# SHIVAJI UNIVERSITY, KOLHAPUR

# SYLLABUS

For

M.Sc. Zoology

(Semester Pattern)

M. Sc. Sem. I to IV

Academic flexibility with credit system

To be implemented

From

June, 2013 onwards

M.Sc. Zoology Academic flexibility with credit system

Shivaji University, Kolhapur.

**M.Sc. Part – I & II**

| Sem | Paper/Practical | **Title of the paper/practical** | Hours/ wk | CIE Marks | Exam Marks | Total Marks |
|---|---|---|---|---|---|---|
| I | Paper - I | Biosystematics and Biodiversity | 4 | 20 | 80 | 100 |
| | Paper - II | Ecology and Environmental pollution | 4 | 20 | 80 | 100 |
| | Paper - III | Cell & Molecular Biology | 4 | 20 | 80 | 100 |
| | Paper – IV | Applied Entomology | 4 | 20 | 80 | 100 |
| | Practical I | Practical based on paper I and II | 6 | 20 | 80 | 100 |
| | Practical II | Practical based on paper III and IV | 6 | 20 | 80 | 100 |
| II | Paper - V | Physiological Chemistry | 4 | 20 | 80 | 100 |
| | Paper - VI | Quantitative Biology & Tools and Techniques in Biology | 4 | 20 | 80 | 100 |
| | Paper - VII | Elements of Physiology | 4 | 20 | 80 | 100 |
| | Paper – VIII | Biology of Parasites | 4 | 20 | 80 | 100 |
| | Practical III | Practical based on V and VI | 6 | 20 | 80 | 100 |
| | Practical IV | Practical based on VII and VIII | 6 | 20 | 80 | 100 |

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|---|---|---|---|---|---|---|
| III | **Core course** | | | | | |
| | **Paper – IX** | Genetics | 4 | 20 | 80 | 100 |
| | **Paper- X** | Enzymology | 4 | 20 | 80 | 100 |
| | **Elective Course** | | | | | |
| | Special Course | Any one of the following (Optional) | | | | |
| | **Paper - XI** | | | | | |
| | Cell Biology | Computational Molecular Biology | 4 | 20 | 80 | 100 |
| | Physiology | Animal Physiology | 4 | 20 | 80 | 100 |
| | Entomology | Basic Entomology | 4 | 20 | 80 | 100 |
| | Aquaculture & Fisheries | Fisheries Resources – Inland and Marine fisheries | 4 | 20 | 80 | 100 |
| III | **Paper – XII** | | | | | |
| | Cell Biology | Molecular Biology of Gene | 4 | 20 | 80 | 100 |
| | Physiology | Applied physiology | 4 | 20 | 80 | 100 |
| | Entomology | Agricultural Entomology | 4 | 20 | 80 | 100 |
| III | Aquaculture & Fisheries | Fish Pathology and Reproductive Endocrinology | 4 | 20 | 80 | 100 |
| | Practical V | Practical based on IX and X | 6 | 20 | 80 | 80 |
| | Practical VI | Practical based on XI and XII of each Elective Subject. | 6 | 20 | 80 | 80 |

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|---|---|---|---|---|---|---|
| IV | **Core Course** | | | | | |
| | **Paper XIII** | Animal Cells in Biotechnology | 4 | 20 | 80 | 100 |
| | **Paper XIV** | Toxicology and Immunology | 4 | 20 | 80 | 100 |
| | **Elective course** | Special Course | | | | |
| | **Paper – XV** | Any one of the following (Optional) | | | | |
| | Cell Biology | Cell in differentiation, development and specialization | 4 | 20 | 80 | 100 |
| | Physiology | Physiology of Health | 4 | 20 | 80 | 100 |
| | Entomology | Insect Anatomy and Physiology | 4 | 20 | 80 | 100 |
| | Aquaculture & Fisheries | Aquaculture practices | 4 | 20 | 80 | 100 |
| | **Elective course** | Special Course | | | | |
| | | Any one of the following (Optional) | | | | |
| | **Paper – XVI** | | | | | |
| | Cell Biology | Cell Pathology | 4 | 20 | 80 | 100 |
| | Physiology | Clinical Physiology | 4 | 20 | 80 | 100 |
| | Entomology | Pest Management Concepts | 4 | 20 | 80 | 100 |
| | Aquaculture & Fisheries | Fishery Technology | 4 | 20 | 80 | 100 |
| | Practical VII | Practical based on XIII and XIV | | | | |
| | Practical VIII | Practical based on XV and XVI for each elective subject. | 6<br>6 | 20<br>20 | 60<br>60 | 80<br>80 |

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|---|---|---|---|---|---|---|
| | | **Project (Individual or in group of 2 – 5 Students: Based on special papers), Seminar, field visit & tour report Submission. Out of 80 marks 60 marks for Project, (10 marks for Seminar one on any elective paper & 10 marks for field visit / students tour report/ submission.)**<br>• Project – 60 marks (Individual / group of 2-5 students: Based on elective papers)<br>• Seminar – 10 marks (one on any elective paper.<br>• Submission of tour/field visit report-10 marks. | | | | 80 |

**CHOICE BASE CREDIT COURSE**

**CBC paper I & II are related to choice base credit course. However, CBC paper I can be opted by regular students of MSC- I Zoology in lieu of any Paper from semester I & II. CBC paper II can be opted by regular students of MSC- II Zoology in lieu of any core paper from semester III & IV**.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M. Sc. I – Sem. I**
**Paper- I Biosystematics and Biodiversity**

**Unit I**

1. **Taxonomy:** Introduction to taxonomy, Stages and importance of taxonomy; Problems, Aim and Tasks of Taxonomy.
2. **Modern Trends in Taxonomy**: Morphological approach, immature stages and Embryological approach, Ecological, behavioral and Cytological approach, Biochemical and Numerical taxonomy.
3. **Kinds of Classification.**

**Unit II**

1. **Concept of species**: Introduction, Typological, Biological, Nominalistic, Evolutionary and recognition species concept with conclusions, Species and their number, polytypic species, Subspecies, other infraspecific group, super species, taxonomic identification.
2. **Zoological nomenclature**: Origin of the code, international code of Zoological nomenclatures rules of nomenclature.

**Unit- III**

**1.Biodiversity Science**. Concept, definition and types of biodiversity, Biodiversity at global, country and local levels. Evolution of biodiversity, Factors promoting high diversity, Endemism and Hotspots, Measures of Bio-diversity, Values of Biodiversity, Uses and Importance of Biodiversity.

**Unit IV- Biodiversity Conservation.**

Loss of biodiversity, Listing of threatened biodiversity, Threats to biodiversity, Goals of biodiversity conservation., In-situ and Ex- situ conservation methods, conservation through gene banking preservation, Role of NGOs, Colleges and Universities.

**Recommended Books:**

Alston, R.E. and B.L. Turner (1963): Biochemical systematics Prentices Hall Inc. Englewood Cliffs, N.J. 404 pp.

Avise, J.C. (1974): Systematic value of Electrophoretic data. Syst. Zool. 23 (4): 465 – 481.

Benazzi, M. (1973): Cytotaxonomy and evolution, General remarks vertebrate evolution. Ed. A.B. Chiarelli and Campus Academic Press, London and N.Y. pp. 1-3.

Blomback, B and M. Blomback (1968): Primary structure of animal proteins as a guide in taxonomic studies. In chemitaxonomy and serotaxonomy (ed.) Hawkers pp. 3 – 20.
Camp, W.H. (1951): Biosystematics Britania 7: 113 – 127.
CHamberlin, W.J. (1952): Entomological Nomenclature and Literature 3rd edition Dubuvue lowa William C. Brown Co.
Cole, A.J. (1969): Numerical taxonomy proceedings of the colliqui in numerical taxonomy held in the University of St. Andrews Sept. 1968. Academic Press, N.Y 324 pp.
Hennig, W. (1966): Phylogenetic systematics Univ. Illinois Press III, 263 pp.
Heywood, V.H. (1973): Taxonomy and Ecology Systematics Association special Vol. 5 Academic Press, London, and New York 370 pp.
Huxley, J.S. (ed.) The New Systematics Oxford Uiv. Press London 538 pp.
Jeffrey, C. (1977): Biological nomenclature Indian Ed. Oxford and IBH Pub. Co. New Delhi 72 pp.
Mayr, E. (1969): Proinciples of systematics Zoology Mc. Graw Hill N.Y. 428 pp.
Mayr, E. and E.G. Linsley and R.L. Usinger (1953): Methods and Principles of systematic Zoology, Mc Graw Hill N.Y. 328 pp.
Oman, P.W. and A.D. Cushmann (1948): Collection and Preservation of insects U.S. Dept. of Agric. Misc. Pub. 601: 1 – 42.
Pankhurst, R.J. (1978): Biological identification Edwards Arnold Ltd. London, 104 pp.
Pankhurst, R.J. (1984): Online identification programme version 4. British museum (Natural History) London.
Strickland, H.E. (1842): Rules of Zoological nomenclature Report of the 12th meeting of British Association held at Manchester in 1842 Brit. Assoc. Adv. Sci. Rept. 1842: 7 – 18.
Ernst Mayr (1969): Principles of Systematics Zoology TMH Ed. Tata McGraw Hill Publishing company Ltd. Bombay New Delhi.
Primack, R.B. (1950): A primer of conservation biology 3rd edition Sinuer Associates Inc. Publishers Sunderland Massachutts USA.
Ray Samit an Ray A.K. (2006): Biodiversity and Biotechnology New Central Book Agency (P) Ltd.
Wilson, E.O.: Biodiversity.
Knudsen, J.W.: Biological techniques collecting preserving and illustrating plant and animals.
Black Welder, R.E. and Blair W.F. Guide to the Taxonomic literature of vertebrates.
Alexander, R.M. The Chrodate.
Waterman, A.J. Chordate
Saxena and Saxena: Plant taxonomy
Vyas,Purohit, Grag: A text book of Angiosperms.
Chan and Noel Krieg: Microbiology
Sharma, K.: Text Book of Micorbiology
Sharma K Manual of microbiology
Prescott: Microbiology

Wilson, E.O. Biodiversity National Academy Press 1988.
Tandon, Biodiversity status and prospects
Ray: Biodiversity and Biotechnology
Y.A. Abrol: Biodiversity and its significance
Prithipalsingh: An Introduction to Biotechnology
Chanchan Modern Pattern of Biodiversity conservation.
S.K. Jain: Conservaiton Biology
Bowles, M.L. and Whelman, C.J. Restoration of endangered species
Norton, B.G. The Preservation of speices The value of Biological Diversity.
1. An advance Text book on Biodiversity- K. V. Krishnamurthy.
2. Biodiversity and Biotechnology- Ray and Ray.
3. Biodiversity – Mandal and Nandi.
4. Perspective in environmental studies- Kaushik and Kaushik.
5. Biodiversity- K. C. Agarwal.
6. Theory and practice of animal taxonomy- V. C. Kapoor.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M. Sc. I – Sem. I**
**Paper – II - Ecology and Environmental Pollution**

**Unit I**

**1. Habitat and Niche:** Concept and types of habitat, Ecological niche, Niche width and overlap.

2**. Species interaction**: Types of interactions, Interspecific competition, Symbiosis.

3. **Community ecology**: Types and nature of communities, Structure of community, Community dominance, edge and ecotones.

**Unit II**

**1. Ecological Succession**: Types and Patterns of succession, Climax.

**2. Ecosystem**: Structure and Functions of ecosystem, Primary production.

**3. Environmental Impact Assessment:** Definition and scope,characteristics, objectives, components,methodology, procedurefor obtaining EIA clearance, preparation of EIA document.

**Unit III**

**Concept, Scope and Definitions of Environmental Pollution**- Important characteristics of pollutants, population increase, industrial production and

consumption of natural resources, local and global effects of pollution on climate. Types of pollutants- based on physical properties, forms, causes of environmental pollution, pollution in relation to public health (Air, water, pesticide and radiation pollution).

**Air pollution-** Definition, sources, principle air pollutants, effects of air pollutants.

**Smog-** Classical smog and industrial pollution, photochemical smog and vehicular emission. Prevention and control of air pollutants.

**Unit IV**

**Water pollution**- Definition, Sources of water pollution, Types of water pollutants and their effects, BOD, COD water pollution control, Sewage treatment.

**Agricultural pollution**- Farm animal waste, Soil erosion plants residues, agrochemical- fertilizers and pesticides.

**Soil pollution**- Sources, effects of soil pollutants and remedial measures. **Radioactive pollution**- types, sources and effects of radiation.

Suggested Readings:

1. Fundamentals of Ecology- Dash and Dash.
2. Basic Ecology- Odum E. P
3. Fundamentals of Ecology- Odum E. P
4. Modern concepts of ecology- K. D. Kumar.
5. Concepts of Ecology- H. D. Kumar.
6. Ecology - P. D. Sharma.
7. Environmental pollution Half, Rinehart and Winston, New York (1977)- Laurent Hodges.
8. Pandey Kamleshwar., Shuklar J. P. and Trivedi S. P. (2005): Fundamental of Toxicology. New Central book agency PVT. LTD. Kolkata.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-I Sem.- I**
**Paper – III Cell and Molecular Biology**

**Unit –I: Nuclear Components:**

1. Nucleus – EM. Structure.
2. Nuclear envelope – structure & function.
3. Chromosomes – Packaging of genome, chromosome structure, genetic maps, nucleolus.
4. Heterochromatin

**Unit –II: Secretary Pathway:**

1. ER-structure (SER, RER), transport.
2. Ribosomes, polysomes, free ribosomes, membrane associated ribosomes & secretary pathway.
3. Vesicles involved in intracellular transport.

**Unit –III: Cellular respiration & degradation:**

1. Mitochondria -structure, assembly components.
2. Peroxisomes – structure and functions.
3. Endosomes – late and early – structure, formation, assembly & components.
4. Lysosomes – structure & polymorphism.
5. Proteosomes – types structures, assembly & functions.

**Unit –IV: Cell cycle division and signal transduction:**

1. Cell cycle – cyclins & cyclin dependent kinases & check points.
2. Cytoskeleton & intracellular movement – microtubule, MTOC.
3. Micro filaments & intermediate filaments.
4. Signal transduction.

**Reference Book:**


1. Molecular biology of the Cell –Bruce Albert Pub. By Garland Pub. Inc. New York & London.
2. Molecular Cell biology – Lodish Berk, Matsudaira, Kaiser, Krleger (2004) pub. By W,.H. Freeman & Company, New York.
3. Molecular cell biology – Gerald carp (2005) pu. By John Wiley &Sons.
4. Avers C.J. (1986)/ latest edition) Molecular Cell Biology, Addison- Westey, Reading in Massachusettes.
5. Baserga, R (1985)/ latest edition) The Biology of Cell Reproduction. Harward University Press Cambridge, Massachuselts.
6. Beck, F. and J.B. Lloyd (eds) (1974) The Cell in Medical Science, Academic Press, London.
7. Callan, H.G (1986)/ latest edition) Lampbrush Chromosomes Springer – verlag New York.
8. Chambliss, G(ed)(1980)/latest edition) Ribosanes – Structure, Function & Genetics University of Park Press, Baltimore.
9. Edmunds, L.N. 1984 / latest edition- Cell Cycle Clock, Marcel Dekker, New York.
10. Edmunds, L.N. 1987/ latest edition. Cellular & Molecular Basis of Biological Clocks Springer – Verlag Berlin.
11. Gomperts, B.D.(latest edition) Plusma Membrance Academic press, New York.
12. Henning, W (ed) 1987/ latest edition Structure & Function of Eukaryotic Chromosanes Springer – Verlag, Berlin.
13. Moens, P.B. (ed) 1987/ latest edition Meiosis Academic Press, Orlands, Florida, USA.
14. Nomura, M.A./Tissiers & P. Lengyel (eds). 1974 Latest edition – Ribosomes Cold Spring Harber Laboratory Press, New York.
15. Tzagtoloff. A 1982/ latest edition Mitochondria Plenum Press, New York.
16. E. Munn 1982/ latest edition, Mitochondria: Structure, assembly & function.
17. Whaley – The Golgi apparatus 1976/ latest edition. The Frontiers in Cell Biology series Academic Press.
18. HoltgmanE The frontiers in Cell Biology series Academic Press.
19. Petty H.R 1993. Molecular Biology of Membrance Plenum.
20. Yeagle P.L. 1993. The Membranes of Cells 2nd ed.Academic Press.
21. Berger E.G. et.al. 1998. Reviews of Golgi Comlplex Trends Cell Biology Vol. 8 No.1.
22. Rapoport, T.A. etal. 1996. Protein Transport across the eukaryotic ER & Bucteria inner membrance Annu. Rev. Biochem. 65:271-303.
23. Robinron M.S. 1997. Coats & vesicle budding Tred Cell Biol. 799-102.
24. W.Baumeister etal. 1998- The Proteosome: Paradigm of a self compartmentalizing protease Cell 92:367-380.
25. Robison, M.S. etal 1996 Membrance dynamics in endocytosis Cell 84: 13-26.
26. Amos, L.A & Amos W.B. 1991 Molecules of Cytoskeleton Guilfor Press.
27. Bay,D. 1992 Cell Movement Garkud.
28. Drubin, D & Hirokawa N. Eds 1998. Cytoskeleton Curr. O pin. Cell. Biol. Vol.10,1.
29. Hyams, J.S. & Lloyd, C,.W. 1994 Microtubules Wiley-liss.
30. Stearns, T. & Winey, M. 1997. The Cell Center at 100 Cell 91:303-309.

31. Shaw, P.J. & Jordan, E.G. The nucleotus, 1995 Ann. Rev.Cell. Dev. Bio. 11: 93-121.
32. Green, R. & Noller, H.F. 1997.
33. Ribosomes & translation. Ann.Rev. Biochem. 66: 679-716.
34. Hill W.E. et al 1990 The Riboson: Structure function & Evolution – American Society Microbiology.
35. Davis L.I. 1995. The nucleus pore complex Ann.Rev. Biochem. 64: 865-896.
36. Lamond, A.I. & Earnshaw, W.C. 1998. Structure & function in the nucleus science 280-547-553.

37. Ohino, M. et al. 1998. Nucleocytoplasnic transport The last 200 nanometers Cell 92: 327-336.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M. Sc. I – Sem. I**
**Paper- IV- Applied Entomology**

**Unit –I:**

Study of generalized insect: Grass hopper (Morphology and Anatomy Brief Account)

Identification, Characteristics, Biology, Damage and Control of following insect pests.

**House hold pests:** Cockroach, Ant, Cricket, Clothes Moth, Carpet beetle,

Furniture beetle, Cigarette beetle, House hold hairy caterpillar, Silverfish, Book louse, Wasp.

**Stored grain pests:** Rice weevil, Rice moth, Khapra beetle, Pulse beetle, Rust red floor

beetle.

**Medicinal Pests:** Mosquitoes, Housefly, Bedbug, Sand fly, Human lice, Tse Tse fly, Rat

flea, Hippobosca.

**Unit –II:**

**Veterinary pests:** Mosquitoes, Sandfly, Horsefly, Blowfly, Stable fly, Warble fly,

Crew worm fly, Flea.

**Forest Pests:** Termites, *Eutectona machearalis*, *Hyblea puera*, *Sahyadrassus*

*malabaricus*, *Batocera rufumacualata*, Shisham defoliater *Plecoptera reflexa*, Deodar defoliater *Ectropis deodare*, *Scolutus major*, *Sinoxylon crassum*, *Trabala Vishnu*, Oak bark weevil, Sal bostrichid beetle, *Lymantria mathura*, Sal scolitid.

**Unit III**

**Sericulture:** History of Sericulture, Life cycles of Mulberry and Non-mulberry Silkworms, Rearing technology of mulberry silkworm, Diseases and pests of Mulberry silkworm, Moriculture and cultural practices, Diseases and pests of Mulberry.

**Unit-IV**

**Apiculture**: The honey bees, Social organization of honey bees, Life history of honey bees, Methods of bee keeping.

**Lac culture:** Lac insect- Taxonomy, distribution and life history, Host plants and lac insects, Strains of lac insect and their propogation, Cultivation practices, Lac extraction and uses.

**Forensic entomology**. History, Corpse- Associated arthropod classes, Role of arthropods in forensic entomology, Examples.

**Nutritional entomology**: Advantages of eating insects (Entomophagy), Examples of insects generally consumed, Nutritional value, Entomophagy as a source of income.

**Suggested Readings**.


1. A text book of Applied Entomology, vol.2 - K. P. Srivastava, 1996.

2. Elements of Entomology- Rajendra singh.

3. A text book of Forest Entomology – T.V. Sathe, 2009.

4. Sericulture and Pest Management – T.V. Sathe and A.D. Jadhav, 2001.

5. Sericultural crop protection – T.V Sathe, 1998.

6. Agricultural Pests of India and South East Asia – A.S. Atwal, 1993.

7. Crickets and Household pests – T.V. Sathe and M.R. Awate, 2009.

8. Beekeeping in the tropics – G.S. Smit, 1960.

9. Beekeeping in India, ICAR, New Delhi, S. Singh, 1975.

10. A handbook of practical Sericulture, CSB, Ullal and Narsimhanna, 1981.

11. Lac culture in India farm information unit, DEMOFA, New Delhi, S. Krishnaswami,

12. A text book of applied entomology- K. P. Srivastava.

13. Elements of entomology- Rajendra singh.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-I Sem.-I**
**Practical – I**

**Practical based on paper – I & II**

1. Study of museum specimens and slides invertebrates phyla (one representative from each class) for biosystematics & biodiversity.
2. Study of museum specimens of chordates phylum (one representative from each class) for biosystematics and biodiversity.
3. Study of plant groups with respect to biodiversity.
4. Identification of insects/ molluscs with the help of keys up to orders.
5. Identification of insects/ molluscs with the help of keys up to families.
6. Identification of animals with the help of keys up to families (fish/ amphibian with the help of preserved specimens / models / pictures).
7. Methods of collection and preservation of animals.
8. Visit to ZSI/ fields.
9. Study of inter relationships parasitism, symbiosis, commensalisms (2-3 examples from each).
10. Study of endangered species. (Models, pictures, charts.).
11. Study of adaptations in animals from pieces, amphibian, reptilian, birds & mammals (2-3 examples from each).
12. Visits to sanctuaries and National parks to study wild life management.
13. Study of community character by Quadrate & transect method.
14. Study of ecosystem (Soil, water, forest).
15. Use of software for identification of plants & animals.
16. Assessing existing data base on www.
17. Harnessing information through Internet regarding Biodiversity.

18. Preparation of culture media isolation of DNA from plants & animals.

19. Study of microbes isolation, culture and staining from soil & water.

20. Determination of DO, CO2 Hardness, Chloride, Alkalinity of freshwater and sewage water.

21. Determination of COD of sewage water.

22. Determination of BOD of sewage water.

23. Estimation of inorganic phosphate and nitrate from water sample.

24. Qualitative and quantitative estimation of Zooplanktons.

25. Detection of heavy metal from the water sample.

26. Practicals set on the network – internet, protein information, Genome & Chromosome database set by teacher.

27. Any other experiment set by the concerned teacher

**M.Sc. Zoology**
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**M.Sc.-I Sem.-I**
**Practical – II**

**Practical based on paper – III & IV**

1. Demonstration of extracellular material
    a. Collagen
    b. Elastin
2. Demonstration of Glycosaminoglycans in the extracellular material using
    a. AB-1
    b. AB-2.5
    c. PAS
    d. AF +AB 2.5 (Sialic Acid)
    e. MgCl2 influence on alcinopoilia.
3. Study of cell Organelles.

a. Nucleus demonstration by

i) Basic Dyes : TB, HE, Methylene blue.

ii) Feulgen reaction Effect of temperature

4. Lysosome demonstration (Acid phosphatase and any other method)

5. Golgi bodies demonstration (Cajal Method)

6. Effect of tonicity of solutions on plasma membrane – Isotonic, Hypotonic, Hypertonic

b) Fragility test of RBC & Osmotic Resistance.

7. Study of generalized insect. Identification economic importance of following insect pests (6-8 pests from each category)

8. Pests of stored gains.

9. Household pests.

10. Pests of medical importance.

11. Pests of veterinary importance.

12. Forest pests.

13. Types of silk moths.

14. Rearing appliances of mulberry silk worm and demonstration.

15. Study of forensic insects

16. Study of nutritional insects.

17. Life cycle and types of honey bees.

18. Lac insect economic importance.

19. Field visit for demonstration of pest damage.

20. Field visit for collection of insects.

21. Any other practical set by concern teacher.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-I Sem.-II**

## Paper- V : Physiological chemistry

**Unit I**

**Principles of Biological chemistry**: Structure of atoms, molecules and chemical bonds, Van der Waal's electrostatic, hydrogen bonding and hydrophobic interactions. Principles of biophysical chemistry (pH, buffer, reaction kinetics dissociation and association constants) Physical constants, thermodynamics, Concept of free energy, Enthalpy, Entropy,

**Water**: Structure and physicochemical properties.

**Unit II**

**Carbohydrates** - structure, classification and function, Carbohydrate metabolism: Glycolysis, TCA cycle, Electron transfer and ATP generation, Bioenergetics of ATP cycle, glycogenesis, glycogenolysis, gluconeogenesis and Pentose phosphate pathway

**Unit III:**

**Proteins** – structure, classification and function, Biosynthesis and Oxidation of amino acids.

**Nucleic acids:** structure, functions and Biosynthesis of nucleotides.

**Vitamins**- structure and functions.

**Unit IV**

**Lipids**- structure, classification and function, Catabolism of fatty acid – Beta oxidation, significance of beta oxidation,

Biosynthesis of saturated and unsaturated fatty acids,

Biosynthesis of triglyceride, biosynthesis of membrane phospholipids,

Biosynthesis of cholesterol, Steroidal hormones- structure and functions.

Biosynthesis of prostaglandins and leukotriene

Lipoprotein metabolism

**Reference Books**

1. A K Anderson- Essentials of physiological chemistry.

2. H. Harper- Review of physiological chemistry.
3. P. Karlson- Introduction to modern biochemistry
4. West E an Todd W- Text book of biochemistry
5. Mahler H and Cordes E – Biochemical chemistry
6. Lehninger's- Biochemistry – COX & Nelson.
7. Reithel F J- Concepts in Biochemistry
8. G H Bell , Je N Davdson and D E Smith- Text book of physiology and biochemistry
9. Mitlon and Toporely- Essentials of biochemistry
10. Outline of Biochemistry by Conn & Stump.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M. Sc. I Sem. II**

**Paper. VI. Quantitative Biology and Tools and Techniques in Biology.**

**Unit. I**

1. Introduction, Application in Biology.

2. Measurement of Central tendency.

3. Measures of dispersion.

4. **Correlation-** Types and methods of correlation.

5**. Regression**- Regression lines and coefficients.

6**. Analysis of Variance (ANOVA).**

**Unit. II**

1. **Probability-** Introduction, addition and multiplication theory.

2**. Probability distribution**- Binomial, Poisson and Normal.

3. **Testing of hypothesis.**

3.1 Tests of Significance.

3.2 Null hypothesis.

3.3 Alternative hypothesis.

3.4 Level of significance.

**4. Student t- test.**

**5. Chi- square test ($X^2$).**

**6. Confidence integral.**

**Unit III:**

**Separation techniques:**

1. Centrifugation techniques. Basic principles of sedimentation and centrifuges & their uses, differential centrifugation, density gradient centrifugation.

2. Chromatographic techniques – Chromatography theory & practices, Molecular Sieve chromatography, affinity chromatography, ion exchange chromatography, HPLC, GLC,

Thin layer chromatography.

3. Electrophoretic techniques – General principles, support media, electrophoresis of proteins and nucleic acids, Isoelectric focusing.

**Unit IV:**

**(A) Analytical instruments and their applications in Biology:**

1. Spectroscopy (Spectrophotometry, Spectroflurometry, NMR, ESR).

**(B) Microscopy, Radiometry & Immunochemical techniques.**

1. Light microscope, phase contrast microscope, fluorescence microscope, Electron Microscope (SEM & TEM).

2. Immunoprecipitation, Labelling antibodies, immunoblotting, immunoassays & immunohisto /cytochemistry.

**References Books**:


1. Fundamentals of Statistics- Gupta S. C.
2. Basic Biostatistics and its applications- Datta A. K
3. Biostatistics and Biometry- Parihar and Parihar.
4. An Introduction to statistical Methods- C. B. Gupta.
5. Practical Biochemistry By Wilson and Walker
6. Cell : A molecular approach By Cooper
7. Molecular Biology of the Cell by Lodish et al.
9. Basic Biostatistics and its applications- Datta A. K
10. Biostatistics and Biometry- Parihar and Parihar.
11An Introduction to statistical Methods- C. B. Gupta.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-I Sem.-II**

## Paper – VII: Elements of physiology

### Unit I: Gastrointestinal Physiology

1.1 Functional anatomy of gastrointestinal tract

1.2 Gastrointestinal tract associated glands ( Liver, Pancreas and salivary gland) with their control mechanism

1.3 Digestion and absorption in gastrointestinal tract

1.4 Dietary balance, regulation of feeding ,obesity and starvation

1.5 Vitamins and their role in nutrition

### Unit II: Physiology of Respiration:

2.1 Mechanism of breathing and pulmonary ventilation

2.2 Pulmonary volumes and capacities

2.3 Physiology of gas exchange

2.4 Regulation of respiration

### Unit III: Physiology of Circulation:

3.1 Body fluids, blood coagulation and homeostasis

3.2 Blood groups and blood transfusion

3.3 Cardiac muscles and cardiac cycle

3.4 Control of excitation and conduction in heart

3.5 Normal electrocardiogram

### Unit IV: Physiology of Excretion:

4.1 Functional anatomy of the kidneys and Mechanism of urine formation

4.2 Regulation of urine formation,

4.3 process of micturation and diuretics

4.4 Cerebrospinal fluid and brain metabolism.

4.5 Conduction of nerve impulse and synaptic transmission

4.6 Pituitary and hypothalamic control

4.7 Structure and functions of thyroid and parathyroid.

**Reference:**

Human Physiology – by A.C. Guyton. Saunders Company Londan, Toronto.
Shepherd G.M. Neuro Biology, New York Oxford University Press 1987.
Hurst J.W et al (eds) The Heart7th ed. New York McGraw- Hill Book Co. 1990.
Hand Book of Physiology Vols. Circulation. Renkin, E.M. & Micbel, C.C.
(eds) Americal Physiological Society, 1984.
Gayton A.C. et al. Circulation Overall regulation Annu Re. Physiol. 34: 13 1972.
Guyton A.C. 1980 Arterial pressure & Hypertension Philadelphia, W.B. Saunders Co-Cartiar output & its regulation 1973.
Kaplan N.M. et al 1989- The Kidney in Hypertension (Perspectives in hypertension vol.2) New York. Raven Press.
Guyton A.C. et al 1975 Dy namics & Control of the Body flerids
Philadelphia, W.B. Saunders, Co., 1975.
Brenner B.M. & Rector, F.C. (Jr) 1986. The kidney 3rd ed. Philadelphia, W.B. Saunders Co., 1986.
Brooks V.B. 1986. The neural Basis of motor control New York, Oxford University Press.
Johnson L.R. et al Physiology of the gastrointestind tract 1987 New York Raven press.
Thampson J.C. et al (eds) Gastrointestinal Endocrinology. New York McGraw Hill book co., 1987.
Setchell K.D.R. et al eds 1988. The Bile Acids New York Plenum Pub. Corp.
Guthrie H.A. 1988. Introductory Hutrition 7th ed. St.Lonis C.V. Mosby Co.,
Felig P et al (eds) 1987. Endocrinology & Metabolism New Your MacGraw- Hill Book Co.,
DeGroot L.J. et al 1989. Endocrinology 2nd ed. Philadelphia, W.B. saunders Co. 1989.
Kannan, C.R. 1988. The adrenal gland New York Plenum Pub. Corp.

## M.Sc. Zoology
## Academic Flexibility, Credit System
## M.Sc. I Sem II

### Paper - VIII Biology of Parasites

**Unit-I**

Animal association, Types of Parasites, Types of Hosts, Interrelationship between host and parasite responses and hosts to parasitic infection, Mode of transmission of parasite, Host specificity and parasitic adaptation.

**Unit- II**

**Vectors,** i) Definition, types, Epidological consideration, Relationship of vertebrate pathogen to vector immunology, Physiology of vector, Population studies and effectiveness of vector.

ii) Arthropod vector of Medical and veterinary importance Human louse, Triatomin bugs, Black flies, Sand flies, Mosquitoes, Horseflies, Houseflies, Tsetse fly, Stable fly and Rat flea, ticks, mites and Vector control.

**UNIT –III :** Study of parasites from protozoa & cestoda

1. Trypanosoma and leishmonia of humans.

2. Intestinal flagellates Giardia, Q Trichomonus, Gregarina.

3. General life cycle of cestodes: Taenia, Diphilabothrium, Diphylidium, Echinococcus.

**UNIT –IV :** Study of parasites from Trematoda & Nematoda:

Schistosomo, Faciola, paragonimus, Opisthorchis.

Nematodes: Wuchreia, Ancylostoma, Strongyloides, Entrobius.

Plant nematodes & Soil nematodes: Cyst nematode, citrus nematode.

Recommended Books:

1. Parasitology – By Ramnik sood, C.B.S. Publisher, New Delhi –1993.
2. Parasitology – By K.D. Chaterjee, Medical Pulisher Calcutta, 1987.
3. Physiology of parasites – By L.S. Chapell, John, Willey & Sions N.Y. (1980).
4. Parasitology – By Hobler, E.R. and Noble, G.A. (1982) 2nd Ed. Lea & Febieger U.S.A.
5. Parasitism & Symbiology – By C.P. Read (1970) Ronald Press New York.
6. Foundation of Parasitology – By Schmidt, G.D. & Robert, L.S. (1981) 2nd Ed. C.V. Mosby Co. St. Lohis ISSR.
7. Introduction Animal Parasitology – By Smit. D.G. (19977) 2nd Ed. Johns Willey Sons New York.
8. The Biology of parasitism and introduction to the study of associate organism- by

White field, P.J. (1977) University Parks Press Baltimore.
9. Animal Parasitism – by Read C.P. Prenters Hall of India Pvt. Ltd., New Delhi.
10. Helminths, Arthropods & Protozoo of domesticated Animals. By E.J.L. soulsby, ELBS publication London Ed. 1969 ed.
11. Parasitology – by Chandler and Chands,
A Text book of Parasitology by S.S. Kelkar and Rohini S. Kelkar, Bombay popular prakashan.
12. Parasitology – By Ramnik sood, C.B.S. Publisher, New Delhi – 1993.
2. Parasitology – By K.D. Chaterjee, Medical Pulisher Calcutta, 1987.
3. Physiology of parasites – By L.S. Chapell, John,Willey & Sions N.Y. (1980).
4. Parasitology – By Hobler, E.R. and Noble, G.A. (1982) 2ndEd. Lea & Febieger U.S.A.
5. Parasitism & Symbiology – By C.P. Read (1970) Ronald Press New York.
6. Foundation of Parasitology – By Schmidt, G.D. & Robert, L.S. (1981) 2nd Ed. C.V. Mosby Co. St. Lohis ISSR.
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9. Animal Parasitism – by Read C.P. Prenters Hall of India Pvt. Ltd., New Delhi.
10. Helminths, Arthropods & Protozoo of domesticated Animals. By E.J.L. souls by, ELBS publication London Ed. 1969 ed.
11. Parasitology – by Chandler and Chands,
12. A Text book of Parasitology by S.S. Kelkar and Rohini S. Kelkar, Bombay popular prakashan.

**M.Sc. Zoology**

**Academic Flexibility, Credit System**

**M.Sc.-I Sem.-II**

**Practical – III**

**Practical based on paper – V & VI**

1. Estimation of glycogen.
2. Estimation of lipids & phospholipids.
3. Estimation of Vitamin C.
4. Estimation of Cholesterol.
5. Estimation of alpha-amino nitrogen by formol titration..
6. To find saponification value for a given fat.
7. To prepare phosphate buffer of known pH and molarity- pH measurement,

measurement of pH of lemon juice, urine and serum.

8. To find absorption spectrum of hemoglobin, bovine serum albumin, tyrosine and (uv-

visible).

9. To estimate free amino acids by Ninhydrin method.

10. To estimate protein content by Biuret method/ Lowry et.al./ Bradford method.

11. To estimate the sugar by Nelson-Somogyi method and glucose.

12. Separation of sugars by TLC.

13. Spot test of amino acids.

14 Examples based on different population genetical principles (Based on theory).

15. To isolate proteins by salting out or by adjusting isoelectric point.

16. To estimate tyrosine content by Folin-phenol method.

17. To estimate the purity of ATP.

18. Examples based on Chi-square test & student t-test.

19 Examples based on regression.

20. Examples based on Correlation coefficient.

21. Examples based on Coefficient of variance.

22. Examples based on ANOVA.

23. Examples based on Probability.

24. Any other practical set by the department.

**M.Sc. Zoology**

**Academic Flexibility, Credit System**

**M.Sc.-I Sem.-II**

**Practical – IV**

**Practical based on paper – VII & VIII**

1) Determination of Bleeding time
2) Determination of Clotting time
3) Estimation of Hemoglobin (Hb) concentration and oxygen carrying capacity
4) Enumeration of Red blood corpuscles (R.B.C)

5) Enumeration of white blood corpuscles (W.B.C)
6) Differential count of W.B.C.
7) Erythrocyte sedimentation rate (E.S.R)
8) Detections of digestive enzymes
9) Microanatomy of Endocrine glands
10) To estimate amylase from saliva
11) To study normal constituents of urine
12) Measurement of breathing rate, heart beat and study of heart sound
13) Collection of parasites: Protozoans/ Nematodes/ Helminthes/ Insects.
14) Preservation and Identification of parasites: Protozoans
15) Preservation and Identification of parasites: Nematodes
16) Preservation and Identification of parasites: Helminthes
17) Preservation and Identification of parasites: Insects
18) Lifecycle studies of parasites: Protozoans
19) Lifecycle studies of parasites: Nematodes
20) Lifecycle studies of parasites: Helminthes
21) Lifecycle studies of parasites: Insects
22) Any other practical set by concern teacher.

**M.Sc. Zoology**

**Academic Flexibility, Credit System**

**M.Sc.-II Sem.-III**

**Paper IX Genetics**

**Unit- I Human Cytogenetics**

1. Techniques in human chromosome analysis
2. Human karyotype - banding, nomenclature
3. Genetics basis of sex determination in human beings

   Y linked genes, X linked genes, Dosage compensation, and testicular feminization Syndrome.

4. Numerical abnormalities of human chromosomes and related syndrome

Nondisjunction, Aneuploidy, Patau syndrome, Edward syndrome, Down syndrome, Turner syndrome and Klinefelter syndrome

5. Structural abnormalities of human chromosomes and related syndromes Robertsonian Translocation

**Unit- II- Microbial Genetics and Population Genetics**

1. Bacterial transformation, transduction and conjugation
2. Genetic variation in natural population, phenotypic variation
3. Hardy- Weinberg principle, Genetic drift, Genetic pool
4. Molecular analysis of quantitative traits
5. Inbreeding depression and heterosis.

**Unit- III- Mutations**

1. Introduction to the mutation, mutation and environment, Spontaneous versus induced mutation.
2. Phenotypic effects of mutations.
3. Somatic and germinal mutation.
4. Pleiotropy, back mutation and suppressor mutation
5. Molecular basis of genetic mutation
6. Radiation induced mutation- Ionizing and non- ionizing
7. Chemical induced mutation
8. Mutation and DNA repair mechanism
9. Mutation frequency
10. Practical application of genetic mutations
11. Mutagenicity and carcinogenicity.
12. Mutations and human welfare

**Unit- IV- Basis of genetic counseling**

1. Introduction to genetic counseling
2. Karyotypic analysis- normal and abnormal chrosomes
3. Ethical and psychological approach of genetic counseling
4. Family pedigree, Genetic inheritance and investigations

5. Inheritance and acquired genetic defects
6. Easy treatments in genetic counseling.
7. Prenatal genetic counseling and diagnosis.
8. Avoidance of risk factor with genetic diseases

**Reference Books:**

Concepts of Genetics By Klug and Cummings
Principles of Genetics By Tamarind
Genetics By Strickberger
Facts of Genetics By Robert Edger
Introduction to biochemical genetics By Mather and Jinks
Molecular Genetics By Gunther Stint
Principles of Genetics By Peter, Snustad and Michael
Genetics of population by Philip Hedrick
Principles of Population Genetics By Hartl and Clark
Gene Clones By Ernst Winnacker

**M.Sc. Zoology**
**Academic Flexibility, Credit System**

**M.Sc.-II Sem.-III**

**Paper-X: Enzymology**

Unit- I:

1.0 Classification and Nomenclature of Enzymes, Isoenzymes, Multienzyme Complexes.

2.0 Cofactors.

2.1 Inorganic.

2.2 Organic: Pyridoxyl Phosphate, Biotin, Lipoic acid, Thiamine diphosphate, Flavin nucleotides, Nicotinamide.

Unit- II:

3.0 Purification of Enzymes.

3.1. Objectives and strategies.

3.2 Methods of separation: Centrifugation, Dialysis, Gel-filtration, Ion Exchange chromatography, Electrophoresis, Isoelectric focusing, Affinity chromatography.

4.0 Structure of Enzymes.

4.1 Primary, Secondary, tertiary and quaternary.

4.2 Active sites and Allosteric sites.

4.3 Structure of chymotrypsin.

Unit- III:

5.0 Enzyme Kinetics.

5.1 Relationship between initial velocity and substrate concentration.

5.2 Michaelis Menten equation.

5.3 Briggs Haldane Hypothesis.

5.4 The Line Weaver Burk Plot.

5.5 The Halden relationship for reversible reaction.

5.6 Effect of Modifiers on enzyme Kinetics.

5.7 Effect of temperate.

5.8 Thermal denaturation.

5.9 Effect of pH.

6.0 Enzyme Actions of-

6.1Chymotrypsin.

6.2 Fructose bisphosphate aldolase.

Unit- IV:

7.0 The control of Enzyme Activities by Non Genetic Mechanism.

8.0 Enzymes in Organised System.

8.1 RNA nucleotidyl transferase.

8.2 The Pyruvate dehydrogenase.

9.0 Enzyme Technology.

9.1 Use of isolated enzymes in industrial processes.

9.2 Immobilized enzymes.

**Suggested Reading Material:**

Fundamentals of Enzymology : Price N.C. and L. Stevens e.. Oxford, New York.

Dixon, M., Webb, E.C; et al. (3rd Ed.) Longman, London.

Methods in Enzymology all volumes.

Scopes, R.K. Protein Purification, Principles and Practice.

Ferdinand, W. (1976) fundamentals of enzyme kinetics, Butterworths, London.

Enzyme by Palmer.

Niggins, I.J. Best D.J. and Jones, J. Biotechnology – Principles and applications, Black well, scientific oxford (1985).

Bulock, J. and Kristiansen, B- (1987) Basic biotechnology.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-II Sem.-III**
**Physiology**
**Elective Paper- I**
**Paper- XI : Animal physiology**

**Unit I: Membrane physiology and Muscle**

1.1 Transport of ions and molecules through cell membrane

1.2 Membrane potential and action potentential

1.3 Physiologic anatomy of skeletal and smooth muscle

1.4 Excitation of skeletal muscle

i) Neuromuscular transmission

ii) Excitation –contraction coupling

1.5 Contraction and Excitation of smooth muscle

**Unit II: Physiology of sense organs**

2.1 Anatomy and physiology of eye

i) Optics of eye

ii) Receptor and neuronal functions of retina.

2.2 Sense of hearing

2.3 Chemical sense –Taste and smell

2.4 Aging and sense organs

**Unit III: Physiology of Reproduction:**

3.1 Male Reproductive system

3.2 Female Reproductive system

3.3 Contraceptives and birth control

3.4 IVF and Embryo Transfer

3.5 Aging and the reproductive system

**Unit IV: Mammalian developmental Physiology**

4.1 Maturation of germ cells and fertilization

4.2 Physiology of Cell and Tissue culture

4.3 Embryonic development

4.4 Prenatal diagnostic tests

4.5 Physiological regulation in embryogenesis.

**References:**


Human Physiology – by A.C. Guyton. Saunders Company Londan, Toronto.

Shepherd G.M. Neuro Biology, New York Oxford University Press 1987.

Hurst J.W et al (eds) The Heart7th ed. New York McGraw- Hill Book Co. 1990.

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(eds) Americal Physiological Society, 1984.

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Brooks V.B. 1986. The neural Basis of motor control New York, Oxford University Press.

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Thampson J.C. et al (eds) Gastrointestinal Endocrinology. New York McGraw Hill book co., 1987.

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Guthrie H.A. 1988. Introductory Hutrition 7th ed. St.Lonis C.V. Mosby Co.,

Felig P et al (eds) 1987. Endocrinology & Metabolism New Your MacGraw- Hill Book Co.,

DeGroot L.J. et al 1989. Endocrinology 2nd ed. Philadelphia, W.B. saunders Co. 1989.

Kannan, C.R. 1988. The adrenal gland New York Plenum Pub. Corp.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M. Sc. II, Semester – III**
**(Aquaculture and Fisheries Elective Paper–I)**
**Paper-XI: Fisheries Resources — Inland and Marine Fisheries**

**Unit 1:**

**A. Marine Capture Fisheries:**

Coastal fisheries: Sardine, Mackerel and Bombay duck; Off-shore fishery: Sole, Tuna, Pomphret; Crustacean fishery: Lobsters and Crabs; Molluscan fishery: Mussels and Oysters.

**B. Marine Fisheries of the World:**

Major fishing nations of the world; their catch and nations harvesting; Present and future status of world fisheries; Estimation of potential harvest and problems of development

**Unit 2:**

**A. Freshwater (Inland) Fisheries of India:**

Riverine fisheries, Reservoir fisheries, Sewage fed fisheries, Pond and Lake fisheries

**B. Carp Seed Resources of India:**

Pre-monsoon survey and selection of sites for spawn collection, Techniques of spawn collection, Spawn collection by nets, Identification, Segregation and transport, Present status of carp seed production in India.

**Unit 3:**

**A. Management of Inland Fishery Resources:**

Fishery management in rivers, reservoirs, ponds and lakes, Productivity of various water bodies in relation to fish stocks; Reproduction, Competition, Predation and Stocking, Techniques in fishery management, Fertilization of water bodies.

**B. Management of Marine Fishery Resources:**

Biological basis of marine fishery management, Objectives of management: Biological and Non-biological, Concept of maximum sustainable yield, Fishery regulation and control of catch composition, Allocation of shares and limited entry, International fishery management i) Law of the sea,

ii) Planning of future exploitation,

iii) Fishery regulatory bodies;

iv) Monitoring control and surveillance.

**Unit 4:**

**Economics of Fisheries and Extension Programme:**

Marketing and economics of fish and prawn farming, Co-operative fisheries societies, Role of government agencies in extension programme, Fisheries education, Training and extension, Problems of fisheries.

**Suggested reading material**:


1. Management of Marine Fisheries: J.A. Gullad.

2. Fishery Science: W.C. Royce.

3. Ecology, Utilization and Management of marine fisheries; G.A.Rounsefell.

4. Fisheries development of India: U.K. Shrivastava and M. Dharma Reddy.

5. Aquaculture research needs for 2000 AD: Jaw. Kai. Wang and P. V. Dehadari.

6. Fish farming hand book: E.E. Brown and J.B. Gratzek.

7. Fresh water biology: K.F. Lagler.

8. Fish and Fisheries of India: V.G. Jhingran.

9. Advances in aquaculture: T.V.R. pillay.

10. Fishes an introduction to ichthyology: P.B. Moyle and J.J. Cech.

11. Fishery management: S.C. Agarwal.

12. Applied fishery science (Vol. I & II): S.M. Shafi.

**M.Sc. Zoology**

**Academic Flexibility, Credit System**

**M.Sc.-II Sem.-III**

**Paper- XI: Basic Entomology**

**(Entomology Elective Paper-I)**

**(Insect Morphology and Classification)**

**Unit I**

1. **Insectan characters, Origin of insect, Evolution of Insect.**

2. **The Head**: Head Segmentation, structure of definitive head, modifications in structure of head, Tentorium, Cephalic appendages- Antennae, Mouth parts and cervix.

**Unit II**

3. **The Thorax**: Generalised structure of thorax- Prothorax & pterothorax , Thoracic appendages- Legs, Wings.

4. **The Abdomen**: Abdominal Segmentation, Abdomen Skeleton, Pregenital, Genital and Post genital appendages of abdomen.

**Unit III**

5. **Classification of insects**.: Historical Background.

6. **Apterygote orders:** Thysanura, , and Collembola.

7. **Pterygote orders:,** Odonata, , Phasmida Orthoptera, , Isoptera, Psocoptera, Mallophaga, and Thysanoptera,

**Unit IV**

8. **Pterygote orders**: Hemiptera, Lepidoptera, Coleoptera, Diptera and Hymenoptera.

While describing Insect orders, detatils of the Habitat, External Morphology, Internal anatomy and Classification upto families with examples are considered.

**Suggested readings:**

1. Principles of Insect Morphology- R. E. Snodgrass.

2. Insect structure and function – R. F. Chapman.

3. Elements of entomology- Rajendra Singh.

4. Gillot, C. (1982). Entomology, Plenum Press, New York and London, 730 .

5. Mani, M. S. (1968). General Entomology. Oxford & IBH Publishing Co., p. 597.

6. Tembhare, D. B (2013). Modern Entomology. Himlaya Publishing House, India., p. 502.

**M.Sc. Zoology**

**Academic Flexibility, Credit System**

**M.Sc.-II Sem.-III**

**Cell biology – Elective Paper- I**

**Paper-XI: Computational Molecular Biology**

**Unit –I: Advanced molecular techniques**

1 DNA physical, chemical, biological properties

2 DNA sequencing, PCR, Nucleic acid hybridization technology, DNA libraries

3 RNA sequencing and Protein sequencing

4 Gene Structure Prediction of open reading Frame, 6 frame translation

5 Genomic markers- RAPD, RFLP, SNP, EST.

**Unit –II: Sequence comparison methods & search algorithms:**

1. Searching sequence databases by sequence similarity.

(Nucleic acid and proteins).

2. Pairwise alignment techniques – local and global sequence alignment

Needleman-Wunsch algorithm, Smith-Waterman algorithm .

3. Multiple sequence alignment, consensus sequences.

**Unit –III: Phylogenetics and Sequence annotation**

1. Phylogenetics, Cladistics and Ontology

2. Building Phylogenetic trees

3. Evolution of macromolecular sequences

4. Principles of genome annotation

5. Annotation tools and sequences

**Unit –IV: Structural bioinformatics.**

1. Conceptual models of protein structure
2. The evolution of protein structure and function
3. Obtaining and viewing and analyzing structural data
4. Structural alignment
5. Classification of protein to known CATH and SCOP
6. Structure prediction by comparative modeling
7. Secondary structure prediction
8. Advanced structure prediction and prediction strategies

**Reference Books:**

1. Introduction to Bioinformatics (2002) – AM Lesk Pub. By oxford University Press.

2. Bioinformatics – A practical guide to the analysis of genes & proteins (2001) = Ed by A.D. Baxevanis & B.F, Francis Ouelletele pub. By A Jahn Wiley & sons publication, New York.

3. Introduction to Bioinformatics (2003) T.K. Atwood & D.J. Parry smith.

4. Instants notes – Bioinformatics (2003) West head D.R. Parish J.H. & Twyman R.M.

5. Pearson Education (Cell & Molecular biology in action series).

**M.Sc. Zoology**

**Academic Flexibility, Credit System**

**M.Sc.-II, Sem.-III**

**(Entomology Elective– Paper –II)**

**Paper- XII: AGRICULTURAL ENTOMOLOGY**

Identification, characteristics, biology, damage and control of important agricultural pests.

**Unit –I: 1.0 Pests of Cereals:**

Paddy and Jowar stem borers, midgefly, aphid, Grasshopper,

Paddy Leaf hoppers, armyworm and blister beetle.

**2.0 Pests of pulses:**

Gram pod borer, Cutworms, Turplume moth, Turpod Bug,

Turpod fly, Lentilpod borer, and Beanfly.

**Unit –II: 3.0 Pests of fruits and fruit trees (Temperate):**

Sanjose scale, apple wooly aphid, white fly, cherry stem borer, codling moth, apple stem borer, peach fruit fly and Almond weevil.

**4.0 Pests of fruits and fruit trees:**

Citrus caterpillar, citrus psylla, citrus white fly, citrus fruit moth, Mango stem borer. Mango jassid, Mango mealy bug, Mango stone weevil, Ber fruit fly, Ber beetles. Grapevines leaf hopper, grapevine thrips, grapevine

beetle & girdler, Pomegranate anarbutterfly, Banana weevil, Guava fruitfly, papayaAK grasshopper

**Unit –III: 5.0 Pests of sugar cane:**

Sugarcane woolly aphids, White grubs, borers, Pyrilla, Whitefly, Mealybug, Termites.

**6.0 Pests of fiber crops:**

Cotton pink boll worm, Spotted boll worms, Red cotton bug, Dusky cotton bug, cotton aphid, cotton leafroller, jute stem girdler, jute stem weevil and sunhemp capsid.

**7.0 Pests of Oilseed Crops:**

Mustard aphid, Mustard Sawfly, groundnut aphid, groundnut stemborer, white grub, castor semilooper, castor capsule borer, Til halkmoth, linseed gall midge and safflower aphid.

**Unit –IV: 8.0 Pests of vegetable crops:**

Cabbage caterpillar, Diamond back moth, potato tuber moth, Onion thrips, Brinjal fruit & stem borer, Red pumpkin beetle and Hadda beetle.

**9.0 Pests of plantation crops:**

Coffee stem borer, Tea mosquito bug, coconut weevil, Rhinoceros beetle and coffee shoothole borer.

**10.0 Pests of Spices and Narcotic:**

Chilli thrips, caster capsule borer, white grub, Bihar hairy caterpillar, Tobacco caterpillar, Tobacco aphid and Hespirid caterpillar.

**Books Recommended:**

1. Agricultural pest of India and South East Asia, By A.S. Atwal, Kalayni publ.

New Delhi.

2. Hand Book of Economic Entomology for South India by T.U. Ramkrishna

Ayyar.

3. A textbook of Agricultural Entomology. ICAR New Delhi by Druthi S.H.

4. A text book of Applied Entomology, By K.P. Shrivastava Kalyani Publ. New Delhi.

5. Agrochemicals and pest management, DPH New Delhi by T.V. Sathe.

**M.Sc. Zoology**

**Academic Flexibility, Credit System**

**M. Sc. II, Semester – III**

**(Aquaculture and Fisheries Elective Paper– II)**

**Paper - XII: Fish Pathology and Reproductive Endocrinology**

**Unit 1: Fish Pathology**

Signs of sickness in fishes, defensive devises in fishes against diseases, diseases of fishes, intrinsic causes of diseases, diseases caused by pathogens (bacteria, fungal, viral, protozoan and helminthes) and parasites; their symptoms and treatments

**Unit 2:**

**A. Parasites and Diseases of Fish and Crustacean:**

Major protozoan and metazoan parasites of commercially important fish, crustacean and mollusca, their morphology and life history, Modes of infection and host –parasite relationship, Microbial diseases of crustaceans, Symptoms, diagnosis, pathology and treatment

**B. Control Measures of Diseases of Fish, Crustacean and Mollusca:**

Sanitary and prophylactic measures in the control of disease of cultured fishes, Crustaceans and Molluscs, Use of filters, Disinfection by irradiation, chemicals and Bio-organic manures, Experimental study on disease resistance.

**Unit 3:**

**A. Fish Health in Relation to Environment:**

Abiotic factors influencing disease outbreak in cultured and feral populations, Rural and urban developmental programmes like sewage disposal, Effect of industrial and agriculture waste on diseases and pathogens, Effect of pesticides substances on fish in relation to water quality.

**B. Epizootic Ulcerative Syndrome (EUS):**

History and areas affected by EUS, Spread of disease and fish species affected, Present state of knowledge of EUS, Extension of range and human significance, Recommendations for treatment, Socio-economic impact of EUS.

**Unit 4:**

**Reproductive Endocrinology:**

Pituitary gonadotropins: role of gonadotropins in pre-spawning and spawning behavior, Gonadal steroids and reproductive behavior – differentiation of secondary sexual characters.

**Suggested reading material:**


1. Fish physiology (Vol.I to XII): W.S. Hoar and D.J. Randall.
2. Fish endocrinology: A.J. Matty.
3. Fishery science: W.F. Royce.
4. Introduction to fishes: S.S. Khanna.
5. Pond fisheries: F.G. Martyshev.
6. Fresh water fishery biology: K.F. Lagler.
7. Coastal Ecosystem management: John Clark.
8. Applied Fishery Science Vol. I & II : S.M. Shafi.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-II Sem.-III**
**Physiology**
**Paper- XII Applied Physiology (Elective Paper- II)**

**Unit I- Environmental physiology**

1.1. Physiology of high altitude.

1.2. Physiology of deep sea diving.

1.3. Temperature, light and life.

1.4. Space Physiology-

a) Physiological requirement of space travel

b) Adaptations due to space travel

**Unit II- Exercise physiology**

2.1. Fundamental of physical exercise

2.2. Energy for exercise, Enhancement of energy- Aerobic and Anaerobic power

2.3. Exercise physiology- Muscles in exercise, Respiratory exercise, Cardiovascular system exercise, Nervous system exercise, Body heat in exercise

2.4. Biochemical changes in exercise

2.5. Recovery from exercise.

**Unit III- Ergonomics and Industrial physiology**

3.1. Man- machine and environment

3.2. Physiology of man and women at work

3.3. Physical fitness and efficiency

3.4. Aging and occupational disease/ hazards

3.5. Problems of Child labour in India.

**Unit II- Occupational Physiology**

4.1. Work place environment

4.2. Occupational health.

4.3. Occupational stresses

4.4. Occupational hazards and diseases

4.5. Management of Occupation hazards and diseases

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Brooks V.B. 1986. The neural Basis of motor control New York, Oxford University Press.

Johnson L.R. et al Physiology of the gastrointestind tract 1987 New York Raven press.

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**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-II Sem.-III**
**Cell Biology – Elective Paper – II**

## Paper – XII : MOLECULAR BIOLOGY OF GENE

**Unit I: Molecular Genetic Technique**

1. Chromosome as a carrier of genes
2. Linkage groups, genetics maps, crossing over and genetic recombinations.

3. Genetic recombinations analysis in Drosophilla
4. Hybridization techniques –Southern blotting, Northern blotting, In situ hybridization, DNA microarray

**Unit II: Genes, Genomics and Chromosome.**

1. Simple sequence DNA – satellite DNA
2. Transposable DNA elements
   a) DNA Transposones
   b) LTR Retrotransposones
   c) Non LTR Retrotransposons (SINES and LINES)
3. Organelles DNA
   a) Mitochondrial DNA
   b) Chloroplast DNA

4.Genomics- Genome wide Analysis of Gene Structure and Expression

5.Morphology and Functional Elements of Eukaryotic Chromosomes

   a) Chromosome number, size and shape at metaphase
   b) Banding patterns
   c) Chromosome painting and DNA sequencing

**Unit III:**

**1. Gene and its expression:**

a) Concept of gene

b) Transcriptional control of gene expression in prokaryote (Lac, trp operon).

**2. Transcriptional control of gene expression in eukaryotes:**

a) RNA polymerases and gene control.
b) Regulatory sequences in protein coding gene.
c) Activators & Repressors of Transcription.
d) Regulation of transcription factor activity.
e) Regulation of elongation and termination of transcription.

f) Other eukaryotic transcription systems.

3. **Post transcriptional gene control and nuclear transport:**

a) Processing of pre m-RNA.

b) Regulation of pre m-RNA processing.

c) Macromolecular transport across the nuclear envelope.

d) Cytoplasmic mechanisms of post transcriptional control.

**Unit IV: Genetic engineering**

a) Recombinant DNA technology

b) Selection, screening and analysis of recombinants

c) Knockout gene technique

d) Production of transgenic mice

**Reference:**


1. Genes by Benjamin Lewin.
2. Molecular Biology of the gene by Watson
3. An introduction to genetic engineering By Desmond S.T. Nicholl


**M.Sc. Zoology**

**Academic Flexibility, Credit System**
**M.Sc.-II Sem.-III**
**Practical – V**
**Practical based on paper – IX & X**

1 Human lymphocyte culture.
2. Preparation of metaphasic chromosomes from human lymphocyte culture.
3. Study of human chromosomes explaining aspects of chromosome structure.
4. Study of human normal karyotype.
5. Manual preparation of human karyotype from metaphasic chromosomes.
6. Assessing quality and quantity of metaphases.
7. Harvesting of mitotic chromosomes from rat bone marrow.
8. Estimation of mitotic index.
9. Study of X chromosome heterochromatinization by Barr body staining .
10. G banding of rat chromosomes/Human chromosomes.
11. Preparation of chromosome ideogram.
12. Karyotype identification with reference to Patau syndrome, Edward Syndrome, Down syndrome, Klinefelter syndrome and Turner syndrome (from photographs).
13. Identification of cases of Patau syndrome, Edward Syndrome, Down syndrome,

Klinefelter syndrome and Turner syndrome from photographs by morphological/ symptomatic features

14. Principle of Fluorescence In Situ Hybridization, Interpretation of results FISH for Patau syndrome, Edward Syndrome, Down syndrome, Klinefelter syndrome and Turner syndrome (from photographs).
15. Drosophila culture
16. Sexual dimorphism in Drosophila
17. Study of heritable characters in Drosophila
18. Examples based on Hardy-Weinberg Equilibrium
19. Symbols used in Pedigree analysis
20. Studies of Human pedigrees concerned with autosomal recessive disorders, autosomal dominant disorders, X linked dominant disorders and X linked recessive disorders.
21. Clinical test for Phenylketonuria by Guthrie test /Ferric chloride test
22. Study of bacterial transformation
23. Study of bacterial transduction
24. Estimation of proteins.
25. Estimation of Amylase / any other suitable enzyme.
26. Effect of pH on Amylase activity / any other suitable enzyme.
27. Effect of temperature on Amylase activity / any other suitable enzyme.
28. Michaelis – Menten constant determination for Amylase / any other suitable enzyme.
29. Effect of modifiers on enzyme activity / Thermolability of enzyme.
30. Isolation of Amylase or any other enzyme.
31. Any other practical set by the Department.

AT LEAST 12 EXPERIMENTS TO BE COVERED IN THE SEMISTER FROM GENETICS.

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**M.Sc.-II Sem.-III**
**Practical – VI**
**Cell Biology Practical-I**
**Practical based on paper – XI & XII**
**(Cell Biology Elective paper – I & II)**

1. Example based on DNA sequencing.
2. Example based on RNA sequencing.
3. Example based on Protein sequencing & SS bond prediction, transmembrane & signal peptide sequence prediction.
4. Examples based on Genetic code
   - 6 frame translation at frames.

- Codon preference base translation frames.
- Open reading frame search.

5. Database serach- NCBI, DDBJ, EMBL, BRENDA, KEGG, Uni Prot.
6. Primary sequence analysis of proteins- Prot PARAM
7. Secondary structure prediction
8. Tertiary structure analysis
9. Pairwise sequence alignment- FASTA, BLAST,
10. Multiple sequence alignment- Clustal W
11. Phylogenetic analysis- PHYLIP, PAUP.
11. Metaphasic chromosome preparation from bone marrow cells.
12. C-band of metaphasic chromosomes.
13. Isolation and estimation of DNA & RNA.
15. Demonstration of RNA (by RNase digestion & TB pH 3.5) & estimation.
18. Estimation of Histones.
19. Demonstration of Histones.
20. Estimation of phosphate from isolated nucleic acids.
21. Any other experiments / practicals set by the Department.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-II Sem.-III**
**Practical – VI**
**Physiology -Special**
**Practical-I based on Animal Physiology(XI) & Applied Physiology(XII)**

1) Study of histology and histochemistry of reproductive organs.
2) Vaginal smear technique.
3) Study of Uterine muscles.
4) Study of sperm count.
5) Capacitation and motility of sperm.

6) Study of placental type.
7) Contraceptive devices.
8) Gonadectomy in white rat
9) Estimation of lactate content of rat blood.
10) Estimation of calcium content of rat blood.
11) Determination of PEFR.
12) Study of physical fitness by Step Test method
13) Determination of Grip strength.
14) To study effect of work load on finger muscle by Finger Ergometery.
15) Absorption spectra of blood pigments.
16) Estimation of Chloride content in rat blood.
17) Visit to the industrial area to study man- machine environment.
18) Demonstration of principal of dialysis.
19) Demonstration of IVF procedure (Lab. visit).
20) Project work/ Review articles.
21) Any other practical set by concern teacher.

**M.Sc. Zoology**

**Academic Flexibility, Credit System**

**Practical - VI**

**Special Practical - I**

**Aquaculture and Fisheries (I and II)**

1. Identification of important food fishes, prawns and molluscs upto the species level (Freshwater and Marine)
2. Estimation of the rate of oxygen consumption in fish
3. Fecundity assessment in fish
4. Slides of different types of scale
5. Demonstration of induced breeding technique by ovaprim / ovatide.
6. Estimation of DO, $CO_2$, Alkalinity, Inorganic nitrate and Phosphate from water sample
7. Qualitative analysis of digestive enzymes
8. Identification of diseased fish – Bacterial, fungal and viral infections (Slides)
9. Blood glucose estimation in fish
10. Sexual dimorphism and secondary sexual characters in fishes

11. Short term bioassay of LC50 determination (Demonstration)
12. Field trips and study tours to fish farms, fisheries institute, or national laboratory etc..

13. Any practical set by the concerned teacher / Department.
14. Allotment of project work which is to be submitted in semester IV
15. Any other experiment set by the teacher/ Department.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-II Sem.-III**
**Practical – VI**
**Practical based on Paper – XI & XII**
**Entomology Special Practical**

1. Collection and preservation of Insects. (Dry and wet preservation)
   - Preparation of permanent slides of small insects.

2. Study of insect head and its appendages:

   - Types of mouth parts & Antennae.

   - Preparation of permanent slides.

   - Mounting of tentorium.

3. Study of Thorax and its appendages -

   - Types of wings & legs.

   - Mounting of appendages including halters.

4. Study of Abdomen and its appendages.

   - Types of gentalia, Cerci, tympanum, pseudo leg, & sting etc.

5. Type study of insect orders of locally available with sufficient examples of each order.

6. Collection and preservation of insect pests.

7. Preparation of slides of insect pests.

8. Identification and economic importance of 6-8 pests of following crops.

9. Pests of cereals.

10. Pests of pulses.

11. Pests of fiber crops.

12. Pests of fruit and fruit trees.

13. Pests of Oil seed crops.

14. Pests of Vegetable crops.

15. Pests of spices & Narcotic crops.

16. Field visit for demonstration of pest damage.

17. Any practical set by the concerned teacher.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-II Sem.-IV**

**Paper- XIII: Animal Cells in Biotechnology**

**Unit I:**

**1. Laboratory design and introduction of cells:**

- Design of Tissue Culture Laboratory
- Equipments : Laminar Flow Hoods, CO2 incubator, Microscopes, centrifuge, Refrigerators and Freezers, pipetting aids, Miscellaneous Equipments.
- Glass wares/plastic wares and filters for tissue culture.
- Basic Aseptic Techniques
- Cryopreservation for Storage and shipment
- Primary cell culture, Established cell line, transformed cell line

**Unit II:**

**2. Growth media**

- Physical requirements and Nutritional Requirements of Cells
- Natural media
- Basal salt solution (BSS)-Various types
- Minimum Essential Medium( MEM)
- Antibiotics in media
- Serum dependent defined media
- Serum independent defined media – Cell specific media

**3 Basic Techniques of mammalian cell culture**

- Open and closed cell cultures
- Primary Cell culture – Isolation and separation of cells, viable cell count, maintenance of cell culture, maintenance of stock culture, Antibiotic free stock cultures
- Types of cell cultures – Monolayer, Suspension, Clonal culture, Mass culture-micro carrier culture (monolayer), Stem cell cultures (ESC)

**Unit III:**

**5. Biology and Characterization of cultured cells**

- Karyotyping
- Contamination Testing of Culture
- Viability measurement and cytotoxicity
- Measurement of growth parameters
- Cell cycle analysis and Synchronization of cultures

**6. Uses of Animal Cells in Culture**

- Evaluation of Chemical carcinogenicity, Cell malignancy Testing
- Uses of Embryonic stem cells and Pluripotent stem cells

**Unit IV:**

**7. Cell surgery and Cell Fusion Methods**

- Surgical manipulation of *in vitro* fertilization
- Cell fusion by Sendai virus and Polyethylene glycol
- Hybridoma cell preparations and their properties

8. **Tissue Engineering**

- Capillary culture Units
- Techniques for culturing differentiated cells: Use of Reconstituted basement membrane rafts and use of feeder layers.

**Reference:**


1. Morgan, S.I. Animal Cell culture 1993 Bio. Scientific Publishers Ltd Oxford.

2. Freshney, R.I. Culture of Animal Cells: A manual of Basic Technique, 1994, John Wiley & Sons Inc. Pub. USA.

3. Butler, M. Mammalian Cell Biotechnology.: A practical Approach 1991 IRL Press Oxford.

4. Jenni P. Mather & David Barnes Eds: Animal Cell culture Methods. Methods in Cell Biology Vol. 57 Academic press.

5. Cell Culture: Methods in Enzymology, vol. 58 1979/recent volume. Academic Press.

6. Kuchler, R.J. Biochemical Methods in Cell culture & vivology 1977. Dowden, Huchinson & Ross, Inc. Strausberg, USA.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc. II Sem IV**
**Paper XIV Toxicology & Immunology**
**Toxicology**

**Unit- I**

i. **Concept and Scope of Toxicology**: Definition, History, Recent development, Disciplines of toxicology. Classification of toxicants, toxic effects, principle aspects and importance of toxicology.

ii. **Toxicity Tests:** Types of toxicity tests, acute, sub acute and chronic toxicity tests and their objectives, experimental design, route of administration, doses and number. Bioassays i.e determination LD50 or LC 50 value using fish/mollusk/ insects graphical and statistical methods.

**Unit- II**

i. **Insecticides and metals toxicity-** Synthetic organic insecticides, their classification, prospectus effects, symptoms mechanism of toxic action of Organochlorine, Organophosphate, Carbamate and synthetic Pyrcthroid insecticides, toxic metals- Arsenic, Lead, Mercury and Cadmium, their toxic effects on animals and toxicokinetics.

ii. **Bio-accumulation and bio magnification toxicants**- Oranochlorine insecticides and heavy metal mercury.
**Bio-transformation of toxicant-** Organochlorine and Organophosphate insecticides i. e Metabolism of insecticides- DDT, BHC, Parathion and Malathion- Mechanism Phase I and Phase II reaction.

iii. **Food Toxicants-** Food addictives, Contaminants, adulterants , food poisoning due to bacterial fungal and algal toxins.

## Immunology

**Unit –III:** Antigens: Antigenicity and immunogenicity, Factors influenceing immunogenicity, Epitopes, Antibody:Basic structure of antibodies, obstacles to antibody sequencing, Immunoglobulin fine structure, Antibody classes and biological activities. MHC molecules: Genomic map of MHC genes, Cellular distribution of MHC molecules, Regulation of MHC expression, MHC and immune responsiveness

**Unit –IV:** Innate immunity:Anatomy, physiologic, phagocytic and inflammatory, Adaptive immunity: Antigenic specificity, diversity, immunologic memory, self and non self recognition, Hypersensitive reactions, IgE mediated (Type I) hypersensitivity, Antibody mediated cytotoxic (Type II) hypersensitivity, Immune complex mediated (Type III) hypersensitivity, Delayed type (Type IV) hypersensitivity

**Reference Books:**


Chris Kent (2001) : Basics of Toxicology

Devid J.K. and Kit A.K. (2006): Toxicological testing handbook 2nd Ed.

Gupta P.K. and Salunkhe D.K. (1985): Modern toxicology (Vol. I,II &III)

Pandey, Shukla and Trevedi (2004): Fundamentals of Toxicology.

Thomas J.H. and William O.B. (1987): Handbook of Toxicology.

Kuby Immunology, WH Freeman, USA.

W Paul Fundamentals of Immunology.

I.M. Roitt, Essential Immunology, ELBS edition.

Roiff, I Brosfott, J and Male D – Immunology.

Sharma, J.M. : Avian Cellular Immunology.

Karger and Basel: The year of Immunology 1988.

Zapata A.G. and Co oper, E.L. The immune system.

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Laurie Hoffman – Goetz : Exercise and immune function.

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Clark W.R.. Experimental functions of Modern Immunology.

Immunobiology - Charles A. Janeway and oyhers – 2001.

Pandey Kamleshwar., Shuklar J. P. and Trivedi S. P. (2005): Fundamental of Toxicology. New Central book agency PVT. LTD. Kolkata.

Chris Kent (2001) : Basics of Toxicology

Devid J.K. and Kit A.K. (2006): Toxicological testing handbook 2nd Ed.

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**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-II Sem.-IV**
**Physiology**

**Paper- XV: Physiology of Health (Elective Paper- III)**

**Unit I- Physiology of gastrointestinal disorders and Diseases ( physiological basis, , histopathology, biochemistry)**

1.1. Digestive glands

1.2. Swallowing and oesophagus

1.3. Stomach

1.4. Small intestine

1.5. Rectum

1.6. Large intestine- constipation, diarrhea, and defecations.

1.7. Aging and general disorders of digestive tract.

1.8. Appendix

**Unit II- Disorders and Diseases of respiratory and circulatory systems ( physiological basis, histopathology, biochemistry)**

2.1. Respiratory insufficiency- Chronic pulmonary Emphysema, Pneumonia, Atelectasis,

Aathama, Tuberculosis.

2.2. Hypoxia, Hypercapnia, Hypocapnia.

2.3. Haemolysis and clotting defects

2.4. Congenital and Ischemic heart diseases,

2.5. Hypertension, cardiac arrest and heart failure.

2.6. ECG-defect, Angiogram and Angioplasty.

**Unit III- Renal Disorders and Diseases ( physiological basis, histopathology, biochemistry)**

3.1. Acute renal failure- Peripheral internal and post renal failure.

3.2. Chronic renal failure – injury to glomeruli and interstitium

3.3. Hypertensions and kidney diseases.

3.4. Uremic toxicity, dialysis and artificial kidney.

3.5. Kidney transplantation

**Unit IV- Disorders and Diseases of Nervous and muscular system (physiological basis, histopathology, biochemistry)**

4.1. Disorders of Cerebrospinal fluid (CSF)

a) Psychosis b) Epilepsy c)Alzimers diseases

4.2. Inherited neurological disorders.

4.3. Clinical physiology of muscular system.

4.4 Muscular atrophy and dystrophy

**References:**

Human Physiology – by A.C. Guyton. Saunders Company Londan, Toronto.

Shepherd G.M. Neuro Biology, New York Oxford University Press 1987.

Hurst J.W et al (eds) The Heart7th ed. New York McGraw- Hill Book Co. 1990.

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Wozney J.M. et al 1988. Novel regulators of bone formation: Molecular clones & cultivates science 242: 1528.

Martin R.B. & Burr D.B. 1989. Structure, function & adaptation of compact Bone New York, Raven Press 1989.

Knobil E. et al (eds) The physiology of Reproduction New York, Raven Press 1988.

Leung P.C.K. et al (eds) Endocrinology & Physiology of reproduction New York Plenum Pub. Corp. 1987.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M. Sc. II Sem. IV**
**Paper XV- Entomology Elective Paper- III**
**Insect Anatomy and Physiology**

**Unit I**

**1. The Integument:**

1.1. Structure of Integument.

1.2. Physiology of Integument.

1.3. Functions of Integument.

**2. Food Uptake and Utilization.**

2.1. The Alimentary canal and associated glands.

2.2. Digestion and Absorption including special diet.

2.3. Filter chamber.

**3. Muscles**

3.1. Structure of Muscles.

3.2. Muscle contraction.

**Unit II**

**1. Respiration**

1.1. Organisation and structure of tracheal system.

1.2. Types of tracheal systems.

1.3. Mechanism of gaseous exchange within tracheal system.

1.4. Respiration in aquatic and parasitic insects.

**2. Circulation**

2.1. Structure of Circulatory organs- Dorsal vessel and Accessory pulsatile structures.

2.2. Haemolymph- Composition and function.

2.3. Haemocytes- Types and function.

2.4. Mechanism of Circulation.

**3. Excretion**

3.1. **Excretory system** – Malpighian tubules and other excretory structure.

3.2. Physiology of Excretion and Osmoregulation.

**Unit III.**

**A) Nervous system**

1.1. Structure and function

1.2. Physiology of neural integration.

**B) Endocrine systems.**

1.3. Structure and function of endocrine organs.

**C) Sense organs.**

1.4. Photoreceptors.

1.5. Mechanoreception.

1.6. Chemoreception.

1.7. Phonoreceptors.

**Unit IV**:

**1. Reproduction.**

1.1. Male Reproductive system.

1.2. Female Reproductive system.

1.3. Physiology and reproduction.

**2. Embryonic development**

2.2. Cleavage and Blastoderm Formation.

2.3. Formation and Growth of germ band.

2.4. Gastrulation.

**Suggested Reading.**

1. Principles of Insec Morphology- R. E. Snodgrass.

2. Insect structure and function – R. F. Chapman.

3. General entomology- M. S. Mani.

4. Insect Physiology and anatomy- Pant N.S and Ghai S. L

5. Elements of entomology- Rajendra Singh.

6. Entomology of Insects- A. O. John and F. H. Butt.

7. Entomology- Cedric Gillot

8. Modern entomology- Tembhare, D. B

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M. Sc. II, Semester – IV**
**Paper– XV**
**(Aquaculture and Fisheries Elective Paper - III)**
**Aquaculture Practices**

**Unit 1:**

**A. Introduction:**

Scope and principles of aquaculture, History of aquaculture, Importance of aquaculture.

**B. Classification of Aquaculture:**

Mariculture (Salmon, Eel, Sturgeon, Milkfish), Carp culture (Indian major carps, common carps, and Chinese carps), Brackish water culture

**Unit 2:**

**A. Fish Culture Practices: Aquaculture Management:**

Monoculture and composite culture, Hatchery management: types of hatcheries, Pond management and fertilization; pre and post stocking management, induced breeding with special reference to Indian major carps.

**B. Fertilization and Artificial Feeding in Aquaculture:**

Need for fertilizing fish pond, Fertilizers (organic, inorganic and bio-fertilizers), Artificial fish feeds and their formulation, Balanced fish feeds and their preparation.

**C. Aquatic Weeds and Their Control:**

Introduction, position of aquatic weeds in fishery ponds, classification of aquatic weeds, aquatic weeds control measure, importance of aquatic weeds.

**Unit 3:**

**A. Prawn Culture**

Species of prawns,habit and habitat, food and feeding, types of prawn fishery, culture of freshwater prawn, culture of marine prawn, preservation and processing of prawns, pollutional impact on prawn fishery, environmental issues of prawn culture, fate of prawn culture.

**B. Culture of Planktons:**

Definition, occurrence, types of planktons, significance of planktons, culture of planktons.

**Unit 4:**

**A Culture of Marine Molluscs (Mariculture):**

Production of marine molluscs through aquaculture, Species of edible molluscs, Culture of oyster and mussels, Techniques of natural seed collection and breeding under controlled conditions, Different methods of culture – bottom culture, raft culture, long line culture.

**B Pearl oysters**

Species involved, methods of seed collection, techniques of pearl culture, Prospectus in India.

**Suggested reading material:**

1 Fishery Science:  W.C. Royce.

2. Ecology, Utilization and Management of marine fisheries; G.A.Rounsefell.

3. Fisheries development of India: U.K. Shrivastava and M. Dharma Reddy.

4. Aquaculture research needs for 2000 AD: Jaw. Kai. Wang and P. V. Dehadari.

5. Fish farming hand book: E.E. Brown and J.B. Gratzek.

6. Fresh water biology: K.F. Lagler.

7. Fish and Fisheries of India: V.G. Jhingran.

8. Advances in aquaculture: T.V.R. pillay.

9. Fishes an introduction to ichthyology: P.B. Moyle and J.J. Cech.

10. Fishery management: S.C. Agarwal.

11. Applied fishery science (Vol. I & II): S.M. Shafi.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-II Sem.-IV**
**Cell Biology Elective Paper- III**

**Paper – XV: Cell In Differentiation, Development & specialization**

**Unit I: Differentiated cells and maintenance of tissues:**

1. Differentiated State
2. Tissues with Permanent cells (Eye lens, photoreceptor cells of retina)
3. Renewal of Cells by Mitosis (Liver cell, endothelial cells)
4. Renewal of Cells by Stem cells (Skin epithelium, intestinal epithelium)
5. Renewal of cells by pluripotent stem cells (Blood cell formation).

**Unit II: Cell Differentiation**

1. General Characteristics of Cell Differentiation

2. Molecular Mechanisms of Cell Differentiation, Chromatin and DNA methylation

3. Localization of Cytoplasmic Determinant in Eggs: Role of maternal contributions in early embryonic development; Neucleocytoplasmic Interactions
4. Genetic regulation of early embryonic development in Drosophila, Homeotic genes.

**Unit III:**

**1. Muscle as a cell and contraction unit:**

a. Genesis, modulation and regeneration of skeletal muscle.
b. Fibroblasts and their transformations- The connective tissue cell family.
c. Bone remodeling.

**2. Mammalian neurons:**

a. Neurons: Building Blocks of the nervous system
b. Voltage-gated Ion Channels and the propagation of action potential in nerve cells
c. Communication at synapses

**Unit IV**

**1. Pancreatic Cells**

a. Acinar Cells
b. Islets of Langerhans
c. Ductal Cells

**2. Pituitary Cell Type**

**3. Neurosecretary Cells**

**4. Corneal Endothelial cells**

**5. Hepatoparenchymal cells**

**Reference:**


1. Cell & Molecular Biology by Gerald Karp (2005) published by John Wiley & sons.
2. Molecular cell biology by Lodish, Berk, Matsudaira, Kaiser, Krieger (2004) published by W. H. Freeman & company, New York.
3. The Cell by Bruce Alberts, published by Garland publishing Inc. New York & London
4. Developmental Biology By Gilbert
5. Cell & Molecular Biology by E.D.P. De Robertis


**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M. Sc. II, Semester – IV Paper - XVI**
**(Aquaculture and Fisheries Special Paper- IV)**
**Fishery Technology**

**Unit 1:**

**Fishing Technology:**

Conventional fishing methods: types of crafts and gears, Unconventional fishing methods, Modern methods of fishing, Rules and regulations for fishing operations and safety at sea.

**Unit 2:**

**A. Techniques of Breeding Food Fishes:**

Breeding habits of food fishes, Environmental control of reproductive cycles, Induced breeding – breeding techniques of Indian major carps, Chinese carps, and Fecundity studies of these fishes.

**B. Packing of fish and fishery products:**

Food packing, its purpose and procedures, technological aspects of packing fishery products, packing of fresh and frozen fish, packaging for transport, shipping and institutional supplies, packing standards for domestic and international trade

**Unit 3:**

**Biotechnology in Aquaculture:**

Prospects of aquaculture biotechnology, Biotechnological tools in diagnosis of diseases in aquaculture, Application of hybridism technology in aquaculture, Cryopreservation technology in fishes, Application of biotechnology in health management in aquaculture

**Unit 4:**

**Post Harvest Technology:**

Reasons for spoilage of fishes, methods for fish preservation, refrigeration, deep freezing, freeze drying, salting, smoking, drying, canning, demerits of fish preservation, fish by products, HACCP for fish processing industry.

**Suggested reading material:**


1 Fishery Science: W.C. Royce.

2. Ecology, Utilization and Management of marine fisheries; G.A.Rounsefell.

3. Fisheries development of India: U.K. Shrivastava and M. Dharma Reddy.

4. Aquaculture research needs for 2000 AD: Jaw. Kai. Wang and P. V. Dehadari.

5. Fish farming hand book: E.E. Brown and J.B. Gratzek.

6. Fresh water biology: K.F. Lagler.

7. Fish and Fisheries of India: V.G. Jhingran.

8. Advances in aquaculture: T.V.R. pillay.

9. Fishes an introduction to ichthyology: P.B. Moyle and J.J. Cech.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-II Sem.-IV**
**Physiology**
**Paper- XVI Clinical Physiology (Elective Paper- IV)**

**Unit I- Disorders and diseases of Endocrine glands (physiological basis, histopathology and biochemistry)**

1.1.Pitutory glands

1.2.Thyroid glands

1.3.Parathyroid glands

1.4.Endocrine pancreases.

1.5.Adrenal gland and Kidney

1.6.Disorders of Testis, Overies

**Unit II- Disorders and diseases of Special senses ((physiological basis, histopathology and biochemistry)**

2.1. Hearing defects

2.2. Occular defects

2.3. Hyperthermia and Hypothermia.

2.4. Defects in Chemoreception.

2.5. Aging and defects in special sense.

**Unit III - Disorders of Blood and immunity ((physiological basis, histopathology and biochemistry)**

3.1. Different causes of Anemia.

3.2. Genetic blood disorders

3.3. Polycythemia and Leukemia

3.4. Types of immunity and its mechanisms

3.5. Hypo and Hypersensitivity mechanism

**Unit VI – Physiology of Carcinoma ((physiological basis, histopathology and biochemistry)**

4.1. Introduction and mechanism of different types of carcinoma

4.2. Carcinoma of digestive tract and associated glands

4.3. Brain tumor

4.4. Brest cancer

4.5. Malignancy of Gonadal cells

4.6. Altered biomechanics in cancer cells.

4.7. Skin cancer

**References:**

Human Physiology – by A.C. Guyton. Saunders Company Londan, Toronto.

Shepherd G.M. Neuro Biology, New York Oxford University Press 1987.

Hurst J.W et al (eds) The Heart7th ed. New York McGraw- Hill Book Co. 1990.

Brenner B.M. & Rector, F.C. (Jr) 1986. The kidney 3rd ed. Philadelphia, W.B. Saunders Co., 1986.

Brooks V.B. 1986. The neural Basis of motor control New York, Oxford University Press.

Johnson L.R. et al Physiology of the gastrointestind tract 1987 New York Raven press.

Thampson J.C. et al (eds) Gastrointestinal Endocrinology. New York McGraw Hill book co., 1987.

Setchell K.D.R. et al eds 1988. The Bile Acids New York Plenum Pub. Corp.

Guthrie H.A. 1988. Introductory Hutrition 7th ed. St.Lonis C.V. Mosby Co.,

Felig P et al (eds) 1987. Endocrinology & Metabolism New Your MacGraw- Hill Book Co.,

DeGroot L.J. et al 1989. Endocrinology 2nd ed. Philadelphia, W.B. saunders Co. 1989.

Kannan, C.R. 1988. The adrenal gland New York Plenum Pub. Corp.

Wozney J.M. et al 1988. Novel regulators of bone formation: Molecular clones & cultivates science 242: 1528.

Martin R.B. & Burr D.B. 1989. Structure, function & adaptation of compact Bone New York, Raven Press 1989.

Knobil E. et al (eds) The physiology of Reproduction New York, Raven Press 1988.

Leung P.C.K. et al (eds) Endocrinology & Physiology of reproduction New

York Plenum Pub. Corp. 1987.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-II Sem.-IV**
**(Entomology special paper-IV)**
**Paper – XVI: PEST MANAGEMENT CONCEPTS**

**Unit –I:**

1. Natural control of Insect Pests: Biotic and Abiotic Factors.

2. Cultural, Mechanical, Physical and Legal control of Insect Pests.

3. The role of Antifeedent, Attractants, Repellents and

Chemosterillants in Pest Management.

**Unit –II:**

**4. Biological Pest Control:**

Definition, history, methods, biocontrol agents, aspects of biocontrol, organizations, Biocontrol programs in India.

**5. Microbial Control:**

Definition, Pathogens used in microbial control (Fungi, Bacteria,

Viruses, Protozoans, Nematodes etc.) Toxins produced and mode

of action and application.

**Unit –III:**

**6. Genetic Control:** Defination, methods and application.

**7.** The role of Hormonal and Radiational Control in Pest Management.

**8. Behavioral Control:**

Pheromones – mode of action and applications.

**Unit –IV:**

**9. Chemical Control:**

Plant origin and synthetic (organic and inorganic) insecticides, chemistry, mode of action and applications.

**10. Integrated Pest Management:**

Definition, logic and necessity of IPM, Tools of IPM, Kinds of

pests.

**11. Recent Advances in Pest management**

**Suggested Reading Material:**

1. Agricultural Pests of India and South East Asia – A.S. Atwal, 1986.

2. A textbook of applied Entomology, Vol. II-.K.P. Shrivastava.

3. Genetic control of insect pests- G.Davidson.

4. Biological Pest Suppression – Copell & Martins, 1977.

5. Agrochemicals and Pest Management – T.V. Sathe 2003.

6. Biological Pest Control – T.V. Sathe, P.M.Bhoje, 2000

7. Insect sex pheromones – Martin.

8. Pest Management: Ecological concepts – T.V. Sathe and Jyoti Oulkar, 2010.

9. Vermiculture and Organic Farming – T.V. Sathe, 2004.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M. Sc. II, Semester – IV**

**Paper – XVI: Cell Pathology**

Unit I: **Cell in stress and death**

1. Different types of stressful conditions on cell and cell response
2. Cell death and its regulation: Apoptosis-molecular mechanism and regulation
3. Cell organelles during cell degeneration/necrosis

Unit II: **Cancer Biology**

1. Tumor cells and onset of caner
2. The genetic basis of cancer
3. Oncogenic mutations in growth promoting protiens
4. Mutations causing loss of growth inhibiting and cell-cycle controls
5. Carcinogens and caretaker genes

Unit III: **Ageing**

1. Mechanism of ageing (Theories of ageing)
2. Cellular changes during ageing
3. Molecular changes during ageing
4. Immunological changes during ageing
5. Accumulation of toxins and chemical garbage, formation of lipofuschin granules
6. Ageing and cell cycle
7. Strategies against ageing

Unit IV:

A. **Effects of inhibitors:**

1. DNA synthesis (Mitomycin)
2. RNA synthesis (Actinomycin and Rafampicin).
3. Protein synthesis (Cyclohexamide, Tetracyclins, Chloramphenicol, streptomycins).
4. Mitochondrial metabolism (CN, CO, Actinomycin –A, Azide etc.)

**B. Animal viruses:**

1. RNA viruses – Polio (+ strand RNA), VSV (-RNA), influenza (segmented RNA),
2. DNA virus (SV40-ds DNA with circular genome), adenovirus (linear ds DNA genome), parvo virus (ssDNA virus),

**References:**


1. Cell & Molecular Biology by Gerald Karp (2005) published by John Wiley& sons.
2. Molecular cell biology by Lodish, Berk, Matsudaira, Kaiser, Krieger (2004) published by W. H. Freeman & company, New York.
3. The Cell by Bruce Alberts, published by Garland publishing Inc. New York & London.
4. Laboratory Investigation –Vol.14, 1965,.
5. Inhibitors of nucleic acid synthesis by Kersen & Kersen.
6. Inhibitors of Protein Synthesis FBII publication.
7. Metabolic Inhibitors Vol. I –IV.
8. Molecular Biology of gene by James Watson


**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-II Sem.-IV**
**Practical – VII**
**Practical based on Paper – XIII & XIV**

1. Preparation of glassware for cell culture. Preparation of cells that do not need enzyme digestion ( RBC, Spleen lymph nodes, B.M.)

2. Isolation of cells by enzyme digestion

3. Separation of cells by suitable methods

4. Viable cell count (Tyypan Blue)

5. Primary cell culture and its maintenance

6. Measurements of growth parameters- DNA

7. Cell cycle analysis – mitotic cells.

8. Karyotype studies- Bone marrow peritoneal macrophages.

9. Evaluation of acute toxicity by using static renewal bioassay test ( In fish / Insect).

10. Determination of LC50 of toxicant in fish / stored grain pest by employing probit analysis.

11. Effect of toxicant (sublethal dose) on fish gill and alimentarytract in fish and in insect on alimentary canal haemolymph (Mulberry silkworm)

12. Detection of heavy metal from animal issue by AAS (Lead/cadmium/chbromium).

13. Detection of pesticide by TLC method from water sample (organochlorine/ organophosphate).

14. Paw edema test.

15. Granulometa – Quantification by weight and differential cell count.

16. Spleenectomy.

17. Study of spleen replica for germinal centers.

18. Separation of immunoglobulin by Electrophoresis.

19. Immuno diffusion technique of agar gel diffusion.

21. RBC rosette technique.

22. Harem agglutination inhibition test.

23. Blood group analysis.

24. Histology of lymphoid organs spleen, thymus, lymph node & Bone marrow.

25. Any other practical / experiments set by the Department.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-II Sem.-IV**
**Practical – VIII**
**Physiology**
**Practical-I Physiology of Health & Clinical Physiology**

1) Study of blood indices.
2) Effect of toxicant / drug to the digestive/ reproductive cell/ glands (Histology and Histochemistry).
3) Qualitative test of Carbohydrate, Protein and fatty acids.
4) Determination of Oxygen Consumption in fish.
5) Effect of pH on Amylase activity.
6) Study of Electrocardiogram (ECG).
7) Study of Arterial blood pressure (BP).
8) Effect of Insulin on blood sugar level.
9) Effect of Adrenalin on blood sugar level.
10) Study of colour index from blood sample by using haemocytometer.
11) To study effect of temperature on enzyme activity
12) Effect of temperature on heart beat.
13) Demonstration of role of brain hormones in developmental stage.
14) Determination of Calcium in given sample of blood plasma.
15) Separation of serum proteins by Electrophoresis.
16) Estimation of blood Cholesterol.
17) Tracheacotomy in rat
18) Pancreactomy in rat

19) To study pathophysiology of muscle fiber – smooth, skeletal and cardiac muscle (Histology and Histochemistry).

20) Detection of reducing substances in urine using Chromatography.

21) Histochemical detection of uric acid crystals by using $AgNO_3$ Formalin method.
22) Study of Endocrine disorders
23) Any other practical set by concern teacher.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-II Sem.-IV**
**Practical – VIII (based on Paper – XV & XVI)**
**Cell Biology Practical- II**

Motosis in rat bone marrowe.

Meiosis in rat & grass-hopper testis.

Meiotic non-disjunction in human (Identification based on pictures.)

Dorsal nerve root development in chick embryo (Colchicines treatment & observation of cells by fulguen technique).

Eye lenses differentiation in chick embryo.

Nervous system development in chick embryo.

Study of Angiogenesis in chick embryo.

Demonstration of stem cells renewing by mitosis (liver cells Intestinal crypt cells. Bone marrone cells – demonstration of cell division by fulguen technique).

Demonstration of neurons in cerebral cortex of rat.

Demonstration of pituitary cells.

Demonstration of pancreatic islet cells (L, B, Cell types).

Demonstrations of muscle striations (PAS method, phase contrast method) smooth muscle cells observations.

Demonstration of austochardria in striated & smooth muscle cells (Phase contrast & Janus green B staining).

In vitro cell degeneration of liver (histology – nuclear (E+H, Fulguen) alterations lysosmaloby acid phosphatase alterations in rat).

In vivo cell degeneration – of kidney by Induced ischemia (histology, nuclear alterations – E+H, fulguen).

Age related lipid peroxidation in various organs of rat / mouse.

Demonstration of lipofuschin granules in brain of aged (natural & induced) rat / mouse.

Drug induced lipid peroxidation in liver & kidney (CCl4 / any suitable drug).

Any other practical / experiments set by the Department.

Project work / Review article.

**M.Sc. Zoology**

**M.Sc. Zoology**

**Academic Flexibility, Credit System**

**M.Sc.-II Sem.-IV**

**Practical – VIII**

**(Practical based on paper – XV & XVI)**

**Entomology special practical**

1. Dissection of following organ systems of any pest insects.
    1. Digestive system.
    2. Nervous system.
    3. Reproductive system.
2. Histology of digestive system, Neuroendocrine system & reproductive system.
3. Study of haemocyte types & their total haemocyte count.

4. Demonstration of chitin by using chitosan test.

5. Uptake of dyes by the malpighian tubules.

6. Chromatographic analysis of amino acids in insect hoemolymph.

7. Estimation of digestive enzymes Amylase / Invertase / Trehalase.

8. Collection and preservation of insect pests.

9. Collection and preservation of Biological pest control agents.

10. Study of insecticide appliances.

11. Insect pest damage detection.

12. Identification and economic importance of parasitoids (Biocontrol agents).

13. Identification and economic importance of insect predators.

14. Identification and economic importance of vertebrate pest biocontrol agents.

15. Field visit for collection and demonstration of pest damage.

16. Study of weed controlling insects.

17. Any practical set by concerned teacher.

18. Project work / Review article.

**M.Sc. Zoology**
**Academic Flexibility, Credit System**
**M.Sc.-II Sem.-IV**
**Practical – VIII**
**(Practical based on paper – XV & XVI)**

**Practical based on Aquaculture and Fisheries**

1 Identification of fishes, prawns and mollusks.

2. Study of different nets, crafts and gears (models/drawings).

3. Estimation of glycogen, protein and lipids from fish tissue.

4. Study of fish products and by-products.

5. Identification and control measures of aquatic weeds and insects

6. Assessment of pollutants from farm water – heavy metals and pesticides

7. Estimation of primary productivity of water sample by light and dark bottle experiment.

8. Qualitative and quantitative study of zooplanktons.

9. Method of fish preservation and canning.

10. Project report / Review article.

11. Any other experiment set by the concerned teacher.

**MSc Zoology**
**Academic Flexibility, CBC System**
**MSc I Semester I**
**CBC Paper I: Insect Biotechnology**

**Unit I**

i. Mulberry silk technology- importance, Technology, Application, Economics and marketing, rearing, reeling, marketing

ii. Eri Silk Technology- Rearing, Reeling, Marketing

iii. Tasar silk Technology- Rearing, Reeling, Marketing

**Unit II**

**Bee keeping:** importance, technology, application, economics and marketing

i. Honey technology

ii. Wax technology

iii. Pollination and crop yield technology

**Unit III**

**Lac culture:** importance, technology, application, economics and marketing. History, lifecycle of lac insect, cultivation practices of host plants, extraction and uses of lac, pest and diseases of lac insects and marketing.

**Unit IV**

**Biocontrol agents production technology:** importance, technology, application, economics and marketing.

i. Parasitoids: *Trichogramma, Meteorus, Nexolyx, Chilonus blackburni*

ii. Predators: *Cryptolaemus montrouizieri, Crysoperla carnea*

iii. Viruses NPV

**Insect food technology**

i. Insect types

ii. Insect dishes

iii. Cooking technology

iv. Economics and Marketing

**Suggested reading**


1. A text book of applied entomology vol 2 KP Srivastava
2. Elements of Entomology Rajendra Singh
3. Vermiculture and organic farming TV Sathe
4. Sericulture and pest management: TV Sathe
5. Sericultural crop protection TV Sathe
6. Agricultural pest of India and South East Asia AS Atwal
7. Crickets and Household pests: TV Sathe amd MR Awate
8. Beekeeping in tropics: GS Smit
9. Beekiping in India S Singh
10. A handbook of practical sericulture Ullal and Narsimhanna
11. Lac culture in India Krishnaswami

**MSc Zoology**
**Academic Flexibility, CBC System**
**MSc I Semester I**
**CBC Paper II Animal Biotechnology**

**Unit I**

Vermiculture and vermiwash technology: importance, technology, application, economics and marketing

**Vermiculture:** earthworm diversity, Vermiculture technology, applications, economics and marketing

**Vermiwash:** vermiwash technology, application, economics and marketing

**Unit II**

**Poultry and ostrich farming:** importance, technology, application, economics and marketing

i. Poultry farming

ii. Ostrich farming

**Unit III**

**Doggery:** importance, technology, application, economics and marketing

**Ornamental fisheries:** importance, technology, application, economics and marketing

**Unit IV**

**Crab culture:** importance, technology, application, economics and marketing

**Prawn culture:** importance, technology, application, economics and marketing

**Pearl culture technology:** importance, technology, application, economics and marketing

**Suggested reading: as suggested by concern teacher**