SENTOMO
LOGY-I

(Credits:3+0+2=5)

Learning Objectives:

Insects are considered as an important subject under phylum Arthropoda. Entomology comprises basic information relating to insect diversity, taxonomy. Also, different ethnozoological and ecological aspect relevant to medical and forensic entomology are being taught under this course.

Learning Outcomes:

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-

(INSECTSTRUCTURE ANDFUNCTION, ECOLOGY)

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Unit5 :Medical entomology7L

1. Insect of medical importance (Life cycle and control) – Mosquitoes (Aedes, Anopheles, Culex); flies (housefly, horsefly, tsetse fly and sandfly); 2. Study of viral diseases – Dengue, Malaria, Kala-azar, Japanese Encephalitis, chikungunya, zika; 3. Insect in forensic science.

PRACTICAL: Credit-2

10. Mounting of mouth parts of mosquito, cockroach, butterfly and honeybee
11. Mounting of legs, antennae and wings (at least of two types)

12. Preparation of arolium, empodium, tentorium and pollen basket.
13. Identification of medically important insects.
14. Study of insect collecting devices.
15. Study of methods of insect collection and preservation.
16. Field visit to Agricultural field/Wild life institute/National Park/Forensic lab visit and submission of field report.
17. Practical record book.
18. Vivavoce.

Books Recommended

19. *A general text book of entomology*, Imms, A. D., Chapman and Hall, UK
20. *Introduction to the study of insects*, Borror, D. J., Triplehorn, C. A., and Johnson, N. F., M Saunders College Publication, USA
21. *Principles of Insect Morphology*, Snodgrass, R. E., Cornell Univ. Press, USA
22. *Host Selection by Phytophagous insects*, Bernays, E. A., and Chapman, R. F., Chapman and Hall, New York, USA
23. *Insect Plant Biology*, Schoonhoven, L. M., van Loop, J. A., & Dicke. M. Pub. Oxford Univ. Press. USA
24. *Insects: Structure and Function*. Chapman RF. 1998. ELBSEd., London.
25. *The Insects: Structure, Function and Biodiversity*. Duntson PA. 2004. Kalyani Publ., New Delhi.
26. *Physiology of Insects*. Patnaik BD. 2002. Dominant, New Delhi.
27. *Entomology*. 10th Ed. Vol. 1. *Structure, Physiology and Development*. Chapman & Hall, New York.
28. *Entomology at a Glance*. Saxena RC & Srivastava RC. 2007. Agrotech Publ. Academy, Jodhpur.
29. *Ecology: Principles & Applications*. 2nd Ed. Chapman JL & Reiss MJ. 2006. Cambridge Univ. Press, Cambridge.
30. *Advances in Insect Biodiversity*. Gupta RK. 2004. Agrobios, Jodhpur.
31. *Insect Ecology*. 3rd Ed. Price PW. 1997. John Wiley, New York.
32. *Ecology of Insects: Concepts and Application*. Speight MR, Hunta MD & Watt AD. 2006. Elsevier Science Publ., The Netherlands.
33. *Modern entomology 2014*. Thembrae DB, Himalayan Publishing House
34. *Biology of Disease Vectors*, 2nd Ed; Marquardt WC, 2004, Elsevier Academic press
35. *Medical entomology : A textbook on Public Health and Veterinary Problems Caused by Arthropods*, Revised Edition, Edited by Bruce Eldridge and John Edman
36. *Medical and Veterinary Entomology* Mullen, G., Durden, L., A.

PAPER:ZOO905S

FISHBIOLOGYANDFISHERYSCIENCE-I

(Credits:3+0+2=5)

Learning Objectives:

Fishes are considered as an important subject under aquaculture. Fish biology and fishery science comprises basic information relating to fish diversity, fish physiology both in terms of morphometric and meristic counts. Also, different genetically relevant topics viz., fish barcoding can be assessed and learnt. Basic and advanced knowledge pertaining to fish culture can also be gathered along with different techniques of fish breeding.

Learning Outcomes:

Upon completion of the course students should be able to-

LO1: Understand the most important outcomes underlines the assessment of diversity in relation to identification and classification of species.

LO2. Understand the basic anatomy and structures of various fish fauna along with its physiological phenomenon.

LO3. Know the different culture practice along with feeding formulations under the heading of aquaculture.

LO4. Know advance techniques related to fish breeding.

(TAXONOMY, ANATOMY, PHYSIOLOGY AND OSTEOLOGY, AQUACULTURE)

Unit 1. Taxonomy(5L)

1. Taxonomic characterisation, taxonomic keys, taxonomic methods for identification of freshwater teleosts, 2. Molecular taxonomy in fishes.

Unit 2. Anatomy, Physiology and Osteology 11L

1. Overview of external and internal fish anatomy, Major anatomical features of different types of fishes, 2. Sensory and related anatomical features of fishes, 3. Skin, Scale and Fins of freshwater fishes, 4. Digestion: digestive system and feeding types in fish, 5. Respiration: Structure and function of gills, accessory respiratory organs, 6. Excretion: Kidney: structure and function, osmoregulation in freshwater and marine teleost, 7. Reproduction and development of teleost, 8. Osteological study of skull, pectoral and pelvic girdle, vertebral column of freshwater teleost.

Unit 3. Aquaculture II 16L

1. Scopes of aquaculture including fisheries, 2. Types of aquaculture (warm and cold water), aquaculture systems (monoculture, polyculture, semi-intensive, intensive culture, monosex culture), 3. Fish breeding technology (induced, hatchery, haplo, broodstock breeding and stripping) and its importance, 4. Integrated fish farming (paddy cum fish, duck cum fish, pig cum fish, fish cum livesock), 5. Composite fish farming: methods and importance, 6. Culture of ornamental fishes (exotic and indigenous) and their importance., 7. Aquatic weeds, 8. Larvivorous fishes, 9. Threatened and endemic fishes of Northeast India with special reference to Assam, 10. Fish genetic diversity, conservation methods and strategies.

Unit 4. Aquaculture III 16L

1. Types of capture fishery resources, 2. Fishery resources in major river systems of India with special reference to Brahmaputra and Barak river system, 3. Hill stream fisheries: Mahaseer fisheries, 4. Floodplain wetland (beel) fisheries of Assam, their problems and management, 5. Fundamentals of marine fisheries (Sardine and Meckerals), 6. Fishing gears in inland fisheries and fishing crafts in marine fisheries., 7. Migration of fish, 8. Sewage fed fisheries, 9. By-products of fish, 10. Transportation of fish seed and fishes, 11. Principle and practice of fish preservation, processing and care.

PRACTICAL:Credit- 2

1. Morphometric and meristic analysis of teleost.
2. Study of skeletal system of freshwater fishes.
3. Dissections: Accessory respiratory system of *Anabas* sp., *Channa* sp. and *Heteropneustes fossilis*. Urino-genital system of carp, Weberian ossicle of carp, IXth and Xth cranial nerves in carps.
4. Induced breeding techniques of IMC.
5. Identification of ornamental fishes of freshwater with reasons up to order.
6. Identification of freshwater exotic fishes with reasons up to order.
7. Identification of fishes of the river Brahmaputra with reasons up to order.
8. Identification of marine water fishes.
9. Study of fishing gears used in Assam.
10. Submission of fish specimens representing different groups (at least 10 numbers).
11. Submission of fish skeleton representing different groups.
12. Visit to fish farm, wetlands within Assam.

(Open Elective)
PAPER: ZOO906P

GENERAL TOXICOLOGY-I
(Credits: 3+0+1=4)

Learning Objectives:

General toxicology aims to study the possibility of chemical causing negative health effects following a single or multiple exposures, whether accidental or intentional. The kind and intensity of the effects are determined by elements such as the toxicity mechanism, chemical bioavailability, exposure route, and the amount of chemical a human or animal is exposed to. When designing and conducting general toxicological research, all of these issues must be taken into account.

Learning outcomes:

Upon completion of the course students should be able to-

- LO1:** Demonstrate a knowledge of toxicology's key principles, such as hazard identification, exposure assessment, dose-response assessment, and an understanding of toxic substances' mechanisms of action and consequences at many levels of biological organisation.
- LO2:** Demonstrate an awareness of the relevance of risk analysis, management, and communication in the field of toxicology. Students will be able to recognise and debate current toxicological issues.
- LO3:** Know the technical aspects and experimental approaches in toxicological research, testing, and risk assessment.

Unit 1: INTRODUCTION TO TOXICOLOGY (11L)

1. Definition, Scope and sub division of toxicology. 2. Classification of toxic agents, 3. Dose, Dose effect and Dose response relationship – Acute toxicity and Chronic Toxicity. 4. Factors affecting toxicity 5. Absorption and Distribution of toxicants

UNIT 2: BIOCHEMICAL TOXICOLOGY 10L

2.1. Mechanism of toxicity

1. Reaction of toxicants with target molecules 2. Cellular disrepair and repair mechanisms. 3. Lipid peroxidation – ROS and RNS, Superoxide, Hydrogen Peroxide and Hydroxyl radicals in toxicity of Xenobiotics. 4. Oxidative Stress, 5. Xenobiotic induced alterations in intracellular calcium distribution, disruption of cellular energy production. 6. Introduction to Phase I and II reactions. 31

Unit 3: SYSTEMIC TOXICOLOGY 12L

3.1 Basics of Organotoxicity

1. Target organs, Organ selectivity and specificity. 2. Hepatotoxicity- susceptibility of the Liver, types of Liver injury and Biochemical mechanism. 3. Pulmonary toxicity – Lung injury, Systemic Lung toxins, Lung pathology. 4. Renal toxicity – susceptibility of the Kidney to toxicants, Chemical induced renal injury. 5. Neurotoxicity – Effect of toxic agents on Neurons, Axonopathy, Myelionopathy, ion channel, neuro toxins, Lesions of specific neurons.

Unit4:SYSTEMICTOXICOLOGYAND CHEMICALCARCINOGENESIS(15L)

4.1 ReproductiveToxicology :4L

1. Reproductiveorgans,Chemicals affectingreproduction2. Teratogenicity.

4.2 Endocrine toxicology :3L

1.Toxicity of Adrenal,2.Thyroid and3.Pancreas.

4.3 Bio-magnification,bio-transformationofxenobiotics

4.4 Genotoxicity:4L

1. DNA interaction,2.DNAadductsandMutations3.DNA repair

4.5 Carcinogenesis:4L

1.Typesof carcinogens2.Mechanismsofaction

PRACTICAL:(Allexperimentsinvolvinglive animalsare fordemonstrationonly)Credit:1

1. DeterminationofLC50/LD50ofselectedtoxicant(bioassaymethod)
2. EffectofselectedtoxicantonPhaseI enzymeactivity (CytP450)(enzymaticassay)
3. EstimationofLPOactivitybyTBRAmethod
4. EffectoftoxicantonGlycogen,Glucose andAmino acids
5. Hepato-toxicanteffectonTotalBilirubinContent(directandindirectmethod)
6. EstimationofSGOT andSGPT as amarker enzyme for hepatotoxicity
7. Estimationof SerumCreatinineactivityasamarkerenzyme forRenal toxicity
8. Micronucleitest
9. Effectoftoxicantonspermmorphology

RecomendedBooks:

1. Principles of ecotoxicology- 3rd edition 2006, C H Walker, S P Hopkin, R N Sibly and D BPeakall (Eds.),TaylorandFrancis,NewYork, NY.
2. Introduction to Environmental toxicology -3rd edition 2003, W.G.Landis and M.H.Yu.Lewis publishers,Florida.
3. Text Book of Modern Toxicology 2000 edition, Ernst Hodgson and Patrica Levi, McGraw –HillInternationaledition. Singapore.
4. Principlesof toxicology2010edition,AnjuAgarwalandKrishnaGopal,ibdcpublishersIndia.
5. Essentials of Toxicology 2011 edition, Vijay Kumar Matham, New India Publishing Agency,New Delhi,India.
6. Principlesof BiochemicalToxicology-Jatimbrell;Taylor andFrancisLtd,London.
7. BasicEnvironmentalToxicology–LorrisG.Cockerham,BarbaraS Shane; CRCPress,London.
8. Hand book of Toxicology – Thomos J Haley, Willan O Berndt; Hemisphere Publishingcooperation,Washington.

9. Modern Toxicology (3 Volumes) - P K Gupta and Salunkha; B V Gupta Metropolitan BookCo., Ptv Ltd, NewDelhi.

10. EncyclopediaofToxicology – OP Jasra.

PAPER:ZOO1001C

EVOLUTIONARY AND APPLIED ANIMAL BIOLOGY

(Credits:3+0+1=4)

Learning Objectives:

The purpose of this course is to provide students with a thorough understanding of how evolution works as well as a broad awareness of the most relevant research problems in evolutionary biology. Students will learn about all elements of evolutionary biology in this course. Again from the second part student will learn the basic principles involved in the culture and breeding of common edible and ornamental fishes; applications of insects in Medical & forensic field; Solid waste management, Organic farming and medical application.

A. GENERAL AND MOLECULAR EVOLUTION(25L)

Unit 1: General evolution

(15L)

1.1: Non-Classical theory of evolution 3L

1. An overview of evolutionary thoughts, developments and the concept of synthetic theory
2. Basic concept of synthetic theory with reference to Hardy-Weinberg equilibrium in populations.

1.2: Other theories of evolution 7L

1. Goldschmidt's concept of micro- and macroevolution; 3. Macroevolution & concept of phylogenetic gradualization 5. Speciation: Biological & phylogenetic species concept, allopatric speciation, sympatric speciation & parapatric speciation, 6. Reproductive isolation mechanism.

1.3: Evolution of eukaryotes:

5L

1. Concept of evolution of eukaryotes 2. Zenith of insect evolution & Evolution of sociality in insect society
3. Evolutionary origin of fishes, tetrapod, bird & mammals.

Unit 2: Molecular & genome evolution

(11L)

2.1: Molecular evolution 5L

1. Molecular concept of Origin of life & Origin of molecular divergence (protein & nucleotides); RNA world 2. Concept of evolution of Molecular clock & molecular drive.

2.2: Genome evolution 6L

1. Genome evolution: Evolution of multi gene family, Acquisition of new genes, Exon theory & mechanisms 4. Gene duplication, Kimura's hypothesis & divergence, 5. Genetic variation in population, Causes of genetic variation, genetic polymorphism & measuring genetic variation

B. APPLIED ZOOLOGY & AQUACULTURE

(23L) Unit 3: Applied entomology (9L)

3.1: General application of insects 5L

1. Insect as pollinators in agriculture 2. Role of insects in tropical forest ecosystem. 3. Lac & silk products & industrial economy 3. Insect as bioreactors & insect cell culture

3.2: Medical & forensic entomology 4L

1. Pests of public health importance and their control (Mosquitoes, house flies, bad bugs, fleas)
2. Insect borne diseases

Unit 4: Economic zoology(14L

4.1. Generaleconomic zoology8L

1. Solid waste management with vermicompose, 2. Organic farming 3. Biology and importance of finfish(Indian major carps, freshwater catfish) and shellfish (Prawns and shrimps). 4. Composition and nutritive value of raw fish, processed fish & preserved fish 5. Ornamental fishes, Exotic & indigenous ornamental fish&economicimportance, 6.Honeybee products &economy.

4.1 : Medicalzoology 3L

1. Preliminary knowledge on zoonotic diseases 2. Genetics of Neurological Diseases; Pharmacogenetics and application 3. Venom&allergens-types, delivery&medical application

4.2 :Aquaculture3L

1. Integrated fish farming-(Fish cum livestock farming& paddy cum fish culture) 2. Polyculture of fish for high yield 3. Edible oyster &pearloyster.

PRACTICAL:

1. To study the copentadactyl limbs and common ancestry of vertebrates through observation of forelimbs and hindlimb common pattern of s(frog, Calotes, bird and mammal).
2. Identification of 5 economically important insect specimen belong to different order.
3. Identification and study of morphological differences of any three economically important fish species i.e., Major carps, exotic, indigenous, ornamental and medicinally important fishes.
4. Study and identification of at least two insects and two venomous snakes and their impact.
5. In silico analysis of phylogenetic tree of 5 vertebrate animals.
6. Estimation of protein and lipid from edible insect/any marketable fish.
7. To study the median threshold concentration of glucose solution in feeding response in ants.
8. Study of learning behaviour in mice by using zig-zag or T-shaped maize/ To study the geotaxis behaviour of earthworm.

SPECIAL PAPER: ZO
O1002SP1
CELL & MOLECULAR BIOLOGY -II
(Credits: 3+0+2=5)

Learning Objectives:

This paper aims to provide detailed information about DNA structure and its organization along with its application in molecular biology. This paper is the final part of specialized study in cell and molecular biology and comprised of most of the related fields of cell and molecular biology.

Learning Outcomes:

Upon completion of the course students should be able to-

LO1. Various structure of DNA and its organization in prokaryote and eukaryote.

LO2. Transcription and translation

LO3. Have a clear understanding about metabolic disorders.

LO4. Various applications of molecular biology such as tissue culture, stem cell biology etc.

A. MOLECULAR BIOCHEMISTRY

Unit 1: Molecular Biochemistry (17L)

1.1: DNA Structure & Reaction of DNA 8L

1. Helix parameter of DNA (A, B, C and Z DNA), triplex DNA, Interrupted DNA & functional role
2. Biological significance of double strandness, DNA re-association kinetics (Cot curve analysis)
3. Supercoiling of DNA & Topoisomerase I & II, C-value paradox
4. DNA replication (inhibition, elongation & termination) in eukaryotic & prokaryotic cells
5. Telomere shortening & its replication
6. Gene library – Construction of c-DNA & genomic library.
7. Isolation and sequencing of DNA, Maxam-Gilbert, Sanger's dideoxy methods.

1.2: RNA & Transcription 4L

1. Transcription in Prokaryote and Eukaryote
2. Transcription factors-RNA binding motif and proteins, Activators and repressor of transcription
3. Post transcriptional processing (Capping, Tailoring, splicing and alternate splicing, mRNA Stability, RNA degradation, RNA editing)
4. Transcription Attenuation and RNA Export

1.3: Protein and Translation 5L

1. Protein folding: enzymes for protein folding, processing and thermodynamics Ramachandran plot. Molecular chaperonin and chaperones
2. Prion structure and function.
3. Translation machinery: Translation in prokaryotic and eukaryotic, fidelity of translation and post-translational modification.
5. Protein sequencing method.

B: GENOME ORGANIZATION

Unit 2: Genome Organization and Gene Expression: 8L

1. Organization of genome in prokaryotic and eukaryotic cells.
2. Genetic features of nuclear genome, organelle genome organization - mitochondria and chloroplast, virus genome and mobile DNA element (Transposable element, IS element, P element, retrovirus and retro-transposome).
3. Mapping of genome – physical and genetic mapping.
4. Genome sequencing and High-throughput screening and sequencing {next-Gen}, Genetic markers.
5. Genome analysis technique (RFLP, AFLP, RAPD, ISSR) and Pedigree Analysis.
6. Gene silencing (DNA methylation and acetylation, dosage compensation, histone code, RNA Interference, antisense RNA) and gene amplification.

Unit 3: Molecular Diseases:

(6L) 3.1:

Neurodegenerative disease:

1. Molecular pathway to neurodegeneration. 2. Misfolding and aggregation of disease proteins - Parkinson, Alzheimer & Huntington's disease.

3.2: Metabolic disorders:

1. Molecular mechanisms of metabolic diseases - inborn errors of metabolism, Alkaptonuria, Phenylketonuria

C: APPLIED MOLECULAR BIOLOGY

Unit 4: Applied Molecular Biology (16L)

4.1: Cell & tissue culture technique 3L

1. Cell culture media properties & preparation 2. Primary & secondary cell culture, continuous cell lines - lymphocytes & fibroblast cell culture, cell separation by FACS 3. Application of animal cell culture (in-vitro drug testing).

4.2: Stem cell biology 3L

1. Properties and types of stem cells (embryonic, umbilical, adult), Haemopoietic stem cells and formation of blood cells, bone marrow transplantations. 2. Stem cell disorders - Stem cell therapy, Stem cell and cancer, Stem cell research in India. 3. Stem cells and tissue engineering - ethical, legal and social implications (ELSI) of stem cell technology.

4.3: Application of Molecular Biology 10L

1. Concept of System biology - Transcriptomics, proteomics, metabolomics, lipidomics, glycomics, and phosphoproteomics. 2. Nano biology & application - Elementary concept of nanotechnology and its applications, bio-inspired nanomaterials for a new generation of medicine and nanoscience in medicine, vaccine and delivery system, nanoparticles in medical detection and diagnoses. 3. Antisense and ribozyme technology 4. Hybridization techniques - Southern-Northern hybridization, Chromosome painting, FISH, DNA chip technology. 5. Gene therapy & application - (Gene therapy for inherited immunodeficiency syndromes, Cystic fibrosis and HIV-1 gene therapy, Retroviral mediated gene transfer.)

PRACTICAL: Credit- 2

1. Preparation of different types of buffer & cell culture media used in molecular biology.
2. Procedures of autoclaving of materials required in molecular techniques.
3. Demonstration of Agarose Gel Electrophoresis for DNA and its visualization.
4. Isolation of genomic DNA from mouse liver cell.
5. SDS-polyacrylamide Gel Electrophoresis for protein and its visualization.
6. Short-term culture of whole blood & lymphocyte culture from mammalian blood/bone marrow cell.
7. Histochemical detection of DNA by Feulgen reaction/DNA, RNA from animal tissues by Methyl green pyronin method.
8. Biochemical estimation of DNA (diphenyl method) and RNA from blood and tissue collected from slaughter house.
9. Biochemical estimation of alkaline phosphatase & LDH.
10. Isolation of mitochondria by ultracentrifugation technique from suitable tissue material.
11. In silico designing of primer 16S rRNA, 18S rRNA, degenerate and specific primer, n/p blast.
12. Study of molecular evolution and construction of Phylogenetic tree, in silico.

13. InsilicostudyofDNA microarraytechnique.
14. Visittoadvancedlaboratory/institution(Reporttobe submitted)
15. Practicalrecordbook&vivavoce.

Booksrecommended:

1. T.A.Brown:Genomes3(2ndEd.),Geraldpublication,2009
2. J.D.Watsonetal.:Molecular BiologyoftheGene(4thEdn.)Benjamin/CummingsPubCo.(2010)
3. R.R.Sinden:DNAStructureandFunction,AcademicPress,1998
4. D.L.Hartl andE.W.Jones:Essential Genetics:A Genomic Perspective,Jonesand Bartlett(2002)
5. B.Lewin:GenesVIII,Prentice Hall; Tchedition(2004)
6. B.Albertsetal.GeraldPublications;6thEdn.(2014)
7. J.F. Atkins et al.: RNA Worlds: From Life's Origins to Diversity in Gene Regulation Cold Spring HarborLaboratory Press,U.S;1stEdn.(24 September2010).
8. V. Ramamurthy and S. Raveendran, Fundamentals of Biochemistry, Aruna Publications, Koradacherry(2010)
9. J.L.Jain, FundamentalsofBiochemistry, S.Chandand Co. Ltd. New Delhi.
10. L.Stryer,Biochemistry, W.H.Freemanand Co.NewYork.(1988)

PAPER: ZOO1002SP2

ECOLOGY AND WILDLIFE BIOLOGY-II

(Credits:3+0+2=5)

Learning Objectives:

This course is designed in such a way that it provides a detail understanding about wildlife management strategies and their implementation while conserving threatened faunal elements with special reference to northeast India. The course also provides insight on the need of studying wildlife behaviour as well as use of advance tools and techniques in wildlife studies.

Learning Outcomes:

By studying this course students will be able to

LO1. Apply conservation management strategies in the conservation actions.

LO2. Work on various conservation agencies with this thorough knowledge of wildlife conservation laws and techniques required to implement any conservation projects.

WILDLIFE MANAGEMENT AND CONSERVATION

(48L)

Unit-1: Definitions and Acts, Ecological Role of Wildlife (13L)

1.1 Definitions and acts 7L

1) Wildlife Conservation Models, Human Wildlife Conflict and Its Impact on Natural Systems, Eco-Tourism, 2) Indian Constitution Provisions of Environment Protection, 3. CITES, CMS, Legal Definitions of Forest, Biodiversity, Wildlife Crime, Conservation Breeding, Importance of DNA Bar-coding and Forensic, 4. Major Groups of Mammals, Social Structure in Elephants, Tiger, Gibbons, 5. Birds: Residential and Migratory birds, Endangered and Threatened birds of N.E India, Migratory Routes, 6. Food and Feeding Behaviour of: Rhino, Gibbon, Golden Langur, Leopards, Pigmy hog.

1.2 Ecological Role of Wildlife 6L

1) Mega Herbivore, Elephants as Ecological Engineer, Ecological Role of Water Buffalo, 2) Key Stone Species, Umbrella Species, Flagship Species: Its Importance and Its Conservation, 3) Foraging Strategies, Optimal Foraging Theory, 4) Ecological Role of Herpeto- Fauna and Climate Change.

Unit-2: Wildlife Habitat, Conservation Biology (17L)

2.1 Wildlife habitat 8L

1) PA Network in India, Other Habitat Conservation Initiatives: IBA (Important Bird Area), 2) Habitat Connectivity and Corridors, Source and Sink Population, Meta-Population, 3) Habitat Utilization Pattern of Rhino, Tiger, Pigmy Hog, 4) Wetland and Grassland as Wildlife Habitat, 5) Man- Animal Conflicts: Cause, Impact and Mitigating Measures, 6) Man and Biosphere Programme

2.2: Conservation Biology 9L

1) Introduction of Conservation Genetics, 2) Genetic Management of Wild Population, 3) Genetics and the Fate of Endangered Species, 4) Impact of the Reduction of Population Size: Loss of Genetic Diversity, Inbreeding Depression.

Unit- 3: Wildlife Services 8L

1) Principles of Wildlife Management in Kaziranga and Manas, 2) Ethics of Wildlife Management, 3) Development in the Use and Management of Wild Animals, 4) Estimation of Population Size and Management of Large Herbivores

Unit -4: GIS for Wildlife Management, Wildlife Behaviour

(10L)4.1: GIS for Wildlife Management 5L

1) Assessment and Planning of Wildlife, 2) Wildlife Protection Acts, Wildlife Monitoring through GIS, 3) Wildlife Health and GIS Generating Mitigating Passages, 4) Habitat Maps Using GIS

4.2: Wildlife Behaviour 5L

1) Behavioural Studies of Endangered Species of Birds of N.E India, Its Relation to Ecological Aspects, 2) Primates, Behaviour of Capped Langur, Stump Tailed Macaque, etc. in Wildlife Sanctuaries.

PRACTICALS:

1. Ecological sampling and census technique- Direct and Indirect methods. Field based studies of bird and butterfly census techniques and species identification
2. Study of diversity index, dominance index
3. GIS, GPS and RS technology
4. Soil analysis- N, P, K, macro and micro analysis, soil organic carbon, moisture
5. Water analysis- TDS, Conductivity, TSS, BOD, Chloride, Fluoride
6. Plankton- Limnological studies.
7. Data representation- Construction of composite climatograph and Ergo graphs
8. Taxonomic Study: Study of local birds/butterflies/herpetofauna.
9. Report on field visit to Biodiversity rich area.

Recommended Books:

1. Wildlife Ecology and Management Author : Eric G. Bolen and William Robinson, Pearson; 5th Edition (July 20, 2002).
 2. Sacred Ecology Author: Fikret Berbes, Routledge; 1st Edition (March 2, 2008).
 3. Wildlife Ecology, Conservation and Management, John M. Fryxell, Anthony R.E. Sinclair, Graeme Caughley. Wiley- Blackwell: 3rd Edition (August 11, 2014).
 4. Essentials of Conservation Biology, Richard B. Primack. Sinauer Associates, Oxford University: 6th Edition (May 9, 2014).
 5. Essential Reading in Wildlife Management and Conservation, Paul R. Krausman, Bruce D. Leopold, Johns Hopkins University Press ; (February 7, 2013).
 6. Traditional Ecological Knowledge and Natural Resource Management, Charles R. Menzies, University of Nebraska Press: (November 1, 2006).
 7. Forest Health and Protection, Robert L. Edmonds, James K. Agee, Robert I. Gara, Waveland Press: 2nd Edition, (May 1, 2010).
- Remote Sensing for Ecology and Conservation: A Handbook of Techniques (Techniques in Ecology & Conservation) : Ned Horning, Julie A. Robinson, Eleanor J. Sterling, Woody Turner, Sacha Spector Oxford University Press; 1st edition (August 20, 2010)

PAPER:
ZOO1002SP3ENTOMOLOGY-
II
(Credits:3+0+2=5)

Learning Objectives:

Insects are considered as an important subject under phylum Arthropoda. Entomology comprises basic information relating to insect diversity, taxonomy. Also, different ethnozoological and ecological aspect relevant to medical and forensic entomology are being taught under this course.

Learning Outcomes:

Upon completion of the course students should be able to-

- LO1.** Understand the classification and identification of insects.
- LO2.** Understand various morphological characters of insects and its modifications.
- LO3.** Know the diversity and ecological correlates of insects.
- LO4.** Know the application of insects in various fields like medical and forensic science.

(INSECTPHYSIOLOGY& GENETICS; & PESTMANAGEMENT)(48L)

Unit 1:Insect physiology20L

1. Structure and Physiology of – Integumentary and musculature system, digestive, respiratory and circulatory system, excretory, nervous and reproductive system, 2. Endocrine system and functions: Anatomical organization, hormones, Endocrine control of growth and metamorphosis, reproduction, diapause, 3. Glands and organs of secretion; Ectohormones: Pheromones and allomones, 4. Immunity in insects: Mechanism of innate immunity, antibacterial immunity; signaling pathways, antiviral immunity: antiviral RNAi response, regulation of antimicrobial peptide gene expression by JAK-STAT pathways; bacterial resistance to insect immunity.

Unit2:Insect genetics12L

1. Insect as genetic tool, 2. Genome study in insects: Expression of p-elements in Drosophila, 3. Genetic regulation of insect development

Unit3:Pestecology andmanagement16L

1. Economically important pest and their status, nature of damage and control measures of pest of cereals, pulse, crops, vegetables, fruits, sugarcane and stored grains, 2. Integrated Pest Management – concept of injury level, economic injury level, and economic threshold level. Tools of pest management and their integration - legislative, cultural, physical and mechanical methods. 3. Chemical control – classification of insecticides on the basis of their mode of entry, mode of action and chemical nature; Organochlorines, organophosphates, carbamates, pyrethroids and botanicals. Development of pesticide resistance, metabolism and degradation of pesticides – Phase I and Phase II reaction, 4. Hormonal control: concept and use of Juvenoids, ecdysoids and IGRs, 5. Biological control: Use of parasite and predators and Use of ectohormones in pest control, 6. Genetic control of vector borne diseases and pests.

PRACTICAL: Credit2

1. Dissection of male and female reproductive system of cockroach.
2. Dissection of nervous system of grasshopper and cockroach.
3. Mounting of salivary glands of cockroach and honeybee.
4. Alimentary canal of housefly.
5. Mounting of hepatic caeca and Malpighian tubules
6. Mounting of sting apparatus of honeybee
7. Dissection of drosophila imaginal disc, polytene chromosome
8. Preparation and identification of haemocytes
9. Detection of urease
10. Detection of chitin

11. Study of mutant varieties of *Drosophila*
12. Identification of Rice pest, Tea pest, vegetable pest, stored grain pest etc.
13. Estimation of LD50/LC50 using insects
14. Visit to an advance lab/Institution and submission of report
15. Practical record book and Viva voce

Books Recommended

1. *The Insects: Structure and function*, Chapman, R.F., Cambridge University Press, UK
2. *Physiological system in Insects*, Klowden, M. J., Academic Press, USA
3. *The Insects, An outline of Entomology*, Gullan, P. J. , and Cranston, P. S., Wiley Blackwell, UK
4. *Insect Physiology and Biochemistry*, Nation, J.L., CRC Press, USA
5. *The Complete Book of pesticide management*, Whitford, F., Wiley Interscience, John Wiley and Sons, UK
6. *Safer Insecticides*, Hodgson, E., and Kuhr, R.J., (ed), Marcel Dekker Inc., New York, USA
7. *Pesticide Application Methods*, Matthews, G.A., Blackwell Science, London, UK
8. *Pesticide Biochemistry and Physiology*, Wilkinson, C.F., Plenum Press, New York, UK
9. *Metabolic pathways of agrochemicals Part II*, Roberts, T. R., and Hutson, D. H. The Royal Society of Chemistry, UK
10. *Chemical Ecology of Insects*, Carde, R.T., and Bell, W. J., Chapman & Hall, New York, USA
11. *Entomology & Pest Management*, Pedigo, L.P., Prentice Hall, New Jersey, USA
12. *Concepts of IPM*, Norris, Caswell-Chen and Kogan, Prentice-Hall, USA
13. *Agricultural insect's pests of the tropics and their control*, Hill, D. S., Cambridge University Press, UK.

PAPER:ZOO1002SP4
FISHBIOLOGYANDFISHERYSCIENCE-II
(Credits:3+0+2=5)

Learning Objectives:

Fishes are considered as an important subject under aquaculture. Fish biology and fishery science comprises advance information relating to FishGrowth, FishPathology, FishGenetics. Also, different FisheryBiotechnology, Limnological aspect are also being taught under this course.

Learning Outcomes:

Upon completion of the course students should able to-

LO1: Understand the most important outcomes underlines the assessment of pathology in relation to their clinical aspects

LO2. Understand the advance Geneticsof fishes andFisheryBiotechnology.

LO3. Know the different limnological aspects.

Unit 1: FishGrowth9L

1. Factors controlling reproduction and development of fish. 2. The types of fish growth. Length-weight relationship. Annual growth. Factors affecting the age and growth. Condition factor and their significance. 3. Nutritional requirements of fishes: Protein, Carbohydrate, Fat, Vitamin and Minerals. 4. Feed manipulation in fish growth, growth promoter agents., 5. Hepatosomatic index, Gonadosomatic index, Index of fullness, Ponderal index, Index of propagation – their estimation.

Unit 2: FishPathology7L

1. Diseases: definition, disease problem of aquaculture, infectious and non-infectious diseases. 2. Bacterial, fungal, protozoan diseases, their clinical symptoms and prophylaxis., 3. Diseases caused by other factors- hereditary, tumour of hereditary origin, benign and malignant tumour.

Unit 3: FishGeneticsandFisheryBiotechnology16L

1. Cytogenetics of fishes. 2. Hybridization, Polyploidy, Androgenesis and Gynogenesis in fishes. 3. Population genetics and selection. 4. Sex determination in fishes. 5. Biochemical and molecular techniques and their applications in fisheries. Genetic biotechnology in fish health management.

Nutraceuticals and fish health, 6. Gene transfer and transgenic fish., 7. Hormonal biotechnology in aquaculture. 8. Cryopreservation technology. 8. Culture of fish cell lines. Germ cell transplantation techniques.

Unit 4: Limnology 16L

1. Physical and chemical characteristics of fresh water: pH, DO, TA, TH, Free CO₂. 2. Productivity of water bodies: primary, Secondary and Tertiary. Factors affecting primary production., 3. Plankton: its importance in aquaculture. Classification, Structural dynamics and seasonal variation of plankton.

Plankton sampling: collection, preservation and identification., 4. Benthos: collection, preservation and identification. Nektons.

PRACTICAL: Credits- 2

1. Estimation of HI, GI, IF, PI and IP.

2. Study of prepared slides of disease causing organisms of fresh water species.

3. Estimation of physical and chemical parameters of fresh water: pH, DO, CO₂, TH.

4. Study of prepared slides of plankton and their structural dynamics.

5. Study of benthic fauna of freshwater.

6. Estimation of relative and absolute growth, LW relationship and animal growth marks through scales.

7. Isolation of nucleic acids from fish tissue/ blood.
8. Horizontal gel electrophoresis for DNA estimation.
9. Protein extraction from fish tissue and estimation in SDS PAGE.
10. Spectrophotometric estimation of nucleic acids and protein.
11. Polymerase chain reaction for targeted fish gene amplification.
12. Methods of cloning.
13. *In-silico*: data retrieval and data submission tools, construction of phylogenetic tree, primer designing.
14. Visit to advanced laboratory/ institution/research centre of India.

Recommended Book:

1. Freshwater fishes of the world. Gunther.
2. Fish and fisheries. S. K. Gupta.
3. Limnology. Wetzel.
4. Fish biotechnology. Naik and Rao. Pacific Books International, New Delhi.
5. Textbook of fish genetics and biotechnology. ICAR, New Delhi.
6. Fisheries biotechnology. Lakra, Abidi, Mekherjee and Ayyappan. Narendra Publishing House, Delhi.
7. Fundamentals of environmental biology. Arora.
8. Limnology. Goldman.
9. Biology of fishes. Bone and Moore. Taylore and Francis Group, CRC Press, U.K.
10. The physiology of fishes. Evans and Claiborne. . Taylore and Francis Group, CRC Press, U.K.
11. Physiology of fishes. Brown.
12. Fish physiology-recent advances. Nilsson.
13. Fish and fisheries of India. Jhingran.
14. Fishes of India. C. B.L. Shrivastava.
15. An introduction to fishes. S. S. Khanna.
16. Handbook of fisheries and aquaculture. ICAR, New Delhi

(Open Elective)
PAPER:
ZOO1003OP1GENERAL TOXICOLOGY-II
(Credits:3+0+1=4)

Learning Objectives:

This course aims to study advanced toxicological aspects related to environmental, and industrial attributes. It aims to study the approach to ecotoxicology in ecosystems, Ecotoxicology of heavy metals, Integrated approach to wildlife toxicology, Bioremediation and prevention of occupational diseases.

Learning outcomes:

Upon completion of the course students should be able to-

LO1: Predict harmful responses to representatives from important chemical classes in terms of target organs, physiological processes, and toxicity molecular pathways.

LO2. assess the risk of environmental and occupational risks..

LO3. Understand the technical principles of toxicological research, testing, and risk assessment, as well as experimental techniques.

ZOPEL-PG-402: ADVANCED TOXICOLOGY-II Credit:3(48L)

Unit 1: Environmental toxicology 12L

1.1 Environmental pollution:

1. Sources and types of Pollution, important pollution events, 2. Scientific approach to ecotoxicology- entry, movement and fate of pollutants in ecosystems.

1.2 Eco-toxicology of heavy metals:

1. Mechanism of heavy metal toxicity, 2. Case studies of Arsenic, Mercury and Cadmium.

1.3 Environmental persistence of pollutant:

1. Abiotic degradation, Biotic degradation, 2. Nondegradative elimination process.

1.4 Sources of toxicants:

1. Sources of toxicants to the environment and transport process

1.5 Bioaccumulation-

1. Definition of Bioaccumulation 2. Factors influencing bioaccumulation.

Unit 2: Toxicity of Pesticides and Solvents

(10L) 2.1: Pesticides:

1. Definition & Classification of Pesticides 2. Bio-magnification of Pesticides.

2.2: Pesticide toxicity:

1. Introduction to Pesticide toxicity 2. Haematotoxicity: Reproductive and developmental effects, 3. Carcinogenicity, Immunological effects. 4. Environmental problems by organochlorine and organophosphate.

2.3: Principles of Solvent toxicity :

1. Nature of toxic effects, toxicity of Aliphatic solvents –a) Carbon tetra chloride b) Chloroform c) toxicity of alcohols.

2.4: Toxicity of Food Additives-

1. Nature and types of Food Additives 2. Polycyclic hydrocarbons, Hydrocyclic-amines, Nitroso amines and synthetic carcinogens.

Unit 3: Occupational and Industrial Toxicology

14L3.1: Occupational hazards:

1. Concept of Occupational hazards- physical, chemical, biological and mechanical hazards. 2. Occupational diseases: Pneumoconiosis, Silicosis, Asbestosis, Anthracosis. 3. Occupational Cancer – Skin cancer, Lung cancer, Bladder cancer and Leukemia;

3.2: Prevention of Occupational diseases.

1. Risk assessment and management of industrial chemicals, 2. Introduction, Legislation and Regulation.

Unit 4: Applied toxicology 12L

4.1 Toxicology of chemical Warfare agents

1. Chemical weapons, classification of chemical warfare agents. 2. Management of warfare agents.

4.2. Veterinary toxicology:

1. Common toxicity in Dog, Cat and Poultry by herbicides, 2. House hold chemicals, heavy metals, mycotoxin etc.

4.3 Wild life toxicology :

1. Susceptibility of wild life to chemicals, 2. Acute ecological hazards, toxicology of chemicals in birds and mammals, 3. Integrated approach to wild life toxicology.

4.4 Cosmetic toxicology:

1. Toxicity of shampoos, conditioners, bleachers and Dyes, 2. Bioremediation and prevention of occupational diseases.

PRACTICAL: (All experiments involving live animals are for demonstration only) Credit: 1

1. Pesticides reduces by TLC techniques.
2. Estimation of Hemoglobin and RBC in Lead exposed experimental animals.
3. Dermal sensitization test.
4. Estimation of AChE activity as a marker of pesticide poisoning.
5. Quantification of DNA damage by SCGE technique (COMET assay).
6. Effect of toxicant on chromosomal aberrations and sister chromatid exchanges.
7. Analysis of pesticide residues in different tissues of fish by TLC technique.

Recommended Books:

1. Principles of ecotoxicology-3rd edition 2006, C H Walker, SP Hopkin, RNSibly and DB
2. Peakall (Eds.), Taylor and Francis, New York, NY.
3. Introduction to Environmental toxicology -3rd edition 2003, W.G. Landis and M.H. Yu. Lewis publishers, Florida.
4. Text Book of Modern Toxicology 2000 edition, Ernst Hodgson and Patricia Levi, McGraw –Hill International edition. Singapore.
5. Principles of toxicology 2010 edition, Anju Agarwal and Krishna Gopal, ibdc publishers India.
6. Essentials of Toxicology 2011 edition, Vijay Kumar Matham, New India Publishing Agency, New Delhi, India.

PAPER:ZOO1004DPW

DPW

(Credit:6)

Paper onDissertationandProject Work(DPW)– I

The dissertation/projectwork tobearried outin4thsemester forallthe specialpapers.

1. DPWfor Celland Molecular Biology6 Credit
2. DPWforEcologyandWildlife Biology6 Credit
3. DPWforEntomology6Credit
4. DPWforFish Biologyand FisheryScience 6 Credit

Submissionofprojectreportandpresentationforallspecialpapers andviva voce
