

M.Sc. Zoology, Semester – III
Paper I - Systems Biology

Unit I – Introduction to Systems Biology 15 hours

- 1.1 History, concept, prospects and applications of systems biology.
- 1.2 Molecules to Organisms – Biomolecules, cell, tissue, organ and organisms.
- 1.3 Basic concepts of systems approach to biology.
- 1.4 Basic concepts of models and modeling, model behavior, classification.
- 1.5 Basic concepts of networks; types of networks.

Unit II – Systems approach 15 hour

- 2.1 Mammalian biological clocks, neuronal and humeral network mechanism.
- 2.2 Biochemical networks and metabolic cycles – Kreb's cycle, Electron Transport System.
- 2.3 Sustainable pest and disease management – quantitative and qualitative models.
- 2.4 Apoptosis - molecular modeling.
- 2.5 Bioremediation - hydrocarbon bioremediation, radionuclide biotransformation, metals bioimmobilization.

Unit III – Predictive modeling 15 hour

- 3.1 Continuous population models for single species.
- 3.2 Insect out break model: Mosquito model.
- 3.3 Predictive ecology, game theory population models, predator-prey model.
- 3.4 Kinetic models of biochemical system – metabolic control analysis.
- 3.5 Data formats, simulation techniques, modeling tools.

Unit IV – Systems biology applications 15 hour

- 4.1 Networks in nervous system: Integrative synaptic mechanism of the neural networks.
- 4.2 Caenorhabditis elegans model system for neurotoxicity.
- 4.3 Endobiogeny: An approach to systems biology, host-parasite interaction.
- 4.4 Evolutionary systems biology; approach to molecular phylogeny.
- 4.5 Nanoparticles in biological systems – application, characterization and interactions.

Practical

Code 301

1. Live cell imaging.
2. Estimation of predator-prey relationship using larvivorous fish.
3. Temperature dependent enzymatic activity in metabolites.
4. In silico phylogenetic analysis.
5. Plant-mediated synthesis of silver nanoparticles.
6. Neurotransmitters – defined systems.
7. Estimation of parasitic load in infected fish/ chicken.
8. Bioassay of neurotoxicity.
9. Estimation of population growth under different environmental conditions.

10. Protein expression profiling using 2D electrophoresis.

Suggested Books

1. An Introduction to Systems Biology: Design Principles of Biological Circuits By Uri Alon.
2. Systems biology: A Text Book by Edda Klipp.
3. Mathematical Biology: An Introduction by Murray J.
4. An Introduction to Mathematical Biology by Linda J.S. Allen.
5. Introduction to Systems Biology by Sangdun Choi.
6. Life: An Introduction to Complex Systems Biology, by Kaneko Kunihiko.
7. Systems biology, by Robert A. Meyer.
8. Systems biology: Principles methods and concepts by A. K. Konopka.
9. Systems biology: The challenges of complexity by Shigetada Nakashini.

M.Sc. Zoology Semester III
Paper - II: Research Methodology

Unit – I: Research, experimental and sampling design

- 1.1. Research – basic and applied research, essential steps in research.
- 1.2. Research – definition, importance and application.
- 1.3. General methods in biological research – natural observation, field study, and experimentations.
- 1.4. Experimental design – basic principles, hypothesis, one & two group experimental design. matched pair data analysis, factorial design, randomized block design.
- 1.5. Sampling method - Concept of population, random sampling and non random sampling, variables – random, independent and intervening variables.

Unit – II: Collection, analysis and interpretation of data.

- 2.1 Data collections: methods for primary data- observation, interview, questionnaire methods, and experiments.
- 2.2 Methods for secondary data – scientific journals, books, reports, databases.
- 2.3 Representation of data – tabular representations of quantitative data, frequency table – one way and two way.
- 2.4 Graphical representation of quantitative data – line graph, histogram, frequency polygon, frequency curve, Ogive, bar diagrams and pie diagrams.
- 2.5 Analysis of data – Tools of statistics and software applications.

Unit – III: Use of inferential statistical tools in research

- 3.1 Use of different statistical estimations depending on the type of data, hypothesis testing, and test of significance.
- 3.2 Student's 't' test – applications and importance in research data.
- 3.3 Application of Chi-square test for the experimental data.
- 3.4 Use of ANOVA – (one-way and two-way ANOVA) for the research data analysis.
- 3.5 Application of correlation and regression analysis for the data.

Unit – IV: Reporting research

- 4.1 Literature collection – Need, review process, consulting source material, literature citation; Components of research report – Text, tables, figures, bibliography.
- 4.2 Writing of dissertations, project proposals, project reports, research papers.
- 4.3 Intellectual Property Rights – Biopiracy, copyrights, patent and traditional knowledge and plagiarism.
- 4.4 Laboratory safety – Biohazardous agents, biosafety levels, lab acquired infections, other hazards; Laboratory good practices.
- 4.5 Animal model systems; animal ethics- animal welfare guidelines for care and use of animals.

PRACTICAL

1. Preparation of charts (histograms, frequency graphs, scatter plots, pie charts).
2. Calculation of Mean and Standard Deviation and preparation of the graph depicting. mean and standard deviation.

3. Calculation of descriptive statistics of data.
4. Calculation of t-test for paired two samples for means.
5. Calculation of correlation for bivariate data.
6. Calculation of regression for bivariate data.
7. Calculation of one-factor ANOVA.
8. Calculation of two-factor ANOVA .
9. Literature review using online resources.
10. Preparation and documentation of research publication/dissertation.

Wherever possible, use the computer for the analysis of data by using MS-Excel.

Suggested Books

1. Biostatistics by N. Gurumani
2. Research Methodology by N. Gurumani
3. Research methodology by R C Kothari
4. Research methodology by Ranjith kumar
5. Research methodology by Khan
6. Practical statistics using Microsoft excel by Dibyojyoti Bhattacharjee
7. Next generation excel by I D Gottlieb

M.Sc. Zoology Semester III
Elective I
Paper III - Neuroscience - I [NS-I]

UNIT I – Cellular Neurobiology 15 Hrs

- 1.1 Ultra structure of neuron, axonal transport and its mechanism.
- 1.2 Types of neuronal and glial cells, organization of neurons in brain.
- 1.3 Organization of CNS and PNS.
- 1.4 Over view of functional anatomy of brain and spinal cord.
- 1.5 Neuroanatomical and neuroimaging technique.

UNIT II – Neurophysiology 15 Hrs

- 2.1 Principles and methods of electrophysiological techniques – voltage and patch clamp.
- 2.2 Ion channels and ion pumps.
- 2.3 Types of biopotentials and mechanism; Action potential and propagation cable conduction.
- 2.4 Synaptic transmission, molecular and physiological mechanisms, EPSP and IPSP.
- 2.5 Synaptic receptor – nicotinic and muscuranic Ach receptor.

UNIT III – Molecular Neurobiology 15 Hrs

- 3.1 Neurotransmitters and neuromodulators.
- 3.2 Metabolism and functional significance of neurotransmitters, specific transmitter defined system.
- 3.3 G-protein coupled receptor mechanisms.
- 3.4 Neuroendocrine circuits.
- 3.5 Neuroimmune circuits.

UNIT IV – Cognitive and Behavior Neurobiology 15 Hrs

- 4.1 Biorthym – Sleep and awake; neuronal – humoral mechanisms.
- 4.2 Types of learning and memory; cellular and molecular basis of learning and memory; role of hippocampus and LTP in memory.
- 4.3 Neuronal basis of feeding.
- 4.4 Neuronal basis of emotion.
- 4.5 Cerebral cortex; organization and behavior.

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

- 1 Demonstration of gross anatomical regions of brain.
- 2 Isolation of hippocampus, preparation of AchE, staining, protocol of hippocampal cell culture.
- 3 Identification of different types of neural and glial cells.
- 4 Estimation of acetylcholine in different regions of brain.
- 5 Estimation of acetyl cholinesterase sodium and potassium ATPase activity.
- 6 Electrophysiological demonstration of biopotentials and conduction velocity.
- 7 Determination of maze learning and estimation of proteins in hippocampus.
- 8 Biochemical differentiation of fast and slow muscles – SDH, LDH activities.

9 Induction of stress and estimation of glycogen, lactate, AChE and Na-K ATPase activities.

Suggested Books

- 1 Physiology and biophysics – Ruch and Patten.
- 2 A text book of muscle physiology – D. A. Jones and J. M. Round.
- 3 Neurobiology – Gordon M Sheperd.
- 4 Principles of neural science – E. Kandel and others.
- 5 Essentials of neural science and behaviour – E. Kandel and others.
- 6 Behavioral neuroscience – Cottman.
- 7 From Neuron to Brain – Nichollas, J. G. others.
- 8 Neuroscience – A. Longstaff .
- 9 Elements of molecular Neurobiology – C U M Smith.
- 10 Physiology of excitable cells – D. J. Aidley.
- 11 Text book of medical physiology – Guyton.

M.Sc. Zoology Semester III
Elective I
Paper III - Medical Entomology - I

Unit 1: Overview of Entomology. 15hrs

- 1.1. Significance of Insects to human importance: Reasons why insects are so successful.
- 1.2. Classification of Class Insecta and Arachnida with special emphasis medically important Arthropods.
- 1.3. Insect Morphology: Exoskeleton, Head, thorax, and abdomen.
- 1.4. Insects Physiology: Digestive system, Excretory system, Circulatory system, Reproductive system, Nervous system, and Endocrine system.
- 1.5. Insect Development: Growth & development, Metamorphosis.

Unit 2: Biology of medically important Insects 15hrs

- 2.1. Diptera: Mosquitoes (Anopheles, Aedes, Culex), Housefly, Horsefly, Tsetse fly and Sand fly.
- 2.2. Hemiptera: Bed bugs.
- 2.3. Siphonaptera: Flea.
- 2.4. Siphunculata: Head louse, Body louse and pubic louse.
- 2.5. Dictyoptera: Cockroaches.

Unit 3: Insect Ecology & Behaviour 15hrs

- 3.1. Insects and climate: Temperature, Light, Rainfall, Wind and Influence of Climate change.
- 3.2. Insect population dynamics: Population functions and factors affecting population size.
- 3.3. Climate change and its influence on Malaria in India.
- 3.4. Community ecology: Classes of interaction, factors affecting interaction and consequences of interaction.
- 3.5. Insect behavior: mating, feeding and defensive strategies.

Unit 4: Arthropod-borne diseases and 15hrs

- 4.1. Bacterial diseases - Plague, Rickettsiasis, Bartonellosis.
- 4.2. Viral disease – Dengue, Japanese Encephalitis, Chikungunya, Zika.
- 4.3. Protozoan diseases – Leishmaniasis, Malaria, Trypanosomiasis.
- 4.4. Helminthic diseases – Filariasis (Wuchereria, Brugia, Loa).
- 4.5. Direct injury, Annoyance, Allergies, toxins, myiasis and venomous arthropods.

Practicals:

1. Insect Collection and Preservation methods.
2. Collection of medically important Insects and identification up to genus level.
3. Maintenance and study the stages life cycle of Cockroach / house fly / mosquito.
4. Preparation of permanent mounts of mosquito respiratory siphon and trumpet.
5. Preparation of permanent mounts of Insect leg and antennae.
6. Preparation of permanent mounts of wings of Cockroach / house fly / mosquito.
7. Dissection, mounting and preparation of permanent slides of Insect mouth parts.
8. Dissection of salivary glands of Cockroach / house fly / mosquito.
9. Dissection of Digestive system, nervous system and reproductive system of Cockroach / house fly / mosquito.

10. Dissecting and mounting of male and female genitalia of Cockroach / house fly / mosquito.
11. Collection of venomous Arthropods and identification.
12. **Maintenance of Insect / venomous arthropod collection box. (**Submission of Insect / venomous arthropod collection box is must during the practical examination)

References:

1. Biology of Disease Vectors, 2nd Ed., William C. Marquardt, 2004, Elsevier Academic Press.
2. Medical and Veterinary Entomology, 2nd Ed., Gary Mullen & Lance Durden.
3. Medical Entomology: A Textbook on Public Health and Veterinary Problems Caused by Arthropods, Revised Edition. by Bruce Eldridge & John Edman.
4. Medical Toxicology by Richard C. Dart. Pub: Lippincott Williams & Wilkin.
5. Manual of Medical Entomology by Deane P. Furman & Paul Catts.
6. Infectious Diseases of Arthropods by Goddard.
7. Medical Entomology for Students 5th edition by Mike Service.
8. General and Applied Entomology by David and Ananthakrishnan.
9. Destructive and Useful Insects by R. L. Metcalf.
10. Ecology of Insects by Martin R. Speight Pub: Wiley-Blackwell.
11. Insect ecology by Timothy D. Schowalter 3rd Edition. Pub: Elsevier, 2011.

M.SC. ZOOLOGY – SEMESTER-III
M.Sc. Zoology Semester III
Elective I
Paper III - PARASITOLOGY - I

UNIT-1: Morphology, Anatomy and Classification (15 hours)

- 1.1 An overview and classification of Monogenea, Aspidogastrea, Digenea and Cestoda.
- 1.2 Ultra structure and function of tegument.
- 1.3 Digestive system, feeding and mechanism of digestion.
- 1.4 Excretory system, paranephridial system and lymphatic system.
- 1.5 Nervous system and its mechanism; sense organs and its functions.

UNIT-2: Reproduction, Ecology and Evolution (15 hours)

- 2.1 Reproductive system, egg shell formation, types of eggs, and morphology of larval forms.
- 2.2 Population concept, factors regulating population, dispersion concept.
- 2.3 Origin and evolution of Monogenea, Aspidogastrea, Digenea & Cestoda.
- 2.4 Helminth's host specificity and its breakdown.
- 2.5 Host – parasite interactions and their significance; the role of helminthes as vectors of microbial infection.

UNIT-3: Trematode and Cestode Diseases (15 hours)

- 3.1 Trematode and Cestode parasites of humans; Morphology, life cycle, pathogenicity, diagnosis, treatment, and control measures of *Clonorchis sinensis*, *Fasciolopsis buski*, *Hymenolepis nana* and *Echinococcus granulosus*.
- 3.2 Helminthes of livestock with emphasis on *Fasciola hepatica* and *Moniezia* spp.
- 3.3 Life cycle and pathogenicity of Trematode parasites - *Dactylogyrus* spp. and *Gyrodactylus* spp.
- 3.4 Life cycle and pathogenicity of Cestode parasites - *Diplostomum* spp. *Sanguinicola inermis*.
- 3.5 General account of Trematode and Cestode parasites of wild animals with emphasis on *Dicrocoelium dendriticum* and *Echinococcus multilocularis*.

UNIT -4: Adult metabolism, Anthelmintics and Immunology (15 hours)

- 4.1 Carbohydrate metabolism - Glycolysis (EMP-pathway), CO₂ fixation, PK/PEPCK branch point, malate dismutation; role of TCA cycle, Electron Transport chain - oxidation.
- 4.2 Protein composition and metabolism-Amino acid catabolism, transamination.
- 4.3 Lipid composition and metabolism-fatty acid metabolism and role of β oxidation.
- 4.4 Immunity to schistosomiasis and fascioliasis; evasion of immunity and molecular mimicry.
- 4.5 Role of arthropods and molluscs in spreading of helminth diseases.

PRACTICALS:

1. Collection, fixation, and staining techniques of permanent whole mount preparations and identification of Monogeneans, Digeneans, Aspidogastreans and Cestode (Host Fishes, water snakes, birds, sheep, goat and cattle viscera).
2. *Fasciola* smear preparation, staining and study for eggs & concentration.
3. Collection and examination of infective larvae from intermediate hosts, snails, microcrustaceans (*Cyclops*, *Gammarus* etc., fishes).
4. Effect of light, and temperature on the emergence of cercaria.

5. Estimation of total proteins, carbohydrates and lipids in helminthes.
6. Measurement of infection: Prevalence, density, intensity and index of helminth parasites.

REFERENCE BOOKS:

1. Animal parasitology – J. D. Smyth (Cambridge Univ. Press., 1976).
2. Foundations of parasitology 6 ed. – L. S. Roberts & J. Janovy Jr (McGraw Hill Publ., 2000).
3. Parasitism – A. O. Bush, J.C. Fernandez & J. R. Seed (Cambridge Univ. Press, 2000).
4. Helminthology – Eds. N. Chaudhury & I. Tada (Narosa Publ. House, 1994).
5. Helminthes, Arthropods, & Protozoa of domesticated animals 6 ed. – E.J.L Soulsby (ELBS, 1976).
6. Introduction to parasitology – B.E. Matthews (Cambridge Univ. Press. 1998).
7. The physiology of Trematodes – J.D. Smyth & D. W. Halton (Cambridge Univ. Press, 1983).
8. The physiology and Biochemistry of Cestodes – J.D. Smyth & D.P. MEmanus, (Cambridge Univ. Press, 1989).
9. T.B.Fish Diseases – (Tr.) – D.A. Convoy & R.L. Herman (narendra Publ. House, 1997).
10. Hand book of Medical Parasitology – V. Zaman & L. H. Keong (K.C. Ang publishing Pvt. Ltd., 1989).
11. T.B. Medical parasitology – P. Chakraborty (New Central Book Agency, 2004).
12. Ecological Animal Parasitology – C. R. Kennedy (Black well Scientific Publ., 1975).
13. Infectious Diseases of fish – S. Egusa (Oxonian Pvt. Ltd., New Delhi, 1978).
14. A.T.B. of Parasitology 2 ed. – S. S. Kekar & R.S. Kelkar (Bomby popular Prakshan, 1993) .

M.SC. ZOOLOGY – SEMESTER-III
M.Sc. Zoology Semester III
Elective I
Paper III - Comparative Animal Physiology - I

UNIT I – Comparative Aspects of Digestion and Nutrition 15 Hrs

- 1.1 Scope, principles and validity of comparative approach to physiology.
- 1.2 Origin of nutritive types - special dietary requirements of some animals, amino acid requirements, and essential vitamins.
- 1.3 Mechanisms of food intake and feeding mechanisms, comparative physiology of digestive enzymes and regulatory mechanism of digestion.
- 1.4 Coordination of digestive activities - visceral autonomic system and gastro intestinal hormones.
- 1.5 Comparative aspects of carbohydrate pathways - Glycolysis and gluconeogenesis pathways and regulation.

UNIT II – Comparative Aspects of Respiration 15 Hrs

- 2.1 Availability of oxygen, uptake of oxygen and factors that influence uptake.
- 2.2 Oxygen consumption by intact animal, modifying agents.
- 2.3 Adaptations to diving and high altitudes.
- 2.4 Comparative aspects of transport of oxygen and carbon dioxide; regulation of respiration.
- 2.5 Respiratory pigments in different phylogenetic groups, genes with reference to hemoglobin.

UNIT III – Osmoregulation, Excretion and Thermoregulation 15 Hrs

- 3.1 Problem of osmoregulation and biological responses in different environments.
- 3.2 Comparative aspect of osmoregulation in different animal groups.
- 3.3 Excretory organs and general mechanisms of excretion in various animal groups.
- 3.4 Freezing, winter hardening, lethal limits and resistance adaptation; behavioral and locomotory adaptations; heat regulation - physical and chemical.
- 3.5 Temperature regulation in homeotherms; neural mechanism of thermoregulation.

UNIT IV – Deranged metabolism and disorders 15 Hrs

- 4.1 Effects of colonic bacterial flora (beneficial and harmful effect); lactose intolerance, GERD.
- 4.2 Liver cirrhosis and its causative agents; fatty liver.
- 4.3 Chronic obstructive pulmonary disease – Asthma, sleep apnea, and snoring.
- 4.4 Electrolyte imbalance - Acidosis, alkalosis; Dialysis.
- 4.5 Heat stroke; thirst and its physiological mechanism.

PRACTICAL

- 1 Estimation of levels of lactic acid and free amino acids levels.
- 2 Effect of Heterosmotic media on blood chlorides in any one animal- crustacean/fish.
- 3 Effect of acclimatization to hetero osmotic media on SDH, LDH in gills and muscle tissue of crustacean/fish.
- 4 Effect of starvation on glycogen levels in fish/crab.

- 5 Effect of starvation on free amino acids in liver and muscles of fish/crab.
- 6 Starvation induced changes in aminotransferases in fish/crab.
- 7 Starvation induced changes in excretory products in fish.
- 8 Acclimatization to cold and high temp in fish/crab and its effect on oxygen consumption.
- 9 Effect of thyroid and anti thyroid agents on oxygen consumption in fish.

Suggested Books

1. Comp. Animal Physiology by Ladd Prosser (Publ. W. B. Saunders, Philadelphia).
2. Comp. Animal Physiology by William Hoar. (Pub. E.E.E. IBH).
3. Animal Physiology – Adaption and function By F. Reed Hainswoth (Publ. by Addison – Wesley Publ. Company, Calofornia).
4. Animal Physiology by Kent Schmidt Nielson (Publ. E.E.E. IBH).
5. Animal Physiology and adaptation by David Gordon.
6. Animal Physiology by Wilson.
7. Concise Medicalphysiology by Sujit K. Chaudari.
8. Text book of medical physiology by Arthur Guyton.

M.SC. ZOOLOGY – SEMESTER-III
M.Sc. Zoology Semester III
Elective I
Paper III - Fisheries - I

UNIT I – Introduction to Fisheries 15 Hrs

- 1.1 History of fisheries, perspectives and prospects of Indian fisheries.
- 1.2 General account of systematic classification of fishes.
- 1.3 Classification of fisheries.
- 1.4 Fisheries resources and management.
- 1.5 Fishery economics.

UNIT II – Ecology of Water Bodies 15 Hrs

- 2.1 Ecology of lentic and lotic ecosystems.
- 2.2 Ecosystem energetic, trophodynamics and ecological productivity.
- 2.3 Physico-chemical characteristics of freshwater, brackishwater and Marine water.
- 2.4 Dynamics of fish population- fecundity, recruitment and harvesting.
- 2.5 Aquatic pollution and its impact on fisheries, eutrophication.

UNIT III – Biology of Cultivable Organisms and Culture Systems 15 Hrs

- 3.1 Criteria for selection of fish species for culture.
- 3.2 Biology of Indian and exotic major carps.
- 3.3 Biology of cultivable prawns and crabs.
- 3.4 Biology of cultivable mollusks, oysters and echinoderms.
- 3.5 Culture systems of fishes, prawns and crabs: open, closed, semi intensive and intensive.

UNIT IV – Fishing Crafts, Gears and Fish Biotechnology 15 Hrs

- 4.1 Fishing Crafts – Non-mechanized and mechanized vessels and maintenance of boats.
- 4.2 Fishing Gears – Gear material, gear making, accessories; types of gear and their preservation.
- 4.3 Cryopreservation; transgenic fish; fish genomics – chromosomal mapping, inbreeding genetic markers.
- 4.4 Sex reversal; monosex culture; hybridization.
- 4.5 Fish processing and preservation; fish by-products and value added products.

PRACTICAL

- 1 Water analysis- pH, dissolved oxygen, total alkalinity, salinity, calcium, magnesium, nitrates, nitrites, phosphates, total dissolved solids, suspended solids, turbidity.
- 2 Soil analysis – pH, total alkalinity, electric conductivity, C/N ratio.
- 3 Identification of fishing crafts and gear models.
- 4 Fabrication of nets.

Suggested Books

- 1 Water quality criteria for fresh water fish. Albastor, J. S. and Lloyd, R. Butterworth Scientific.
- 2 Fish and Fisheries of India – Jhingran, V. G. Hindustan Publishing Corporation New Delhi.
- 3 The fishes of India – Francis. Day. Vol. I &II, New Delhi – CSIR.
- 4 The freshwater fishes of Indian Region – Jayaram, KC. Narendra Publishing house, New Delhi.
- 5 Prawns and prawn fisheries – Kurian, C.V. and Sebastian, V. O. Hindustan Publishing Corporation, New Delhi.
- 6 A manual of freshwater aquaculture – Santhanam, R. Sukllnaran. N. Natarajan Oxford and IBH Publishing Company, New Delhi.
- 7 Freshwater aquaculture – Rath, R. K. Scientific Publishers, Jodhpur.
- 8 Text book of fish culture, breeding and cultivation of fish – MareelHuet, Fishing News Books.
- 9 Aquaculture development, processes and prospects – TVR Pillaay Fishing news books.
- 10 Aquaculture – John, E. Bardach, John H. Ryther, W.O. Mclamey, John Willey and Sons, New York.
- 11 Fish Ecology – RJ. Wotton, Dalckie, Chapman and Hall, New York.
- 12 Environmental stress and fish diseases – Wedemeye, G. A. Narendra. Publishing House.
- 13 Diseases of fishes – C. Vandujn, Narendra Publishing House, New Delhi.
- 14 Aquaculture Principles and Practices by T. V. R. Pillay.

M.Sc. Zoology Semester - III
Elective II
Paper IV - Applied Toxicology

UNIT I – Principles of Toxicology	15 Hrs
1.1	Definition, scope and importance of toxicology; classification of toxic agents - natural toxins, animal toxins, plant toxins, food toxins, genetic poisons and chemical toxins.
1.2	Dose, dose effect and dose response relationship – Acute toxicity, chronic toxicity; toxic kinetics.
1.3	Factors affecting toxicity - species and strains, age, sex, nutritional status, hormone, environmental factors.
1.4	Absorption and distribution of toxicants, portals of entry – Skin, gastrointestinal tract and respiratory system.
1.5	Bio-accumulation, bio-magnification, bio-transformation and elimination of xenobiotics.
UNIT II – Biochemical toxicology	15 Hrs
2.1	Mechanism and reactions of toxicants - Covalent bonding, non-covalent bonding and enzymatic reactions.
2.2	Lipid peroxidation – Reactive Oxygen Species (ROS) and Reactive Nitrogen Species (RNS); Mechanism of Reactive Oxygen Species production; Superoxide, hydrogen peroxide and hydroxyl radicals in toxicity of xenobiotics.
2.3	Oxidative Stress – Consequences of oxidative stress; protein and DNA damage.
2.4	Antioxidant defense mechanism – Role of glutathione, superoxide dismutase, metallothionein.
2.5	Xenobiotic induced intracellular and cellular alterations.
UNIT – III: Systemic toxicology	15 Hrs
3.1	Basics of organ toxicity - Target organs, organ selectivity and specificity.
3.2	Hepatotoxicity - susceptibility of the liver; Types of liver injury and biochemical mechanism.
3.3	Pulmonary toxicity – Lung injury, systematic lung toxins, lung pathology.
3.4	Renal toxicity – susceptibility of the kidney to toxicants; Chemical induced renal injury.
3.5	Neuro toxicity – Effect of toxic agents on neurons, ion channel neurotoxins; Lesions of neural tissue.
Unit – IV: Environmental and Occupational Toxicology	15 Hrs
4.1	Eco-toxicology of heavy metals – Mechanism of heavy metal toxicity; Case studies of Arsenic, Mercury and Cadmium.
4.2	Environmental problems by organochlorine and organophosphate pesticides; case studies of DDT, endosulphan, parathion and malathion.
4.3	Occupational hazards - physical, chemical, biological and mechanical hazards. Occupational diseases: Pneumoconiosis, silicosis, asbestosis; Prevention of occupational diseases.
4.4	Carcinogenesis – Carcinogen types, mechanisms of carcinogenesis; Skin cancer, lung cancer and leukemia.
4.5	Legislation and Regulation – Federal government, State government; Legislation and regulation in other countries.

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

- 1 Determination of LC50/LD50 of selected toxicant (bioassay method).
- 2 Determination of LPO activity by TBRAS method.
- 3 Effect of toxicant on glycogen, glucose and amino acids.
- 4 Hepato-toxicant effect on Total Bilirubin Content (direct and indirect method).
- 5 Estimation of SGOT and SGPT as a marker enzyme for hepatotoxicity.
- 6 Estimation of serum creatinine activity as a marker enzyme for Renal toxicity.
- 7 Micronuclei test.
- 8 Estimation of Hemoglobin and RBC in Lead exposed experimental animals.
- 9 Estimation of AChE activity as a marker of pesticide poisoning.

Suggested Books

- 1 Principles of ecotoxicology- 3rd edition 2006, C H Walker, S P Hopkin, R N Sibly and D B Peakall (Eds.), Taylor and Francis, NewYork, NY.
- 2 Introduction to Environmental toxicology -3rd edition 2003, W.G.Landis and M.H.Yu. Lewis publishers, Florida.
- 3 Text Book of Modern Toxicology 2000 edition, Ernst Hodgson and Patricia Levi, McGraw – Hill International edition. Singapore.
- 4 Principles of toxicology 2010 edition, Anju Agarwal and Krishna Gopal, ibdc publishers India.
- 5 Essentials of Toxicology 2011 edition, Vijay Kumar Matham, New India Publishing Agency, New Delhi, India.
- 6 Principles of Biochemical Toxicology- Jatimbrell; Taylor and Francis Ltd, London.
- 7 Basic Environmental Toxicology – LorrissG.Cockerham, Barbara S Shane; CRC Press, London.
- 8 Hand book of Toxicology – Thomos J Haley, Willan O Berndt; Hemisphere Publishing cooperation, Washington.
- 9 Modern Toxicology (3 Volumes) - P K Gupta and Salunkha; B V Gupta Metropolitan Book Co., Ptv Ltd, New Delhi.
- 10 Encyclopedia of Toxicology – O P Jasra.

M.Sc. Zoology Semester - III
Elective II
Paper IV - BIOINFORMATICS

UNIT-I : INTRODUCTION TO BIOINFORMATICS & SEQUENCING ALIGNMENT CONCEPTS 15Hrs

- 1.1. Need of computers in biology research.
- 1.2. Bioinformatics - Introduction, scope and applications.
- 1.3. File Transfer Protocol (FTP), TELNET, HTTP, Internet.
- 1.4. Pair wise Alignments; Local, Global alignment; Gap- Gap penalty.
- 1.5. Comparison of pair-wise and multiple alignments.

UNIT-II: BIOLOGICAL DATABASES AND DATAMINING 15Hrs

- 2.1. Biological information on the web; Introduction to databases.
- 2.2. Classification of biological databases; Information retrieval from databases.
- 2.3. Sequence database searches FASTA, BLAST programs.
- 2.4. Amino acid substitution matrices - PAM and BLOSUM.
- 2.5. Data Mining and Visualization Tools - RASMOL and PDB viewer.

UNIT-III: PHYLOGENETIC ANALYSIS & GENOME MAPPING AND PREDICTION 15Hrs

- 3.1. Understanding evolutionary process; Origins of molecular phylogenetics.
- 3.2. Phylogenetic analysis algorithms - Maximum Parsimony, UPGMA, Neighbor-Joining.
- 3.3. Probabilistic models of evolution - Maximum Likelihood algorithm; Bootstrapping method; use of tools such as PHYLIP, MEGA and PAUP.
- 3.4. Genome sequencing; Genome mapping; Human genome mapping project.
- 3.5. Gene prediction methods and tools; Gene annotation in prokaryotes and eukaryotes.

UNIT-IV: PROTEIN STRUCTURE PREDICTION METHODS 15Hrs

- 4.1. Basics of protein biology (Classification, structural organization, domains & motifs).
- 4.2. Protein structure prediction concepts: Secondary and tertiary structure predictions; Chou-Fasman method, GOR methods, neural network methods.
- 4.3. Homology modelling; abintio method, threading methods.
- 4.4. 3-D structure visualization and simulation - Visualization of structures using SPDBV.
- 4.5. Structure-based drug discovery; binding sites detection; docking.

PRACTICALS:

1. Bioinformatics databases - NCBI
2. Pairwise sequence alignment using BLAST
3. Sequence similarity searching for DNA
4. Multiple sequence alignment and editing - CLUSTALW
5. Phylogenetic analysis using distance based methods & character based methods using PHYLIP
6. Gene prediction tools – ORF Finder.
7. Prediction of secondary structure of proteins – Homology modeling using GCG.
8. Sequence based prediction and validation of 3d Protein structure – 3D check or Procheck.

9. Docking studies using GOLD or AMBER.

TEXT BOOKS:

1. Bioinformatics. Genome and sequence analysis by David Mount, CSH Publications
2. Essential Bioinformatics by Jin Xiong, Cambridge University Press, 2011.

REFERENCES

1. Cynthia Gibas, Per Jambeck, "Developing Bioinformatics Computer Skills", O'Reilly Media, Inc., 2001. & 2. David Edwards, Jason Eric Stajich, David Hansen, "Bioinformatics: Tools and Applications", Springer, 2009.
2. David W Mount, "Bioinformatics: Sequence and genome analysis", Cold spring harbor laboratory press, 2nd edition, 2004.
3. Stan Tsai C., "Biomacromolecules: Introduction to Structure, Function and Informatics", John Wiley & Sons, 2007.
4. Attwood T K, D J Parry-Smith, "Introduction to Bioinformatics", Pearson Education, 2005.
5. Parag Rastogi, "Bioinformatics Methods And Applications: Genomics Proteomics And Drug Discovery", PHI Learning Pvt. Ltd., 3rd edition, 2008.
6. Computational Molecular Biology – An Introduction by Peter Clote, Rolf Backofen, John Wiley & Sons.
7. Bioinformatics: Methods and Applications- SC Rastogi, N Mendiratta & P Rastogi.
8. Bioinformatics Principles & Applications by Zhumur Ghosh, Oxford University Press

M.Sc. Zoology Semester - III
Elective II
Paper IV - Endocrinology

UNIT –I: Chemical and Neural Integration 15 Hrs

- 1.1 Scope and position of endocrinology.
- 1.2 Concept of neurohumors and neurotransmitters.
- 1.3 Characteristics of neural and hormonal integration, neuro-endocrine mechanism.
- 1.4 Hormones as chemical messengers; Regulation of hormone secretions.
- 1.5 Concept of internal environment and homeostasis.

UNIT – II: Endocrine Glands and their Hormones 15 Hrs

- 2.1 Invertebrate endocrine system – Hormones and their functions (Coelenterata and Annelida).
- 2.2 Invertebrate endocrine system – Hormones and their functions (Arthropoda and Echinodermata).
- 2.3 Hypothalamus and its secretions.
- 2.4 Vertebrate endocrine glands – Structure, hormones and functions of pituitary, thyroid, parathyroid and thymus.
- 2.5 Vertebrate endocrine glands – Structure, hormones and functions of adrenal, pancreas, pineal, gastro-intestinal tract and gonads.

UNIT –III: Chemistry of Hormones and Mechanism of Hormone Action 15 Hrs

- 3.1 Classification of hormones.
- 3.2 Biosynthesis of release and transport of amino acid derivatives.
- 3.3 Biosynthesis and transport of peptide and steroid hormones.
- 3.4 Membrane bound and intra cellular receptors.
- 3.5 Mechanism of action of amino acid derivatives, peptide and steroid hormones.

Unit – IV: Clinical and Applied Endocrinology 15Hrs

- 4.1 Obesity – Role of hormones and its metabolic complications – The role of Adipokines Insulin Resistance and Dyslipidemia.
- 4.2 Hormones in IVF, pregnancy testing, and Amniocentesis.
- 4.3 Clinical disorders of male and female gonads.
- 4.4 Pheromones in applied endocrinology; Induced breeding in fish.
- 4.5 Hormones in Sericulture and Apiculture.

PRACTICAL:

- 1 In situ demonstration of endocrine glands of rat.
- 2 Histology slides of Endocrine glands - Pituitary, Thyroid, Parathyroid, Thymus, Adrenal, Pancreas, Ovary & Testis, and Uterus.
- 3 Effect of Eye Stalk ablation on Blood Glucose levels in Crabs.
- 4 Identification of Gonadotrophin in Human urine samples.
- 5 Effect of thyroxin and thiourea (antithyroid agent) on oxygen consumption in fish.
- 6 Effect of parathormone on serum calcium levels in Rat.
- 7 Effect of insulin and adrenalin on blood glucose levels in Rat.

Suggested Books

- 1 Comparative Endocrinology of Invertebrates by Highman and Hill.
- 2 Comparative Vertebrate Endocrinology by P.J.Bentley, Cambridge Univ. Press.
- 3 General and Comparative Endocrinology by E.J.W. Barrington, Oxford Clarendon Press
- 4 Endocrinology Vol.1-3 by DeGroot L.J.et.al.
- 5 Text Book of Endocrine Physiology by C.R.Martin, Oxford Univ.Press, New York.
- 6 Text Book of Endocrinology by Turner and Bangnara (W.B.Sanders).
- 7 Vertebrate Endocrinology by Mc.Hadley.
- 8 Text Book of Comparative Endocrinology by Gorbman A, and Bern H.A., John Harley and Sous, New York.
- 9 Essential Endocrinology by JoenLaycock and Peter Loise Oxford Univ. Press.
- 10 A Text Book of Medical Physiology by ArthrumaC.Gnyton.
- 11 Text Book of Endocrinology by R.H.Williams (W.B.Saunders).

M.Sc. Zoology Semester - III
Elective II
Paper IV - PHYTONEMATOLOGY

UNIT- I: Introduction, Taxonomy and Collection Methods (15 PERIODS)

- 1.1 Introduction to plant parasitic nematodes, historical perspective and their significance.
- 1.2 Scope, significant and development of phytonematology in India.
- 1.3 General characters, taxonomy upto family level with representative examples.
- 1.4 Techniques of nematode collection from different habitats (soil, root, shoot, leaf, seed and galls).
- 1.5 Collection of nematodes, counting, fixing, staining, mounting, micrometry and deMan's ratio.

UNIT –II: Morphology and life cycles (15 PERIODS)

- 2.1 General account of nematodes, morphology and pattern of life cycles.
- 2.2 Structure of cuticle, cuticular modifications, structure of body wall and musculature.
- 2.3 Habit, habitat, life history and pathology of Rice nematode (*Hirschmaniella*) and Lance nematode (*Hoplolaimus*).
- 2.4 Habit, habitat, life history and pathology of Cyst nematode (*Heterodera*) and Root-knot nematode (*Meloidogyne*).
- 2.5 Predatory nematodes and control measures.

UNIT- III: Feeding, pathology and symptoms (15 PERIODS)

- 3.1 Digestive system –Types of oesophageal modifications and associated digestive glands.
- 3.2 Types of stylet and feeding mechanisms.
- 3.3 Host and nematode parasite relationship; Nematode injury – histopathology.
- 3.4 Field symptoms - General and specific (above ground and below ground).
- 3.5 Nematode associations and formation of disease complexes.

UNIT- IV: Nematode control (15 PERIODS)

- 4.1 Physical methods – Tilling, fallowing, sun drying, hot water treatment, fumigation.
- 4.2 Cultural practices - Crop rotation, trap crops.
- 4.3 Chemical control of nematodes and its consequences in the ecosystem.
- 4.4 Biological control of nematodes and its field application.
- 4.5 Integrated Nematode Management (INM).

PHYTONEMATOLOGY – PRACTICALS

1. Collection of soil and plant parasitic nematodes by various techniques.
2. Nematode counting and calculations (frequency).
3. Nematode fixing, staining and mounting methods.
4. Identification of phytonematodes by deMan's ratio.
5. Identification of predominant plant parasitic nematodes of the following crops:
 1. Rice
 2. Ground nut
 3. Vegetables
6. Field trip – Observation Book.

LIST OF BOOKS

1. Principals of Nematology – Thorne.
2. Nematology - Saucer and Jenkins.
3. Plant parasitic nematodes – Zuckerman, Mei and Rhode.
4. Nematology ecology –and plant diseases – H.R.Wallace.
5. Plant nematodes and their control – Heinz Decker.
6. Plant nemotology – Siddiqui and Jairajpuri.
7. A treatise on Phytoneematology – P.Parvata Reddy.
8. An introduction to plant nematology – J.C.Edwards and S.L.Mishra.
9. Soil and fresh water nematodes – T.Goodey.
10. A manual of Agricultural Helminthology-Filipjev I.N.and Schurmann Steckovan J. H.
11. Introduction to Nematology – Chitwood B.G. and Chitwood M.B.
12. The biology of plant parasitic nemotodes –Wallace H.R.
13. Plant nematology – Edited by Southy J.F.
14. Biological Control – Shamim Jairajpuri et al.
15. Plant Phathogens – Nematodes – R.S.Singh and J.Sita ramaiah.
16. Phytoneematology – Mrinal K.and Dasgupta.
17. Nematode vectors of plant viruses – C.E.Taylor and B.J.F.Brown.
18. Root Parasitic nematodes – Hoplolaimidae.
19. Plant pathology – George N Agrios.

M.Sc. Zoology Semester - III
Elective II
Paper IV - SERICULTURE

UNIT-I: Introduction

- 1.1 Introduction - Sericulture as an agro industry
- 1.2 Mulberry cultivation - Varieties of Mulberry, Agroclimatic conditions for Moriculture, Agricultural practices - Tilling & systems of Planting, intercultivation. Mulching, Pruning, Manuring, Harvesting and Preservation of leaves.
- 1.3 Diseases of Mulberry and their management - Bacterial diseases, Viral diseases, Fungal diseases
- 1.4 Mineral deficiency diseases and their management
- 1.5 Insect Pests of Mulberry and their management

UNIT-II: Biology of silk worms and food plants

- 3.1 Biology, food plants and culture of mulberry (*Bombyx*) and non mulberry Silkworms (*tasar, eri & muga*)
- 3.2 External morphology of silkworm - egg, larva, pupa & adult
- 3.3 Internal morphology of silkworm - Digestive, respiratory, nervous, excretory and reproductive systems
- 3.4 Morphology and anatomy of silk glands.
- 3.5 Properties and composition of silk.

UNIT-III: Silkworm rearing

- 3.1 Rearing House and rearing appliances.
- 3.2 Environmental conditions for silkworm rearing.
- 3.3 Rearing of early stages (*Chawki rearing*) and late stages of silk worms.
- 3.4 Mounting and harvesting of silkworm cocoons.
- 3.5 Silkworm diseases and pests.

UNIT-IV: Harvesting technology

- 4.1 Transport of cocoons to the cocoon markets.
- 4.2 Commercial characters of cocoons, defective cocoons and price fixation
- 4.3 Reeling technology – mulberry and vanya silk rearing.
- 4.4 Seed technology – Grainage, DFLs.
- 4.5 By-products- types and uses.

PRACTICALS:

1. Rearing appliances
2. Study of life history of silkworm by rearing.
3. Identification of different types of silk worms - Mulberry, *Tasar*, *Eri* and *Muga*
4. Identification of defective cocoons
5. Sex differentiation of larva, pupa and adult silkworms
6. Preparation of permanent slides of mouth parts, spiracles and appendages of larva
7. Dissection of silk glands of the silk worm larva
8. Dissection of digestive and nervous systems in the larva
9. Dissection of reproductive organs in the adults moths

10. Calculation of Shell Ratio.
11. Visit to the Cocoon market.
12. Visit to the Reeling Centre and Grainage Units

BOOKS RECOMMENDED:

1. FAO Manuals
2. Ullal and Narasimhanna: Hand Book of Practical Sericulture
3. Manjeet Singh Jolly: Appropriate Sericulture Techniques
4. CSB Bulletins of Sericulture
5. Ganga and Sulochana Shetty: An Introduction to Sericulture
6. NCERT Manuals of Sericulture

M.Sc. Zoology Semester - III
Elective II
Paper IV - Wildlife Biology

UNIT - I: Wildlife in India and its conservation 15 Hrs

- 1.1 Physiographic zones: Himalayas, Indo-Gangetic plains and Deccan Plateau; Biogeographic Zones and their characteristics
- 1.2 Forest types of India and associated wildlife: Evergreen forests, Deciduous forests, Littoral and Swamp forest (Mangrove forest), Thorn forest, Tropical forests, Temperate forests, Sub Alpine forest, and their sub types
- 1.3 Biodiversity hotspots; Protected Area Network of India: Wildlife Sanctuaries, National Parks, Biosphere Reserves, and Community Conservation Areas
- 1.4 Threatened wildlife of India; Laws and legislations: Wildlife Protection Act, Biodiversity Act
- 1.5 International treaties for wildlife conservation: Convention on Biological Diversity (CBD); Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); Convention on Migratory Species (CMS)

UNIT - II: Herpetology 15 Hrs

- 2.1 Systematics of amphibians and reptiles; amphibian diversity in India; reptilian diversity in India
- 2.2 Herpetofauna study techniques: signs (visual, acoustics and indirect evidence); capture techniques – pitfall traps, drift fencing, noose, hooks and tongs, handling, measuring, sexing and aging herpetofauna; Survey techniques – quadrat (random and clustered), transect, visual encounter survey
- 2.3 Inventorying and monitoring techniques: time and area constraint searches, active sampling (dipnetting, kick sampling, stove piping, egg mass and nest counts, basking surveys)
- 2.4 Capturing, handling, measuring, sexing and aging amphibians, turtles and tortoises, lizards and non-venomous snakes; photography and photo-vouchering
- 2.5 Effects of climate change on herpetofauna; amphibian extinctions, chytrid infection; range shifts among reptiles

UNIT –III: Ornithology 15 Hrs

- 3.1 Systematics of birds; bird diversity in India; observational techniques for aquatic and terrestrial birds
- 3.2 Breeding biology: mating systems, courtship, nest building, types of nests; foraging behaviour, food (trophic status), territoriality; social systems - solitary, communal, flocks (single species and mixed species)
- 3.3 Bird communities - guilds, stratification, resource partitioning; economic importance of birds; effects of anthropogenic activities on birds
- 3.4 Bird study techniques: bird signs (visual and acoustics); capture techniques - nets and traps, handling, measuring, sexing and aging birds; Survey techniques - transects (point and line), nest monitoring, capture and marking
- 3.5 Birds as environmental indicators – habitat quality, pollution, biodiversity and disease outbreaks

UNIT - IV: Mammalogy

15 Hrs

- 4.1 Systematics of mammals; mammalian diversity in India; observational techniques for non-volant and volant mammals
- 4.2 Capturing mammals: Capture devices, baits, trap arrays and interval for small terrestrial and volant mammals; sexing and aging mammals
- 4.3 Mammalian study techniques: Visual, olfactory and acoustic signs; remote trip cameras and GPS tags; data handling, analysis and interpretation
- 4.4 Estimation of mammal abundance, species richness, population size and density
- 4.5 Human health concerns in wildlife surveys; ethics in wildlife research – legal and cultural considerations; trapping, processing and handling animals

PRACTICAL

- 1 Mapping the biogeographic zones of India using free open source online resources
- 2 Determination of herpetofaunal diversity through visual encounter surveys
- 3 External morphological measurements and sexing of amphibians
- 4 External morphological measurements, pholidosis and sexing of gecko
- 5 External morphological measurements a bird
- 6 External morphological measurements, sexing and aging of a rat
- 7 Craniodental measurements and analyses of relationships between parameters using mammalian skull
- 8 Estimation of density of birds using strip transect method
- 9 Inventorying bird species richness and calculating diversity indices
- 10 Calculation of diversity and evenness indices between two habitats using birds as example
- 11 Preparation of species distribution map using DIVA GIS
- 12 Acoustic surveys of bats and analysis of call data
- 13 Visit to Nehru Zoological Park / any protected area for field study

LIST OF BOOKS

- 1. Fundamentals of Wildlife Management. By Rajesh Gopal
- 2. Ecological Census Techniques: A Handbook. By Sutherland, W.J.
- 3. Wildlife Biology. By Raymond F. Dasmann
- 4. A Field Guide to Birds of the Indian Subcontinent. By Krys Kazmierczak
- 5. The Book of Indian Animals. By S.H. Prater
- 6. The Book of Indian Reptiles and Amphibians. By J.C. Daniel
- 7. Snakes of India: The Field Guide. By Romulus Whitaker & Ashok Captain
- 8. Amphibians of Peninsular India. By R.J. Ranjit Daniels
- 9. South Asian Mammals: Their Diversity, Distribution, and Status. By Chelmala Srinivasulu and Bhargavi Srinivasulu

M.Sc. Zoology Semester IV
Core Paper
Paper - I: Animal Biotechnology

UNIT –I: Introduction and Animal Improvement 15 Hrs

- 1.1 Introduction to biotechnology- scope, importance and its applications.
- 1.2 Mammalian reproductive systems and gametogenesis.
- 1.3 In vitro fertilization and embryo transfer; ICSI, sperm sexing.
- 1.4 Cryopreservation, cryoprotection and gamete banking.
- 1.5 Biotechnology in improvement of live stock herds and breeding selected traits.

UNIT – II: In vitro culture of cells and tissues 15 Hrs

- 2.1 Cell culture - Equipment and materials for cell culture technology, principle of sterile techniques and cell propagation, primary and established cell line cultures.
- 2.2 Mammalian cell lines & their characteristics.
- 2.3 Basic techniques of mammalian cell culture in vitro, disaggregating of tissue and primary culture, maintenance of cell culture, cell separation.
- 2.4 Tissue culture system – cell tissue fragment, organ and embryo cultures, merits and demerits.
- 2.5 Scaling-up of animal cell culture, cell synchronization, cell cloning, micromanipulation, cell transformation.

UNIT –III: Production of recombinant organisms and transgenic animals 15 Hrs

- 3.1 Cloning of mammals.
- 3.2 Transgenic animals; creation of transgenic mice, retroviral vector method, Microinjection, embryonic stem cell method – short gun, electroporation, lipofection, microinjection.
- 3.3 Production of other transgenic animals – cattle, sheep, pigs and fish.
- 3.4 Large scale culture and production from genetically engineered animal cell culture
- 3.5 Large scale culture and production from recombinant microorganisms –Downstream processing.

UNIT -IV: Application of Biotechnology 15 Hrs

- 4.1 Medical biotechnology – Application of RFLP in forensic science, hybridoma technology and production monoclonal antibodies.
- 4.2 Environmental Biotechnology - Bioassay, biosensors in ecotoxicological screening; Bioleaching of metals by microorganisms; Bioabsorption of metals by bacteria.
- 4.3 Insecticide development – biopesticides; *Bacillus thuringiensis* – mode of action of toxin, toxin gene isolation and engineering of *B. thuringiensis*.
- 4.4 Biotechnology of aquaculture - sex reversal in fish and sterile fish culture.
- 4.5 Use of animals as bioreactors; Knock out model systems and their utility.

PRACTICAL

- 1 Preparation of culture media:
a) Bacteria; b) Fungi
- 2 Methods of cultivating Bacteria and Fungi
- 3 Isolation and characterization of microbes useful in fermentation.
- 4 Staining Techniques for microbes:
a) Gram's staining; b) Spore & Capsule staining;
c) Acid-fast stain; d) Fungal stains

- 5 Determination of microbial Growth Curve.
- 6 Antibiotic sensitivity test.
- 7 Yield estimation in fermentations products:
 - a) *Aspergillus niger*-citric acid;
 - b) *Lactobacillus* – Lactic acid from curd; and
 - c) *Saccharomyces cerevisiae* (Yeast) Alcohol
- 8 Microbial evaluation of stored foods from plant/animal origin for contaminants/toxins.
- 9 Visit to Quality Control Labs.

Suggested Books

- 1 Culture of Animal cells. R. Ian Freshney, Wiley Liss.
- 2 Animal Cell culture – Practical Approach – Ed. John R W Masters, Oxford.
- 3 Animal Cell Biotechnology, 1990 – Speir, RE and Griffith, JB, Academic Press.
- 4 Molecular Biotechnology – Glick & Pasternock.
- 5 Gene manipulation – Old & Primrose.
- 6 Biotechnology – S. Mitra.

M.Sc. Zoology Semester IV
Core Paper
Paper - II: FISH BIOLOGY

Unit – I: Introduction and Diversity of Fishes

- 1.1. Introduction, general characteristics, evolutionary succession and fossil history of fishes.
- 1.2. The early evolution of fishes; Chondrichthian fishes - Sharks, Skates and Rays.
- 1.3. Characterization and classification of: Ostracoderms, placoderms, acanthodians, holocephali, and elasmobranchs.
- 1.4. Characterization and classification of cyclostomes, sarcopterygii, dipnoi, and actinopterygii.
- 1.5. Integumentary system - basic structure of skin, dermal and epidermal pigments, fins, and scales.

Unit – II: Fishes habits and habitats

- 2.1. Buoyancy – Dynamic lift and static lift; swim bladder- structure and function.
- 2.2. Locomotion – Myotomal muscles and caudal fin oscillation mechanisms
- 2.3. Feeding mechanisms – Food habits and feeding, fish as predators and prey; Food chains and food webs.
- 2.4. Osmoregulation and ion balance – Freshwater, brackish water and marine teleosts; kidney and salt balance
- 2.5. Fish migration, migratory mechanisms, mating, and parental care.

Unit – III: Fish Biology

- 3.1. Skeletal system - skull, splanchnocranium, jaw suspension and vertebral column.
- 3.2. Digestive system – Digestive tract, enzymes and digestion.
- 3.3. Respiratory mechanism – Respiratory gills and lungs.
- 3.4. Circulatory system – Heart and accessory pumps.
- 3.5. Excretory system – Excretory organs and excretion.

Unit – IV: Fish biology and Embryogenesis

- 4.1. Nervous system- Central nervous system, brain and peripheral nervous system.
- 4.2. Sense organs – Olfactory, taste buds, touch receptors, photoreceptors, lateral line and internal ear.
- 4.3. Endocrine system – Pituitary gland, urohypophysis, adrenal gland, gonads, and thyroid gland.
- 4.4. Reproductive system- Male and female reproductive organs; role of hormones.
- 4.5. Embryogenesis - Early development and post embryonic development.

Practicals:

1. Morphometric identification of fishes.
2. Meristic characters of fishes.
3. Dissection and preparation of permanent slides of scales.
4. Isolation of pituitary gland.
5. Identification of fish developmental stages - egg, spawn, fry fingerling and adult.
6. Dissection of Weberian ossicles.
7. Dissection of digestive system.
8. Dissection of reproductive system.
9. Sexual differentiation of fishes.

10. Determination of chlorides in heterosmotic media.

Books:

1. Textbook Of Fish Biology & Indian Fisheries Rahul P Parihar
2. A Text Book of Fish Biology and Fisheries by S S Khanna and H R Singh,
3. Handbook of Fish Biology and Fisheries,(Vol I & II) by Paul J. B. Hart and John D. Reynolds
4. Fish Biology by, C B L Srivastava.
5. Fauna of British India, including Ceylon & Burma – by Francis Day.
6. Indian Fishes and Fisheries – Jhingran.
7. Introduction to Fish Physiology – Dr. Lynwood S. Smith
8. An Introduction to fishes – S. S. Khanna
9. Ichthyology – K.F. Lagler, John F., Bardach, R. R. Miller and D. R. May Passino

M.Sc. Zoology Semester IV
Elective I
Paper - III: Neuroscience - II

UNIT- I: Sensory System	15 Hrs
1.1	Types of receptors, basic mechanisms of sensory transduction; sensory circuit and sensory pathways
1.2	Neurobiology of chemoreception – taste and smell
1.3	Neurobiology of somatic sense
1.4	Neurophysiology of hearing
1.5	Neurophysiology of vision
UNIT -II: Sensory and Motor System	15 Hrs
2.1	Pain and it's mechanism - physiological and neurohumoral.
2.2	Muscle sense – receptors, muscle spindle and GTO.
2.3	Neurobiology of Autonomic function; Motor hierarchies.
2.4	Reflex, reflex pathways and coordination of reflexes.
2.5	Mechanism of locomotion and movement.
UNIT- III: Developmental neurobiology	15 Hrs
3.1	Induction and patterning of nervous system
3.2	Generation and survival of nerve cells, neurotrophic factors
3.3	Guidance of axons to their targets, synaptogenesis and developmental plasticity
3.4	Neural connection and their reactions to injury
3.5	Regeneration, reinnervation, sprouting; neural specificity; Remodeling of neural circuitary
UNIT - IV: Applied Neurobiology	15 Hrs
4.1	Concept of stress; physiological basis of stress and its disorders.
4.2	Role of muscles in sports, slow and fast muscles in exercise and its metabolism.
4.3	Diseases of motor units - neuropathies and myopathies.
4.4	Neuronal disorders – Parkinson's, Alzheimer's, psychosomatic disorders.
4.5	Behavioral disorders, drug abuse and dependence.
PRACTICAL: (All experiments involving live animals are for demonstration only)	
1	Tail flick test for measurement of pain.
2	Spinal reflexes in decerebrated animal.
3	Preparation of neuromuscular system for electrophysiological recording.
4	Biochemical differentiation of fast and slow muscles – SDH, LDH activities, glycogen and lactate content in altered neurobiological conditions.
5	Effect of ankle sprain on muscle metabolism.
6	Determination of contractile properties of muscle in pathological condition.
7	Determination of conduction velocity in nerve.
8	Induction of stress and estimation of on glycogen, lactate, AChE and Na-K ATPase activities.
9	Experimental studies on atrophy, hypertrophy of muscles and nerve degeneration as well as regeneration.
10	Moto rod test for motor coordination.

Suggested Books

- 1 Physiology and biophysics – Ruch and Patten
- 2 A text book of muscle physiology – D. A. Jones and J. M. Round
- 3 Neurobiology – Gordon M Sheperd
- 4 Principles of neural science – E. Kandel and others
- 5 Essentials of neural science and behaviour – E. Kandel and others
- 6 Behavioral neuroscience – Cottman
- 7 From Neuron to Brain – Nichollas, J. G. others
- 8 Neuroscience – A. Longstaff
- 9 Elements of molecular Neurobiology – C U M Smith
- 10 Physiology of excitable cells – D. J. Aidley
- 11 Text book of medical physiology – Guyton

M.Sc. Zoology Semester IV
Elective I
Paper - III: Medical Entomology - II

Unit -I: Source Reduction and Environmental Methods for Vector Control 15 hrs

- 1.1. Habitat management; Improvement of water supply and storage; solid waste management.
- 1.2. Prevention of breeding sites and removal or destruction of breeding sites.
- 1.3. Improvement of environmental sanitation and hygiene.
- 1.4. Protection of food, eating utensils and people from contact with flies.
- 1.5. Environmental modification and manipulation.

Unit -II: Physical, Mechanical, and Personal Protective Control measures. 15 hrs

- 2.1. Baits and traps, avoidance and diversion of biting Diptera.
- 2.2. Making houses and shelters insect-proof; Insecticide-treated screening and curtains.
- 2.3. Impregnation - treated clothing, treating fabrics with an insecticide; protective clothing.
- 2.4. Insecticide vaporizers, electric liquid vaporizer, pressurized spray cans, spray gun.
- 2.5. Netting materials, mosquito net models and problems with mosquito nets, Insecticide-treated mosquito nets and outdoor supports.

Unit -III: Biological Control 15 hrs

- 3.1. Biological control of vectors through predators and pathogens.
- 3.2. Extraction of plant materials for vector control.
- 3.3. Synthesis of plant medicated Silver nanoparticles and applications.
- 3.4. Genetic control of vectors: Sterile Insect Technology (SIT)
- 3.5. Insect Growth Regulators (IGR): Chitin synthesis inhibitors and juvenile hormones.

Unit-IV:Chemical Control 15 hrs

- 4.1. Classification of Insecticides and their mode of action; Antiquity of insecticides.
- 4.2. Synthetic insecticides: Organochlorides, Organophosphates, Carbamates, Pyrethroids.
- 4.3. Toxicity of pesticides, Insecticide appliances and safety precautions.
- 4.4. Repellents & attractants: DEET, Semiochemicals.
- 4.5. Methods of insecticide applications, and development of a Module for Integrated Vector Management.

Practical:

1. Surveillance and writing a report on breeding habitat of cockroach / housefly / mosquito breeding habitats.
2. Collection of indoor / outdoor resting mosquitoes / housefly/ Cockroach and preparing an voucher specimen.
3. Preparation of plant extracts for larvicidal activity.
4. Estimation of man hour landing of mosquitoes and assessment of man-vector contact.
5. Bioassay of vectors through biological and chemical agents.
6. Study of species diversity indices - Species Richness, Simpson's Index, Shannon-Weiner Index, and Pileou's Evenness Index.
7. Estimation of gonotrophic cycle duration.

References:

1. Biology of Disease Vectors, 2nd Ed., William C. Marquardt, 2004, Elsevier Academic Press.
2. Medical and Veterinary Entomology, 2nd Ed., Gary Mullen and Lance Durden.
3. Medical Entomology: A Textbook on Public Health and Veterinary Problems Caused by Arthropods, Revised Edition, Edited by Bruce Eldridge and John Edman.
4. Medical Toxicology by Richard C. Dart. Pub: Lippincott Williams & Wilkin.
5. Manual of Medical Entomology by Deane P. Furman & Paul Catts.
6. Infectious Diseases of Arthropods by Goddard.
7. Hand Book of Medical Entomology by [K N Panicker](#), [Geme Urge Dori](#).
8. Medical Entomology for Students 5th edition by Mike Service.
9. Destructive and Useful Insects by R. L. Metcalf.

M.Sc. Zoology Semester IV
Elective I
Paper - III: PARASITOLOGY - II

UNIT-I: Protozoology 15 Periods

- 1.1 Protozoan ecology, nutrition; population structure and kinetics.
- 1.2 Metabolic pathways in protozoa – carbohydrate, protein and lipids.
- 1.3 Antimetabolites analogs, inhibitors and transport phenomenon in protozoa.
- 1.4 Enzyme secretions and activity; nucleic acids composition and its synthesis.
- 1.5 Respiration in protozoa; nutritional requirements and nitrogen excretion.

UNIT-II: General account and Taxonomy of Nematodes. 15 Periods

- 2.1 History, scope and significance of nematodes.
- 2.2 Classification of nematodes upto family level with examples.
- 2.3 Functional anatomy – Structure of cuticle and cuticular modifications, Body wall, musculature and pseudocoelom.
- 2.4 Digestive system with special reference to oesophageal modifications and associated glands.
- 2.5 Excretory system, nervous system and sense organs of nematodes.

UNIT-III: Morphology, Development, Life cycles and Pathology 15 Periods

- 3.1 Reproductive system, types of eggs, embryology and development.
- 3.2 Life cycles, pathology, treatment of the gastrointestinal nematodes; tissue nematodes, epidemiology and geographical distributions of
 - a. *Strongyloides stercoralis*
 - b. *Ancylostoma duodenale*
 - c. Visceral larva migrans, dermatitis and pulmonary bronchitis.
 - d. *Dracunculus medinensis*, *Wuchereria bancrofti*, *Brugia malayi* and *Trichinella spiralis*.
- 3.3 Origin and evolution of animal nematode parasites and host interaction.
- 3.4 General account of entomophilic Nematodes – characteristics and classification.
- 3.5 Nematicides and their action, Nematode drug resistance.

UNIT-IV: Acanthocephala 15 Periods

- 4.1 Medical Acanthocephalans - general account, morphology, life cycle, clinical symptom, pathogenicity, diagnosis, prophylaxis and treatment of the diseases caused by *Macracanthorhynchus hirudinaceus* and *Moniliformis moniliformis*.
- 4.2 The role of vectors in spreading of diseases in humans.
- 4.3 Host -parasite relationships and their immunological reactions.
- 4.4 Innate and acquired immune resistance.
- 4.5 Anthelmintic drug action and drug resistance.

PRACTICALS:

1. Collection of nematode parasites and acanthocephalan parasites, fixation, preparation of permanent slides and their identification.
2. Hosts – cockroaches (invertebrate), fish (carps & catfishes), birds (fowl), and mammals (sheep and cattle).

3. Identification of nematode eggs and larval stages.
4. Blood smear preparation for the identification of *Plasmodium* spp.
5. Qualitative and quantitative estimation of carbohydrates, proteins and lipids in normal, infected tissues and parasites.
6. Ecology of parasites and biostatistical calculations of incidence, intensity, density and index of infection of nematode parasites.

LIST OF BOOKS:

1. Principles of nematology – by Chitwood B.G. and Chitwood M.B.
2. Nematode parasites of domestic animals and of man – by Levine Norman D Burgess publishing Co. Minneapolis.
3. The natural history of Nematodes by Pionar G.O., Prentice Hall, New Jersey.
4. The organization of nematodes by Croll N.A., Academic press.
5. The physiology of nematodes by Lee D. L. & At. Kinson, Columbia University Press, New York.
6. Agricultural Helminthology – Filipjev I. N.
7. General Parasitology by Cheng T.C.
8. Introduction to animal parasitology by J. D. Smith.
9. Entomophilic nematodes and their role as biological control of pest insects by George Poiner, Pub. INC Engle wood cliffs, New Jersey.
10. Parasitology by Noble & Noble.
11. Parasitology by K. D. Chatterjee.
12. Parasitology by Chandler.
13. Human Helminthology - by Faust.
14. Medical Zoology by Sobti.

M.Sc. Zoology Semester IV
Elective I
Paper - III: Comparative Animal Physiology - II

- UNIT- I: Responses of animals to their environment 15 Hrs
- 1.1 General receptor characteristics, receptor potentials and sensory coding.
 - 1.2 Adaptations in organ systems for reception – chemo-, thermo-, mechano-, and electro-receptors.
 - 1.3 Central nervous system - Insect to vertebrate comparison.
 - 1.4 Integration for effective behavior - spinal reflex; Learning and memory and its genetic basis.
 - 1.5 Stress biology and related disorders.
- UNIT –II: Effectors and responses 15 Hrs
- 2.1 Gland effectors for secretion - mechanism of target tissue activation and mechanism of secretion.
 - 2.2 Types of muscle fibers slow, fast and asynchronous flight muscle.
 - 2.3 Mechanism and chemistry of muscle fiber contraction.
 - 2.4 Accessory movements – skeletal levers, elastic movements.
 - 2.5 Effectors for movement – cyclosis, amoeboid, ciliary, flagellar movements, and control of movement.
- UNIT - III: Circulation of body fluids 15 Hrs
- 3.1 Major types of body fluids – fluid compartments.
 - 3.2 Classification of circulatory mechanisms.
 - 3.3 Types of vertebrate hearts, heart rate, regulation and cardiac output, chemical and nervous control of heart rate.
 - 3.4 Invertebrate hearts – annelids, scorpion, insect, crustacean, molluscan, and tunicate hearts.
 - 3.5 Regulation of vertebrate circulatory systems.
- UNIT - IV: Control of reproduction –adaptations to environment 15 Hrs
- 4.1 r -selected and k- selected reproductive patterns; timing with respect to environmental variables, photo periods.
 - 4.2 Hormonal control of insect growth and reproduction.
 - 4.3 Hormones and development; sexual behaviour in vertebrates; pregnancy and parental care.
 - 4.4 Influence of environmental factors on chromatophore systems.
 - 4.5 Biological rhythms circadian - circumlunar and circannual rhythm.
- PRACTICAL: (All experiments involving live animals are for demonstration only)
- 1 Maze behaviour studies in rat.
 - 2 Metabolic distinction of slow and fast muscles.
 - 3 Kymographic studies of muscle properties.
 - 4 Effect of temperature on heart beat of crab
 - 5 Effect of AchE and adrenaline on heart beat in crab.
 - 6 Effect of estrogen on serum calcium levels of rat
 - 7 Pregnancy testing by using HCG kit.
 - 8 Dissection of nervous system of cockroach and crab.
 - 9 Dissection of Male and Female reproductive systems of cockroach and crab.

Suggested Books

- 1 Comp. Animal Physiology by Ladd Prosser (Publ. W. B. Samders, Philadelphia).
- 2 Comp. Animal Physiology by William Hoar, (Pub. E.E.E. IBH).
- 3 Animal Physiology – Adaptation and function., By F. Reed Hainsworth (Publ. by Addison-Wesley Publ. company, Calofornia).
- 4 Animal Physiology by Kent Schmidt Nielson (Publ. E.E.E. IBH).
- 5 Animal Physiology and adaptation by David Gordon.
- 6 Animal Physiology by Wilson.

M.Sc. Zoology Semester IV
Elective I
Paper - III: Fisheries - II

UNIT –I: Seed Production Technology	15 Hrs
1.1	Fish and prawn seed resources in India.
1.2	Collection of seeds from natural resources and transportation of seeds.
1.3	Advanced techniques in seed production - Induced breeding methods in fishes and prawns.
1.4	Bundh breeding, brood stock management.
1.5	Hatcheries – Types, construction and management of hatcheries.
UNIT- II: Pond and Reservoir Management	15 Hrs
2.1	Site selection, design and construction of aquafarms.
2.2	Pre-stocking pond management – Aquatic weeds, insects and their control.
2.3	Farm Management - Nursery, rearing and stocking ponds.
2.4	Reservoir ecosystem.
2.5	Reservoir fisheries and their management.
UNIT III – Feed and Health Management	15 Hrs
3.1	Feed management – Feeding habits of cultivable fishes; nutritional requirements, supplementary feeding.
3.2	Live feed – Fish food organisms, culture of plankton; significance of plankton in aquaculture.
3.3	Health management of fishes – Parasitic and non-parasitic diseases and their control.
3.4	Health management of prawns – Parasitic and non-parasitic diseases and their control.
3.5	Disease diagnosis and therapeutic methods.
UNIT IV – Cultures and Integrated Farming	15 Hrs
4.1	Composite fish culture; Sewage-fed, cage and pen cultures.
4.2	Air-breathing and ornamental fish culture.
4.3	Integrated fish cum agriculture – Paddy, Horticulture and Azolla.
4.4	Integrated fish cum livestock – Poultry, Piggery and Dairy.
4.5	Utilization of renewable energy resources and bio-gas slurry in aquaculture.
PRACTICAL	
1	Identification of freshwater fishes.
2	Identification of Freshwater fish developmental stages.
3	Identification of freshwater prawns.
4	Identification of scampi developmental stages.
5	Identification of diseased fishes and prawns.
6	Analysis and identification of phyto- and zoo-planktons and benthos.
7	Culture of phyto- and zoo-planktons.
8	Separation of pituitary gland from fish.
9	Demonstration of induced breeding technology.
10	Field trips to seed and rearing farms and submit an observation report (weightage of 10 marks to be given to each candidate).

Suggested Books

- 1 Water quality criteria for fresh water fish. Albastor, J. S. and Lloyd, R. Butterworth

Scientific.

- 2 Fish and Fisheries of India – Jhingran, V. G. Hindustan Publishing Corporation New Delhi.
- 3 The fishes of India – Francis. Day. Vol. I &II, New Delhi – CSIR.
- 4 The freshwater fishes of Indian Region – Jayaram, KC. Narendra Publishing house, New Delhi.
- 5 Prawns and prawn fisheries – Kurian, C.V. and Sebastian, V. O. Hindustan Publishing Corporation, New Delhi.
- 6 A manual of freshwater aquaculture – Santhanam, R. Sukllnaran. N. Natarajan Oxford and IBHPublishing Company, New Delhi.
- 7 Freshwater aquaculture – Rath, R. K. Scientific Publishers, Jodhpur.
- 8 Text book of fish culture, breeding and cultivation of fish – MareelHuet, Fishing News books.
- 9 Aquaculture development, processes and prospects – TVR Pillaay Fishing news books.
- 10 Aquaculture – John, E. Bardach, John H. Ryther, W.O. Mclamey, John Willey and Sons, New York.
- 11 Fish Ecology – RJ. Wotton, Dalckie, Chapman and Hall, New York.
- 12 Environmental stress and fish diseases – Wedemeye, G. A. Narendra. Publishing House.
- 13 Diseases of fishes – C. Vandujn, Narendra Publishing House, New Delhi.
- 14 Aquaculture Principles and Practices by T. V. R. Pillay.

M.Sc. Zoology Semester IV

Paper - IV: PROJECT WORK

5 Credits
6

	Credits	Marks
Research Design	1	25
Research work	1	25
Completion seminar	1	25
Dissertation, Final presentation & Viva	3	75