

Department of Zoology

M. Sc. (Zoology)

Course Contents & Syllabus

*Agarwal*

Sri Dev Suman Uttarakhand Vishwavidhyalay,  
Badshahithaul, Tehri Garhwal, Uttarakhand 249 199.

## M.Sc. Course in Zoology

Sri Dev Suman Uttarakhand Vishwavidhyalay,  
Badshahithaul, Tehri Garhwal, Uttarakhand 249 199.

The M.Sc. course will be spread over two years (four semesters). There shall be Four theory papers and one practical examination every semester. Each theory paper has been divided into four units.

### Course Contents & Teaching Schedules:

<b>M.Sc. 1st Semester (July to November)</b>				
Paper	Paper Title	Lectures/ week	Teaching hours/week	MM
Theory Paper C01	Animal Diversity (Invertebrate)	3	03	100
Theory Paper C02	Cell Biology	3	03	100
Theory Paper C03	Genetics, Evolution & Taxonomy	3	03	100
Theory Paper C04	Developmental Biology	3	03	100
Lab Course LC01	Based on Theory Papers	12	12	100
<b>M.Sc. 2nd Semester (December to April)</b>				
Theory Paper C05	Microbiology & Parasitology	3	3	100
Theory Paper C06	Animal Physiology	3	3	100
Theory Paper C07	Immunology	3	3	100
Theory Paper C08	Molecular biology and Elementary Biotechnology	3	3	100
Lab Course LC02	Based on theory papers	12	12	100
<b>M.Sc. 3rd Semester (July to November)</b>				
Theory Paper C09	Animal Diversity (Chordata)	3	3	100
Theory Paper C10	Ecology & Wildlife	3	3	100
Theory Paper E01	Methods & Techniques / Dissertation (Fish Biology/ Entomology/ Environmental Biology)	3	3	100
Theory Paper E02	Fish Biology I Entomology I Environmental Biology I	3	3	100
Special Paper E02 a				
Special Paper E02 b				
Special Paper E02 c	Environmental Biology I			
Lab Course LC03	Lab Course Based on Theory papers	12	12	100
<b>M.Sc. 4th Semester (December to April)</b>				
Theory Paper C11	Endocrinology & Animal Behaviour	3	3	100
Theory Paper C12	Biochemistry	3	3	100
Theory Paper E03	Fish Biology II Entomology II Environmental Biology II	3	3	100
Special Paper E03 a				
Special Paper E03 b				
Special Paper E03 c	Environmental Biology II			
Theory Paper E04	Applied Fish Biology Applied Entomology Applied Environmental Biology	3	3	100
Special Paper E04 a				
Special Paper E04 b				
Special Paper E04 c	Applied Environmental Biology			
Lab Course LC04	Lab Course Based on Theory papers	12	12	100
* Students securing Minimum 70% marks in I & II Semester together can opt for dissertation in place of Theory paper C11				

*Agarwal*

**M.Sc. Zoology 1<sup>st</sup> Semester**  
**Paper C01: Animal Diversity**

No. of Lectures / week  
(3 lectures of 60 minutes each)

**UNIT I**

Protozoa: Comparative morphology of all classes. Locomotor organelles and locomotion. Nutrition: holophytic, holozoic, saprozoic, myxotrophic and parasitic. Reproduction: sexual and asexual reproduction,

**UNIT II**

Porifera: Comparative morphology of all classes. Types of canal system, Reproduction: Asexual and sexual reproduction, regeneration in sponges.

*Coelenterata*: Comparative morphology of all classes. Polymorphism in Coelentrates, Coral reefs & its formation, Affinities of Ctenophora.

*Helminthes*: Comparative external and internal morphology of platyhelminthes and Aschelminthes,

**UNIT III**

*Minor Group*: Characters and Affinities of Phoronida and Rotifera.

*Annelida*: Comparative morphology of all classes, Coelom, Segmental organs. Parasitic adaptations in Hirudinaria.

*Arthropoda*: Appendages & Mouth parts in insects, Larval forms in Crustacea, Arachnida, Organization and taxonomic importance of Onychophora.

**UNIT IV**

*Mollusca*: Comparative morphology of all classes, Major features of the Respiratory and Reproductive Systems, Larval forms, Torsion in gastropods, Pearl formation.

*Echinodermata*: Water vascular system, Larval forms and affinities.

**Recommended Books:**

1. Barnes: Invertebrate Zoology (4th ed.), Holt-Saunders, 1980.
2. Barrington: Invertebrate Structure and function, Nelson, 1987.
3. Hickman, Roberts & Hickman: Integrated principles of Zoology (7th ed) Times-Mirror, Mosby
4. Kotpal R.L: Modern Text Book of zoology: Invertebrates. Rastogi
5. Nigam : Biology of Non-Chordates, Nagin Chand, 1985.
6. Parker TJ & Haswell WA: A Text book of Zoology Vol I & II, McMillan
7. Hyman L: Invertebrate Series, Academic Press
8. Starr et al: Biology, The Unity and Diversity of Life
9. Twenhofel et al: Principles of Invertebrate Palaeontology

**M.Sc. Zoology 1<sup>st</sup> Semester  
Paper C02: Cell Biology**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**UNIT I**

Ultra structure of pro-and eukaryotic cells.

Plasma membrane: Structure - organisation, lipid bilayer, proteins & glycoconjugates, liposomes. Function- Ionic transport, transporter proteins, types of transport (symport, antiport, active & passive, endocytosis, exocytosis).

Endomembrane system: Intracellular compartments/organelles involved in protein sorting, secretory and endocytic pathways.

Cytoskeleton: Components, functions & derived organelles (cilium, flagellum).

**UNIT II**

Mitochondria: Structure, function & genetic organisation.

Ribosome: Biosynthesis & formation in nucleolus.

Cell cycle: Molecular events during interphase, genetic regulation of cell cycle (including yeast as model system).

**UNIT III**

Cellular communication: general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins,

Cellular transformation and malignancy. Retroviruses, Apoptosis and Necrosis, Causes of cancer. Nuclear cytoplasmic interaction.

**UNIT IV**

Mechanisms of signal transduction; Endocrine, Exocrine & Synaptic signaling, Surface and intracellular receptors, G Proteins & generation of second messengers, mode of action of cAMP & Ca<sup>++</sup>Calmodulin, Signal transduction pathways, regulation of signaling pathways,

**Recommended Books:**

1. Lodish-et al, Molecular Cell Biology 6th ed 2007 Free Man
2. Pollard and Earnshaw, Cell Biology 2002 Saunders
3. Karp: Cell and Molecular Biology 2007, Wiley
4. P.K. Gupta: Cell Biology and Genetics, Rastogi

Enrollment No. \_\_\_\_\_

**M.Sc. Zoology 1<sup>st</sup> Semester**  
**Paper C03: Genetics, Evolution & Taxonomy**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**Genetics**

**UNIT I**

Mendelian Laws along with molecular explanations. Exceptions to Mendelian Laws. Lethal alleles. Multiple alleles. Gene interactions (Modification of Dihybrid Ratios) and their biochemical basis. Pedigree analysis in man. Sex linked inheritance and genetic disorders. Cytoplasmic inheritance & Extrachromosomal inheritance.

**UNIT II**

Linkage, genetic mapping techniques (Three point test cross). Gene maps in some organisms. Hardy-Weinberg law & its applications. Mutation (including Molecular basis). Chromosomes: Structure, chemical composition, (histones, DNA, Nucleosome) classification, karyotype, euchromatin and heterochromatin. Giant chromosomes: Polytene and Lampbrush chromosomes

**Evolution**

**UNIT III**

An overview of the concepts of organic evolution and evolutionary theories. Origin of life (including aspects of prebiotic environment and molecular evolution); Variations. Natural selection: Concept; Types of selection and selection coefficient. Role of mutation in evolution. Speciation: Isolating mechanisms; Modes of speciation (allopatric, sympatric, parapatric). Micro and macroevolution. Animal distribution: Zoogeographical divisions of the world (characteristics & fauna). Insular fauna. Fossils and fossilization. Geological distribution of animal. Evolution of Horse and Man; Extinctions.

**Taxonomy**

**UNIT IV**

History of animal taxonomy. Introduction and scope of Systematics. Species concepts (Typological, Nominalistic, Biological and Evolutionary). Principal of classification, functions, systems of classification; Linnean hierarchy. Nomenclature: ICZN; Taxon, Rank and Categories. Methodologies in taxonomy. Preparation of Keys, Techniques of museum preparation.

**Recommended Books:**

1. Lewin: Genes, Vol. VII Oxford, 1998, Inded.
2. Straehan & Read: Human Molecular Genetics 1999, John Wiley & Sons Pte. Ltd.
3. Snustad et al: Principles of Genetics 1997, John Wiley & Sons,
4. Strickberger: Genetics, 1996, Prentice Hall
5. Friefelder: Molecular Biology (2nd ed.), 1996 Narosa Publ. House,
6. Moody : Introduction to evolution (Indian Edition) Kalyani Publ., 1978.
7. Strickberger : Evolution, (Indian Edition). CBS Publ., 1994.
8. Richard Swann Lull: Organic Evolution Seema Publications, 1976
9. Simpson G.G.: Principles of Animal Taxonomy, Columbia Univ. Press, 1961.
10. Mayr, E. Systematics and the Origin of Species, Columbia Univ. Press, 1942.

**M.Sc. Zoology 1<sup>st</sup> Semester**  
**Paper C04: Developmental Biology**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**UNIT I**

Development and differentiation of sperm and oocytes, capacitation, vitellogenesis.

Fertilization: Mechanism of fertilization, acrosomal reaction, cortical reaction and formation of fertilization membrane. Blocks to polyspermy, Parthenogenesis.

**UNIT II**

Concept of organiser and embryonic inductions: primary, secondary & tertiary cellular interactions. Development of Eye and limb.

**UNIT III**

Development in *Drosophila*: Cleavage, gastrulation; Molecular basis of development, maternal-effect genes, segmentation genes and homeotic selector genes.

Teratogenesis: Genetic and environmental Teratogenesis, phenocopies, developmental mechanisms of teratogenesis

**UNIT IV**

Regeneration and Metaplasia: Distribution of regenerative ability, polarity in regeneration, mechanism of regeneration of amphibian limb and lens, metaplasia, super-regeneration and heteromorphosis

Metamorphosis: Kind of metamorphosis. Amphibian metamorphosis. Physiological and biochemical changes during metamorphosis, hormonal control of metamorphosis.

**Recommended Books:**

1. Gilbert: Developmental Biology 1997 Sinauers Ass. Publ. Massachusetts
2. Wolpert: Principles of Development 3rd ed 2007, Oxford
3. Kolthoff: Analysis of Biological development 1996 McGrawHill
4. Balinsky: Introduction to Embroylogy Saunders co. Philadelphia and London
5. Berill: Developmental Biology Tata McGraw Hill

**M.Sc. Zoology 2<sup>nd</sup> Semester**  
**Paper C05: Microbiology & Parasitology**

No. of Lectures /week -  
(3 lectures of 60 minutes each)

**Microbiology**

**UNIT I**

Bacteria - classification, staining techniques, pathological significance. Physiology, genetics & reproduction of viruses of plants and animals, Bacteriophage, lysogenic & lytic cycle, Bacterial genetics. Microbial culture techniques & media enrichment techniques. Microbial fermentation: Microbes in decomposition and recycling processes. Microbes as pathological agents in plants, animals and man.

**UNIT - II**

Laboratory facilities, culture media for animal cell culture, Primary culture, cell lines and cloning, Tissue and organ culture, minisatellites, microsatellites. Application of animal cell culture.

**Parasitology**

**UNIT III**

Parasitism and evolution of parasitism. Protozoan parasites: Biology, life cycle and diseases caused by selected pathogenic protozoans of man their preventive and control measures (*Entamoeba histolytica*, Trypanosomes, *Leishmania donovani*, *Trichomonas vaginalis*, *Giardia intestinalis* & *Plasmodium*).

**UNIT IV**

Parasitic adaptations in Platyhelminthes and Aschelminthes. Common trematode, cestode and nematode parasites. Biology, life history and preventive measures of economically important helminth parasites of man and domesticated animals (*Ascaris*, *Schistosoma*, *Fasciola*, *Wuchereria*) Taenia. Introduction to arthropods and vectors of human diseases (mosquitoes, lice, flies & ticks). Parasitism in Crustacea

**Recommended Books:**

1. Pelczar: Microbiology, Tata McGraw Hill, 1993
2. Davis: Microbiology (3rd ed.) Harper & Row, Publ. Inc., 1980
3. Chandler and Read: Introduction to Parasitology 1970, Wiley
4. Marr et al : Molecular Medical Parasitology 2003, Elsevier
5. Noble and Noble: Parasitology 1996, Cambridge University press
6. Schmidt and Roberts: Williams and Wilkins Foundations Parasitology (4<sup>th</sup> ed), 1989
7. Ash and Orihel: Parasites, A guide to laboratory procedures and identification, Raven press

**M.Sc. Zoology 2<sup>nd</sup> Semester**  
**Paper C06: Animal Physiology**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**UNIT I**

Physiology of respiration: Exchange of respiratory gases at the pulmonary surface. Transport of respiratory gases by blood. Factors affecting oxyhaemoglobin dissociation. Neural and chemical control of respiration.  
Physiology of digestion & absorption: Functional anatomy of the gastrointestinal tract. Gastrointestinal motility and its regulation. Secretions of the gastrointestinal tract. Liver and biliary system. Digestion and absorption of proteins, fats and carbohydrates.  
Physiology of excretion: Formation of urine: Functional anatomy of the kidney. Glomerular filtration and its control. Reabsorptions & secretions in the tubules. Mechanisms of active transport. Excretion and control of urea, sodium, potassium and other ions.  
Functions of aldosterone, antidiuretic hormone and renin-angiotensin system in renal physiology. Osmoregulatory mechanisms.

**UNIT II**

Physiology of cardiovascular system: Characteristics of vertebrate cardiac muscle. Initiation, conduction and regulation of heart beat. Cardiac cycle and cardiac output. Regulation of cardiac amplitude and frequency. ECG and myocardial infarction. Blood pressure and its regulation. Circulation (open and closed, blood composition and function). Blood groups. The cascade of biochemical reactions involved in coagulation of blood. Lymphatic systems.

**UNIT III**

Nervous system: Neuron - the basic functional unit, the sensory & motor divisions. Ionic basis of resting and action potentials of neurons, significance of myelinated nerve fibers and velocity of conduction. Physiologic anatomy of the synapse. Mechanism of synaptic transmission, transmitters (acetylcholine, norepinephrine, histamine, GABA). Reflexes and types of reflexes.

Neuromuscular physiology: Structural proteins of muscle cells, actin myosin complex and source of energy for contraction. Sliding filament theory of muscle contraction. Excitation-contraction coupling.

**UNIT IV**

Sensory physiology: The eye and visual processes - Functional anatomy of the structural elements of the retina. Photochemistry of vision. Extra-retinal photoreception. Visual adaptations in vertebrates.

The ear and auditory processes - Tympanic membrane and the ossicular system. Conduction of sound from tympanum to cochlea. Functional anatomy of cochlea. Sound transmission in cochlea.

Mechanism of thermoregulation in poikilotherms, homeotherms and heterotherms. Aestivation and hibernation.

**Recommended Books:**

1. Ganong: Review of Medical Physiology 22nd ed 2005. Lang Medical Publ.
2. Guyton and Hall: Text book of Medical Physiology 11th ed 2006 WB Saunders.
3. Keel et al: Samson Wright's Applied Physiology 13th ed 1989 Oxford Press
4. C.C. Chatterjee: Human Physiology
5. Nielson: Animal Physiology, Cambridge.
6. Jain A.K: Textbook Of Physiology 6/E, Avichal Publishing Company
7. Singh H R & Kumar N : Animal Physiology.



**M.Sc. Zoology 2<sup>nd</sup> Semester  
Paper C07: Immunology**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**UNIT I**

Historical aspects of immunology, scope and applications, recent advancements and future prospects. Ontogenetic and Phylogenetic developments of immune system in animals including human beings.

**UNIT II**

Overview of the Immune System. Hematopoiesis – formation of B-lymphocytes and T-lymphocytes and its regulation. Cells of the immune system- NK Cells, B-lymphocytes, T-lymphocytes, Granulocytic cells, Dendritic cells. Primary lymphoid organs and their functional role- Bone marrow, Thymus. Secondary lymphoid organs and its functional role- Lymph nodes, Spleen, Mucosal-Associated Lymphoid Tissue [MALT], Intraepithelial Lymphocytes [IEL], Cutaneous-Associated Lymphoid Tissue [CALT]

**UNIT III**

Antigens, Antigenicity versus Immunogenicity, Haptens and Adjuvants.

Basic structure of immunoglobulin. Classes of immunoglobulins and its biological activities. Major Histocompatibility Complex [MHC] - Structure, types and function. Antigen processing and presentation. Structure and functions of BCR & TCR.

**UNIT IV**

Cytokines. The Complement System. Cell mediated cytotoxicity: Mechanism of T cell & NK cell mediated lysis. Ab-dependent cell mediated cytotoxicity (ADCC) Overview of Hypersensitivity and Autoimmunity. Introduction to Transplantation.

Vaccines: Active and Passive Immunization.

Introduction to Monoclonal Antibodies and Hybridoma technology. Antigen-Antibody Interactions: Precipitation Reaction, Agglutination Reactions, Immuno precipitation, Immunofluorescence.

**Recommended Books:**

1. Kuby's immunology- Goldsmith et al, 6th Ed, WH Freeman, New York, USA.
2. Basic immunology: functions and disorders of immune system- Abbas, Litchman. Saunders Publications, Philadelphia, USA
3. Janeway's Immunology- Kenneth Murphy, 8th Ed, Garland Science, Pennsylvania, USA.
4. Roitt's Immunology- Delves et al, 12th Ed, Willey-Blackwell Science, Oxford, UK.
5. History of Immunology, 2nd Ed- Silverstein [2009], Academic Press, New York, USA.
6. Exploring immunology: Concepts and Evidence- Macpherson and Austyn, Willey-Blackwell Science.

**M.Sc. Zoology 2<sup>nd</sup> Semester**  
**Paper C08: Molecular Biology & Elementary Biotechnology**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**Molecular Biology**

**UNIT I**

The central Dogma of Molecular Biology. DNA: Structure and conformation, supercoiling, packing of DNA into chromosomes. Structural polymorphism of DNA & RNA. Three dimensional structure of t-RNA.

**UNIT II**

DNA replication – Prokaryotic and eukaryotic DNA replication, Enzymes and accessory protein involved in DNA replication. Genetic code. Transcription and translation in prokaryotes and eukaryotes. RNA processing. Mutations & DNA repair systems (excision repair, mismatch repair and SOS repair)

Regulation of Gene expression in Prokaryotes and Eukaryotes: Operon concept (*E. coli lac* operon, *trp* operon, *ara* operon),

**Biotechnology**

**UNIT III**

History, definition & Scope. General steps of Gene cloning-cutting, ligation, transformation and analysis of clones, genomic & C-DNA library. A general idea of cloning vectors based on plasmid & phages, blotting techniques, DNA-sequencing, polymerase chain reaction.

**UNIT IV**

Gene therapy, DNA finger printing, Transgenic animals and plants. Potential hazards of recombinant DNA technology. Products of recombinant DNA technology, Human genome project and its applications,

RIA, ELISA, Northern Blotting, Western Blotting, Southern Blotting.

**Recommended Books:**

1. De Robertes & Robertis: Cell & Molecular Biology, 1987, Lee & Fabiger Philadelphia
2. Friefelder: Molecular Biology (2nd ed.), 1996 Narosa Publ. House,
3. Alberts et al: Molecular biology of the cell (4th ed.) 1994, Garland Publ. New York.
4. Elliott & Elliott: Biochemistry and Molecular Biology, 1996, Oxford

**M.Sc. Zoology 3<sup>rd</sup> Semester**  
**Paper C09: Animal Diversity (Chordata)**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**UNIT I**

General Characters development of Urochordata and Cephalochordata.

Affinities of Hemichordata, Urochordata & Cephalochordata.

**UNIT II**

Characters and affinities of Cyclostomata

Salient features of different groups of fishes; comparison between Chondrichthyes and osteichthyes; Dipnoi.

Origin and evolution of Amphibia. Parental care in Amphibia

**UNIT III**

Origin of Reptilia and adaptive radiation in Reptilia.

Characters and affinities of Chelonia and Rhynchocephalia

Origin and ancestry of birds, Characters and affinities of Ratitae. Origin and mechanism of flight in birds. Palate in birds. Migration in birds.

**UNIT IV**

Origin of mammals.

Characters and affinities of Prototheria and Metatheria. Dentition in mammals. Aquatic and flying adaptations in mammals, Adaptive radiation in mammals.

**Recommended Books:**

1. Pandey B.N. and Mathur V. Biology of Chordates, PHI Learning, 2018
2. Parker T.J. & Haswell WA: A Text Book of Zoology, Vol II, ed. 7th, Macmillan & Co. Ltd, London, 1962.
3. Young JZ: The Life of Vertebrates, Oxford, 1950.
4. R.L. Kotpal: Modern Text-book of Zoology, Vertebrates. Rastogi Publication.
5. E.L. Jordan and P.S. Verma: Chordate Zoology. S. Chand & Co. Ltd.
6. Hildebrand: Analysis of Vertebrate structure.
7. Romer & Parsons: The Vertebrate Body, Saunders.

**M.Sc. Zoology 3<sup>rd</sup> Semester**  
**Paper C10: Ecology & Wild Life**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**UNIT I**

Ecology: Definition, Scope, Importance, Application. Limiting Factors: Liebig's law of the minimum, Shelford's law of tolerance. Combined concept of limiting factor, Factor interaction. Homeostasis. Biogeochemical cycle: Concept & Types of biogeochemical cycle (nitrogen, phosphorus, carbon & water cycle). Ecosystem. Concept; Energy flow; Food chains & Ecological pyramids. Habitat Ecology: Concept of habitats & ecological niche.

**UNIT- II**

Population: Concept & attributes: Biotic potential, Density, Natality, Mortality; Intrinsic rate of natural increase, survivorship curves. Population growth forms; Carrying capacity; Population regulation (Density dependent and independent). Cycles and fluctuations. Community: Concept & characteristics: Density, Dominance, Diversity & Stratification. Ecotones & Edge effect; Succession of communities; Key stone species.

**UNIT III**

Biodiversity: Endemism, Genetic, Species and ecosystems diversity; Factors influencing biodiversity Economic valuation of biodiversity: Concepts & Importance. Environmental pollution (Air, water, solid waste, Radioactive); Environmental Impact Assessment: Cumulative Impact Assessment of hydropower development; Environmental flows: need, methodologies, DRIFT, BBM

**UNIT IV**

Techniques in wildlife: Identification by natural marking, pug marks, calls, behavioural idiosyncracies etc. Passive marking (collars, tags, branding, rings etc). Dynamic marking (radiotelemetry, satellite telemetry, radioisotopic tracers). Population estimation techniques: Absolute versus relative density, total count versus estimates. Census methods (Drive count, aerial count, point count). Indices (pug marks, droppings, nests, burrows, dens, calls). Biogeography of India: Topography & Climate. Patterns of distribution of biota. Wildlife Conservation and Management: Wildlife as a resource; Principles of wildlife management. Habitat management; General introduction to Sanctuaries, National Parks and Biosphere Reserves of India; Captive breeding; Conservation of germ plasma (frozen zoo). Endangered species: IUCN categories for conservation. Endangered fauna of Himalaya (distribution, habitat, habits).

**Recommended Books.**

1. Kendeigh : Animal ecology, Prentice Hall 1961.
2. Odum: Fundamentals of ecology, Saunders Co. Publ., 1993 Indian ed.
3. Faabourg: Ornithology. An ecological approach Prentice Hall.
4. Krebs: Ecology (4th ed.) Harper Collins College Publisher
5. Negi: An Introduction to Wildlife Management, 1983.
6. Majupuria T C: Wildlife Wealth of India Tecpress Service, Bangkok, 1986.
7. Saharia: Wild life of India Nataraj Publishers, Dehradun.
8. Robert H. Giles: Wildlife Management Techniques (3rd ed.) Natraj Publishers, Dehradun,
9. Negi: Handbook of National Parks, Sanctuaries and Biosphere Reserves in India, 1995.
10. Negi: Himalayan Wildlife: Habitat & Conservation, 1992. Indus Publi. Comp., New Delhi.
11. Sharma: High Altitude Wildlife of India Oxford & IBH Publishing Co. Pvt. Ltd. 1994.
12. Richard D. Teague: A Manual of Wildlife Conservation Nataraj Publishers, 1989.
13. Smith RL: Ecology and Field Biology, Harper Collins Publ. 1996.
14. Dodson: Ecology Oxford
15. Dash MC: Fundamental of Ecology, Tata Mc Graw Hill 2001, New Delhi

**M.Sc. Zoology 3<sup>rd</sup> Semester**  
**Paper 11: Methods and Techniques**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**UNIT I**

**Microscopic Techniques:** Visualization of cells and sub cellular components by microscopy; Microscopy of living cells; measuring cell size, Scanning and transmission microscopy.

**Histochemical and Immunotechniques:** Microtomy; Localization of Protein, lipids and carbohydrates in tissues. Antibody generation; Detection of molecules using ELISA, RIA; Western Blot; Fluo- cytometry and Immunofluorescence.

**Biophysical Methods:** Molecular analysis using UV/visible; Fluorescence; Spectrophotometry; NMR and ESR Spectroscopy;

**UNIT II**

**Molecular Biology and Recombinant DNA Methods:** Isolation and purification of RNA, DNA and proteins. Analysis of RNA, DNA and proteins by one or two dimensional gel electrophoresis. Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. DNA sequencing methods, strategies for genome sequencing.

**Radio labeling techniques:** Detection and measurements of different types of radio isotopes normally used in biology; incorporation of radioisotopes in biological tissues of cells; molecular imaging of radioactive material; safety guidelines.

**UNIT III**

**Methods in field biology:** Methods of estimating population density of animals and plants; ranging patterns through direct, indirect and remote observation. Estimation of Physico-chemical Parameter- pH, Free CO<sub>2</sub>, D.O., Turbidity in water samples; Estimation of Nitrates, base deficiency in different soil samples.

**UNIT IV**

**Statistical methods:** Measures of central tendency and Dispersion; Probability distributions (Normal, Binomial and Poisson); Sampling distribution; difference between Parametric and Non parametric statistics; Confidence interval; Errors; Correlation and Regression analysis; t-test; Anova and X<sup>2</sup> test.

**Recommended Books:**

1. Sharma, V.K.: Techniques in Microscopy and Cell Biology Tata McGraw Hill, 1991.
2. Alberts et al.: Molecular Biology of the cell (2nd ed.), Garland, 1989.
3. Biochemical Technique: Theory & Practical J.F. Robyt & B.J. White \$ 30.95 Waveland Press, Inc.
4. Wilson & Walker: Practical Biochemistry (4<sup>th</sup> ed) Univ. of Hertfordshire Cambridge Univ. Press
5. Jayaraman: Laboratory Manual in Biochemistry
6. Arnold L. Demain & Julian E. Davies: Manual of Industrial Microbio. & Biotech. 2nd ed.

**M.Sc. Zoology 3<sup>rd</sup> Semester**  
**Paper E02 a : Fish Biology I**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**UNIT I**

**Systematics and Phylogeny:** Introduction and History of Ichthyology. Zoogeographical distribution Origin, evolution, and phylogeny of fishes. Schemes of classification of fossil and recent fishes. General Characters of Teleost and Elasmobranch fishes. Agnatha: Characters, basic biology and affinities of Cyclostomes and Ostracoderms. Placoderms: General characters and affinities. Holocephali: Salient features external and internal morphology and affinities. Dipnoi: Salient features and affinities.

**UNIT II**

**Comparative Morphology of Telesosts and Elasmobranchs:** Morphometric and meristic study of fishes. Integuments (Teleosts and Elasmobranchs), colouration and its significance, mechanism of colour change. Exoskeleton: Structure and development of placoid and nonplacoid scales. Fins and their origin. Skeletal system : Vertebrae, Girdles, Opercular bones, Pharyngeal bones

**UNIT III**

Alimentary canal and associated glands. Modifications based on different feeding behaviour. Structure of heart, afferent and efferent branchial arteries. Structure of a Gill and Pseudobranch. Brain and cranial nerves in fishes. Urino-genital system of a teleost and an elasmobranch fish. Techniques for the study of histology, histochemistry and biochemistry.

**UNIT IV**

**Fish Physiology** Respiration: Functional organization of Gill lamellae, Blood supply of gill. Mechanism of gas exchange, Counter current mechanism. Physiology of excretion and osmo-regulation, Mechanism of water- salt balance in freshwater, marine and estuarine fishes. Reproductive physiology: Spawning patterns and stimulating factors, Follicular atresia. Haemopoiesis: Composition of Blood, haemopoietic tissues, synthesis of Haemoglobin. Physiology of Thermo-regulation in fishes.

**Recommended Books:**

1. Srivastava: Fish Biology, Narendra Publication House, 2008.
2. Ojha: Biology of Hill Stream Fish, Narendra Publication House, 2002.
3. Kyle: The Biology of Fishes, 2007.
4. Singh: Advances in Fish Biology, Hindustan Publishing Corp., 1994.
5. Munshi & Munsi: Fundamental of Freshwater Biology, Narendra Publ. House, 1995.
6. Carlander: Handbook of Freshwater Fishery Biology, vol. 2, Iowa State Univ. Press, 1977.
7. SS Khanna & H.R. Singh: Fish & Fisheries

**M.Sc. Zoology 3<sup>rd</sup> Semester**  
**Paper E02b : Entomology I**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**UNIT I**

Introduction to external morphology: body wall, segmentation. The head: structure of head; appendages, and antennae. The thorax: pro, meso and metathorax; legs. The wings: origin, structure and articulation. The abdomen: structure, appendages; external female and male genitalia.

**UNIT II**

Classification of insect with special reference to that of different orders. General characters, habits, habitats, importance of the insect orders-Collembola, Protura, Diplura, Thysanura, Ephemerida, Placoptera, Odonata. General characters, habits, habitats, importance of the insect orders-Embioptera, Orthoptera, Phasmida, Dermaptera, Blattaria, Menteodea, Isoptera, Zoraptera.

**UNIT III**

General characters, habits, habitats, importance of the insect orders-Psocoptera, Thysanoptera, Heteroptera, Homoptera, Anoplura, Neuroptera, Megaloptera, Trichoptera.

**UNIT IV**

General characters, habits, habitats, importance of the insect orders-Coleoptera, Strepsiptera, Hymenoptera, Lepidoptera, Diptera.

**Recommended Books.**

1. Mani MS: An Introduction to Entomology, National Book Trust, 1971.
2. Mani MS, Introduction to High Entomology, Mathuen & Coy. Ltd. 1962.
3. Snodgrass RE: Arthropod Anatomy, Comstock Publ. Associates, NY, 1952.
4. Wigglesworth VB: Insect Physiology, Cambridge University Press, 1954.
5. Essig EO: College Entomology, Satish Book Enterprise, Agra, 1982.
6. Fox RM & Fox JW: Introduction to Comparative Entomology. Affiliated East-West Press Pvt. Ltd. New Delhi, 1968.
7. Little VA: General & Applied Entomology, Oxford & IBH Publ. Copy, 1963.
8. Imms AD: Insect Natural History, Collinns St. James's Place London, 1947.
9. Elzinga RJ: Fundamentals of Entomology, Prentice Hall of India Pvt. Ltd., 1978.
10. Comstock JH: An Introduction to Entomology, Comstock Publ. Coy. INC., 1950.
11. Richard DW and Davies RG: A General Text Book of Entomology, Mathuen & Coy., Ltd.

**M.Sc. Zoology 3<sup>rd</sup> Semester**  
**Paper E02c : Environmental biology I**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**UNIT I**

Introduction to Environmental biology, its multidisciplinary nature and scope. Components of Environment: atmosphere, lithosphere & hydrosphere. Climate (micro, regional and global); Hydrological cycle; Soil profile. Changing interactions between man and environment (cultural, political, ecological).

**UNIT II**

Terrestrial biomes of the world their characteristics and major biota (Grassland, Desert, Forest, Tundra). Aquatic biomes (lotic, lentic, marine, estuaries, coral reef), their status. Wetlands of India. Environmental adaptations: Aquatic, Aerial, Desert, Arboreal, Fossorial, Defensive.

**UNIT III**

Island biogeography theory. Habitat fragmentation, Habitat selection, Corridors, Community patterns (gradients and Continuum), Community indices. Ecological niche. Population cycles and fluctuations; Dispersal. Intra & Inter specific relationship. Models of succession; Pioneer & climax concept.

**UNIT IV**

Concept of biological indicators; biological monitoring; Indicator organisms. Invasive species and its impact. Biological control: Biomagnification, Bioassimilation & Bioaccumulation. Xenobiotics: Carcinogenic (heavy metals, pesticides).



**M.Sc. Zoology 4<sup>th</sup> Semester**  
**Paper C11: Endocrinology and Animal Behaviour**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**Endocrinology**

**UNIT I**

Endocrine messengers: hormones, neurohormones, hormone like substances (neuronal peptides, autocoids, pheromones, neurosecretion). Hormones and Physiological actions of the following endocrine glands in vertebrates: Thyroid, Parathyroid, Pancreas, Gastro-intestinal tract, Adrenal cortex and Medulla, Thymus & Pineal. Hormone biosynthesis: Protein peptide hormones (gonadotrophins, thyrotrophin, corticotrophin, Steroids and catecholamines). Mechanism of action of Protein hormones and Catecholamines: membrane bound receptors, G-protein and control of adenylyl cyclase, Cyclic nucleotide cascade.

**UNIT II**

Mechanism of action of Steroid and Thyroid hormones: Cytosolic receptors, effect on transcriptional and translational processes. Organisation & physiological actions of the Testis: Androgen binding protein (ABP), Inhibin. Neuroendocrine control of testicular functions (Gn RH regulation, FSH- effects on germinal epithelium, LH-effects on Leydig cells, negative feedback regulation). Organisation & physiological actions of the Ovary: Folliculogenesis, Ovulation, Luteinization, Ovarian cycles; Seasonal reproductive cycles; sexual dysfunctions in man.

**Animal Behaviour**

**UNIT III**

The science of behaviour: History, scope and terminology. Proximate and ultimate causes of behaviour. Instinct: Definition and characteristics (sign stimuli and Fixed Action Pattern). Learning behaviour: Definition. Spatial learning. Associative learning, classical conditioning, operant conditioning, language learning. Imprinting. Kin recognition. Instinct versus learning behaviour. Timing of behaviour: Biological rhythms. The Biological Clock. Circadian rhythms and their synchronisation seasonal rhythms. Photoperiodism.

**UNIT IV**

Communication: Visual, olfactory, acoustic. Bird songs. Amphibian calls. Communication in bats. (echolocation in bats, electrolocation in fish) Chemoreception: Chemicals (pheromones) as signals in insects, fish and mammals. Role of olfaction in communication behaviour (territorial, sex recognition, feeding etc) in fish and mammals. Neural control of behavior: Components of brain involved in various behaviours. Neural control of drinking, learning, eating, activity & rest, sleep, aggression, sexual behaviour. Hormonal Control of behaviour. Hormone brain relationships. Sexual behaviour in mammals (eg. rat). Sociobiology: Elements of sociality and social grouping in animals. Grouping versus predation. Grouping vs foraging. Evolutionary and ecological aspects of animal behaviour. Territoriality. evolution of migratory behaviour, costs and benefits of migration. Ecology of foraging behaviour: Prey detection. Prey capture. Antipredator behaviour. Cooperation and conflict: Evolution of altruism. Evolution of cooperative breeding in birds and mammals.

**Recommended Books:**

1. Alcock : Animal behaviour Sinaur Associates, Inc. 1989.
2. Goodenough et al.: Perspectives on animal behaviour. Wiley & Sons, New York. 1993.
3. Grier : Biology of animal behaviour, Mosby 1984.
4. Krebs & Davies : An introduction to behavioural ecology (3rd ed.) Blackwell 1993.
5. Lehner : Handbook of ethological methods, Garland STPM Press, New York, 1979.
6. Halliday, T.R.: Animal Behaviour Vol. 1 & 2 Communication, 1983.
7. Saunders : Insect Clocks Pergamon Press. 1982.
8. Palmer: An Introduction to Biological Rhythms Academic Press New York.1976
9. Ross & Salisbury: Plant Physiology, Indian ed. (FOR BIOLOGICAL RHYTHMS)
10. Mac E. Hadley: Endocrinology, Prentice-Hall International ed.1988/1992.
11. G J Goldsworthy et al: Endocrinology, Blackie, 1981.

**M.Sc. Zoology 4<sup>th</sup> Semester  
Paper C12: Biochemistry**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**UNIT I**

Enzymes: Classification (rationale, overview and specific example) Zymogens and their activation (protease and Prothrombin). Enzyme substrate complex : concept of E-S complex, binding sites, active site, specificity, Lock and Key Hypothesis, Induced -Fit Hypothesis, Michaelis- Menten equation and its derivation, Different plots for the determination of Km and Vmax.

**UNIT II**

Carbohydrate Metabolism I: Pathway and regulation of Glycolysis, Gluconeogenesis, Glycogenolysis, Glycogenesis. Carbohydrate Metabolism II: Citric acid cycle and its regulation, electron transport chain and oxidative phosphorylation, pentose phosphate pathway and its regulation.

Amino Acid Metabolism: Overview of Amino acid degradation, Urea cycle (conversion of ammonia into urea, linkage between urea cycle and citric acid cycle) and its regulation. Conversion of nitrogen to ammonia by microorganisms, overview of amino-acid biosynthesis.

**UNIT III**

Fatty Acid Metabolism: Fatty Acid Oxidation and regulation  $\beta$ -oxidation, Oxidation of unsaturated fatty acids and odd chain fatty acids.  $\beta$ -oxidation in peroxisomes, ketone bodies and their overproduction. Fatty Acid Biosynthesis and Regulation. Reactions of fatty acid synthase, synthesis of triglycerols, membrane phospholipids & prostaglandins. Cholesterol biosynthesis and regulation.

**UNIT IV**

Nucleic Acid Metabolism: Purine biosynthesis and its regulation, pyrimidine biosynthesis and its regulation. Formation of deoxyribonucleotides. Salvage pathway for purine & pyrimidine in nucleotides, Degradation of purines and pyrimidines into uric acid and urea. Integration of Metabolism.

**Recommended Books**

1. Lehninger: Principles of Biochemistry, 4th ed., Nelson & Cox, WH Freeman and Co., 2007
2. Voet & Voet: Biochemistry, 2nd ed., Wiley & Sons.
3. Berg, Tymoczko, Stryer: Biochemistry, 5th ed., WH Freeman and Company, 2003.
4. Garrett & Grisham: Biochemistry, 4th ed., Brooks/Cole Cengage learning, 2010.
5. Murray, Granner, Rodwell: Harper's Illustrated Biochemistry, 27th ed. McGraw Hill, 2006
6. Conn & Stumpf: Outlines of Biochemistry, 5th ed., Willey India, 2007.

**M.Sc. Zoology 4<sup>th</sup> Semester  
Paper E03a : Fish biology II**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**UNIT I**

**Specialized Characters:** Accessory Respiratory organs in fishes. Swim Bladder and its modifications, Blood supply of Air bladder, Gas secreting complex, Functions Weberian ossicles: Structure and arrangement, Working mechanism and functions. Electric organs: Structure, Mechanism of electric discharge, Functions. Bioluminescence: Luminiscent organs, Mechanism of light emission, Significance. Sound production in fishes

**UNIT II**

**Fish Behaviour** Fish behavior: Social, ecological, reproductive, migratory, foraging behavior. Parental care in fishes. Receptor organs: Eye, Acoustico-Lateralis system; olfactory organs and Taste buds Migration in fishes: Pattern, Causes and Factors influencing. Parental care and viviparity in fishes. Pheromones and their role in sexual behavior of fish

**UNIT III Fish Embryology** Fertilization and development of fish egg (Telēost). Cleavage, Blastulation, Gastrulation and fate map. Hatching and post-embryonic development.

**UNIT IV Endocrine and Biochemistry** Pituitary gland: Micro-anatomy, Hormones of Pituitary and their physiological actions. Thyroid gland: Structure and function Structure and functions of Pancreatic islets in fishes. Location and functions of Corpuscles of Stannius, Pineal and Urophysis in fishes.

**Recommended Books**

1. Agarwal N K : Fish Reproduction, APH Publication
2. Srivastava CBL: Fish Biology, Narendra Publication House, 2008.
3. Carlander: Handbook of Freshwater Fishery Biology, vol. 2, Iowa State Univ.Press,1977.
4. Ojha J: Biology of Hill Stream Fish, Narendra Publication House, 2002.
5. Singh H R: Advances in Fish Biology, Hindustan Publishing Corp., 1994.
6. Munshi & Munsil: Fundamental of Freshwater Biology, Narendra Publ. House, 1995.
7. Kyle: The Biology of Fishes, 2007.
8. Khanna & Singh: Fish & Fisheries

**M.Sc. Zoology 4<sup>th</sup> Semester**  
**Paper E03b : Entomology II**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**UNIT I**

Digestive system: structure, physiology of digestion and absorption of different types of food. Structure of circulatory system: haemolymph its composition and function. Physiology of respiration; the tracheal system, spiracles, respiration in aquatic insects. Nervous system: structural basis, Excretion: structure and physiology of malpighian tubules and its secondary functions. Reproduction: male and female gonads.

**UNIT II**

Structure of compound eye, mosaic vision. Production and reception of sound. Light producing organs. Hormones: neurosecretion and co-ordination, Metamorphosis: types, hormonal control of metamorphosis, Pheromones.

**UNIT III**

Structure of the insect egg, maturation, cleavage, formation of blastoderm, gastrulation, blastokinesis, germ layers, Various types of larvae and pupae, moulting, diapauses, Oviparity, viviparity, ovo-viviparity in insects.

**UNIT IV**

Abiotic factors: effect of temperature, light and humidity on growth of insect population; biotic potential, Malthusian principle and dynamics of population fluctuation, hibernation, aestivation. Biotic factors: parasitism, predation and social life in insects, phase theory of locust, parental care.

**Recommended Books.**

1. Mani MS: An Introduction to Entomology, National Book Trust, 1971.
2. Mani MS, Introduction to High Entomology, Mathuen & Coy. Ltd. 1962.
3. Snodgrass RE: Arthropod Anatomy, Comstock Publ. Associates, NY, 1952.
4. Wigglesworth VB: Insect Physiology, Cambridge University Press, 1954.
5. Essig EO: College Entomology, Satish Book Enterprise, Agra, 1982.
6. Fox RM & Fox JW: Introduction to Comparative Entomology. Affiliated East-West Press Pvt. Ltd. New Delhi, 1968.
7. Little VA: General & Applied Entomology, Oxford & IBH Publ. Copy, 1963.
8. Imms AD: Insect Natural History, Collinns St. James's Place London, 1947.
9. Elzinga RJ: Fundamentals of Entomology, Prentice Hall of India Pvt. Ltd., 1978.
10. Comstock JH: An Introduction to Entomology, Comstock Publ. Coy. INC., 1950.
11. Richard DW and Davies RG: A General Text Book of Entomology, Mathuen & Coy., Ltd.

**M.Sc. Zoology 4<sup>th</sup> Semester**  
**Paper E03c : Environmental Biology II**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**UNIT I**

Natural Resources: Management & conservation; Renewable & non-renewable resources; Concept and currencies of Sustainable development. Biodiversity & its conservation. Environment Protection laws. Earth Summit, Rio+20.

**UNIT II**

Concept of Protected areas: Sanctuary, National Parks & Biosphere Reserves. IUCN. Categories Biodiversity hot spots, conventions on biodiversity. International efforts in biodiversity conservation (UNFP, IUCN, WWF); CITES; UNESCO's World heritage mission; Convention on Biological Diversity (CBD).

**UNIT III**

Global Environmental Problems: Climate change, Green house effect; Acid rain; Ozone layer depletion; Deforestation; Desertification; Marine pollution; Urbanization.

**UNIT IV**

Environmental Problems/Hazards in Hills: Earthquake; Land slide; Soil erosion; Sedimentation; Cloud burst; Flash floods; Glacial retreat. Application of Remote sensing & Geographical Information Systems (GIS) in environment management

**M.Sc. Zoology 4<sup>th</sup> Semester**  
**Paper E04a : Applied Fish Biology**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**UNIT I**

**Aquaculture:** Scope, importance and present status. Concept of different culture systems: Extensive and intensive fish culture, Fish culture in ponds and reservoirs. Culture in rice fields, bheries, Cage culture, Pen culture, Monoculture and polyculture. Preparation and maintenance of fish farm: Fertility and pH maintenance. Role of fertilizers, required water quality and its maintenance. Control of aquatic weeds, insects and predatory fishes. Fish nutrition: Development of natural food and supplementary feeding. Culture techniques Procurement of stocking material from natural sources, Induced breeding and use of new generation drugs, ovaprim, different hatching techniques, Transport of fish seed.

**UNIT II**

**Culture Practices:** Culture of Common carp and Exotic Trouts. Prawn culture. Sewage – fed Fisheries and Integrated fish farming Common fish diseases and their control. Mahseer and Schizothoracid fishery. Current status, problems and perspectives. Culture of Larvicidal fishes. Characters and importance

**UNIT III**

**Harvesting and Post harvesting** Fishing gears used in inland waters and seas. Fish preservation and processing techniques. Fish by-products and their uses. Fish spoilage: Causes of rigor mortis, precautions to control rancidity, microbial spoilage. Nutritive value of fish, biochemistry of fish flesh of Indian major carps. Storage, transportation and marketing.

**UNIT IV**

**Capture and Ornamental Fishery:** Rivers, Lakes, Dams / Reservoir fishery- Problems and perspectives in Capture fisheries. Estuarine fishery. Characteristics and species dynamics. Marine fishery: Coastal, Off shore and deep sea fishery. Exclusive Economic Zone. (Hilsa, Oil sardine, mackerel, Bombay duck, Sole, Ribbon, Shark and Rays). Recreational fishery and Cooperative movements. Fish Farmers Development Agencies (FFDA). Climate change and fishery. Major, Marine and freshwater ornamental fishes, their food & breeding needs. Health management of ornamental fishes. Specific diseases and their cure. Setting and maintenance of aquaria.

**Recommended Books**

1. Singh & Lakra: Cold Water Aquaculture and Fisheries, Narendra Publication House, 2000.
2. S.K. Gupta, P.C. Gupta: General and Applied Ichthyology, S. Chand & Comp., 2006.
3. Vadapalli Satyanarayana: Fish Culture, Narendra Publ. House, 2002.
4. R.K. Rath: Freshwater Aquaculture, 2nd ed., Scientific Publishers, 2000.
5. Singh & Mittal: Dictionary of Aquaculture, Daya Publishing House, 1963.
6. Tor G. Heggberget: The Role of Aquaculture in World Fisheries, Oxford Univ. Press, 1996.
7. Jhingran: Fish and Fisheries of India.
8. Thomas P.C., Rath, S.C. and Mohapatra, Kanta Das. Breeding and Seed Production of Fin Fish and Shell Fish.

Enrollment No. \_\_\_\_\_

**M.Sc. Zoology 4<sup>th</sup> Semester**  
**Paper E04b : Applied Entomology**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**UNIT I**

Insects in relation to man: sericulture, apiculture and lac culture and its parasites, predators and diseases. Insect of veterinary importance; sand fly, horse fly, sucking louse, fleas.

**UNIT II**

Brief knowledge of important household, vegetable, store grain and fruit pests with special reference to distribution, habits, habitat, nature of damage, life history and control. Cut worm (*Agrotis ipsilon*) Cabbage caterpillar (*Pieris brassicae*) Rice weevil (*Sitophilus oryzae*) Mustard aphid (*Lipaphis erysimi*) Red cotton bug (*Dysdercus cingulatus*) Woolly apply aphid (*Eriosoma lanigerum*) Termite: important termites of Fam. Termitidae (*Odontotermis sp.*)

**UNIT III**

Origin of pests, Insect pest control; mechanical, physical, culture, biological. Fenetical control: chemosterilants, radiation.

**UNIT IV**

Integrated Pest Management (IPM), Role of pheromones and hormones in insect pest management. Legislative control of insect pests and quarantine law. Nomenclature and classification of insecticides on the basis of mode of action, chemical nature. Environmental factors influencing effectiveness of insecticides, persistence, biodegradability, hazards of insecticides, precaution and antidodes.

**Recommended Books:**

1. Ananthkrishnan TR: Applied Entomology
2. Atwal: Agricultural Pests of India and South East Asia (1986, Kalyani Publishers)
3. Fernald HT, HH Shepard: Applied Entomology, McGraw-Hill, 1955 .
4. Hill: Pest of stored foodstuffs and their control (2002, Springer)
5. McGavin: Essential Entomology (2001, Oxford Univ Press)
6. Metcal & Flint: Destruction and useful Insects, Tata McGraw-Hill, 1979.
7. Mullen and Durden: Medical and Veterinary Entomology (2002, Academic Press)
8. Pruthi HS: Text Book on Agricultural Entomology, ICAR Publication, 1969.
9. Srivastava: A text book of applied entomology, Vol I & II (1993, Kalyani Publishers)

**M.Sc. Zoology 4<sup>th</sup> Semester**  
**Paper E04c : Applied Environmental Biology**

No. of Lectures /week  
(3 lectures of 60 minutes each)

**UNIT II**

Air: Air pollutants (chemistry, sources & control); Air Quality standards, carbon credits, carbon footprint, Thermal pollution sources and effect. Water: Biochemical aspects of water pollutants (domestic, industrial & agricultural waste). Waste water treatment (Aerobic & anaerobic treatment processes); Water quality standards. Case study-Ganga Action Plan. Noise Pollution: Effects of noise and its control.

**UNIT II**

Radioactive fallouts its effects & safe disposal. Solid waste management: Sources & control methods (composting, Vermi Culture, Biogas). Hazardous waste & their management. Bioremediation (herbicides, pesticides, hydrocarbons, oil spills). Ecological Restoration: wasteland & its reclamation & restoration.

**UNIT III**

Environmental Impact Assessment (EIA): Case study of River valley projects & Mining. Bioassay: Dose-response relationships; Frequency; Response & cumulative response; statistical concepts (LD50-potency v/s Toxicity). Concept of hyper & hypo sensitivity factors affecting Toxicity.

**UNIT IV**

Ecological experimentation & models: Theories & hypothesis; experimentation; Inductive & deductive methods. Models: Analytical & simulation models; Validation & verification. Biological pest control: Use of predators; Parasites, parasitoids & pathogenes; Integrated Pest Management.



**M.Sc. Previous (Zoology) 1<sup>ST</sup> Semester**  
**Lab Course LC01**

**Non Chordate (Invertebrate)**

1. Study of museum specimens/slides (WM/TS/LS) of: Protozoa to Echinodermata
2. Collection, fixation and permanent stained preparation of rectal ciliates and Helminthes

**Cell biology**

1. Study of meiosis in grasshopper testes by squashing method
2. Temporary squash preparation of polytene chromosomes from salivary glands of *Drosophila* larvae
3. Study of colchicinated metaphase chromosomes in bone marrow of rodent by air dry method
4. Study of permanent slides for the following
  - a. Dicentric bridge in the anaphase 1 chromosomes of grasshopper
  - b. Inversion in polytene chromosomes
  - c. Lampbrush chromosomes of *Triturus* oocyte
  - d. G-banded and C-banded metaphase chromosomes
  - e. Chromatid exchanges and chromosomal anomalies
  - f. Sister chromatid exchanges
  - g. Premature chromosome condensation

**Genetics**

1. Handling of *Drosophila* and study of its life cycle
2. Examination of wild type (males and females) and mutants of *Drosophila*
3. Sex linked inheritance in *Drosophila melanogaster*
4. Linkage and crossing over in *Drosophila melanogaster*

**Developmental Biology**

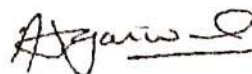
1. Collection of frog spawns and observation of different developmental stages
2. Study of embryonic developmental stages in frog through models
3. Study of spiral cleavage in eggs of snail
4. Study of embryonic development in chick through slides
5. Window preparation to study chick embryo development
6. Whole mount preparation of chick embryos at various stages of development

**Distribution of marks:**

Duration 5

hrs.

1. Spotting (10) (Protozoa to Echinodermata)	20
2. Exercise on Cell biology	10
3. Exercise on Genetics	10
4. Exercise on Developmental Biology	10
5. Permanent slide making (2)	10
6. Record and collection	10
7. Viva Voice	10
8. Sessional Marks	20
<b>Total</b>	<b>100</b>



**M.Sc. Previous (Zoology) 2<sup>nd</sup> Semester**  
**Lab Course LC02**

**Microbiology**

1. Sterilization techniques, media preparation and agar plate preparation
2. Measurement of growth curve of *E.coli.*, calculation of its generation time and viable cell counting
3. Induction of  $\beta$ -galactosidase in *E.coli*

**Parasitology:**

Study of permanent slides of parasitic protozoans, helminthes and insects

**Physiology**

1. Estimation of total leucocyte and erythrocyte number per cubic mm.
2. Differential count of leucocytes
3. Determination of clotting time
4. Determination of haemoglobin percentage
5. Preparation of haematin crystals
6. Blood group test
7. Determination of respiratory rate of fish
8. Action of amylase, pepsin and lipase on their respective substrates

**Immunology**

1. Separation of macrophages from mice and their identification on the basis of non specific esterase staining
2. Immunization of rabbit and collection of antisera
3. Demonstration of antigen-antibody reaction by immunodiffusion
4. Demonstration of direct ELISA
5. Demonstration of western blotting

**Molecular Biology and Biotechnology**

Demonstration of DNA amplification by polymerase chain reaction and Southern hybridization

**Distribution of marks:**

1. Spotting (10) Parasitology	20
2. Exercise on Physiology	10
3. Exercise on Immunology	10
4. Exercise on Microbiology/Biotechnology	10
5. Permanent slide making (2) Parasites	10
6. Record and collection	10
7. Viva Voice	10
8. Sessional Marks	20
<b>Total</b>	<b>100</b>

Duration 5 hrs.

**M.Sc. Final (Zoology) 3<sup>rd</sup> Semester**  
**Lab course LC03**

**Study of museum specimens of:** Protochordates; Cyclostomes; Fishes; Amphibia;  
Reptiles; Birds; Mammals

**Preparation of Permanent slides:**

**Ecology**

1. Determination of standing crop energy status in a grassland area and construction of number and biomass (wet weight) pyramids
2. Study of biotic components of a terrestrial ecosystem and description of their morphological adaptations of the collected organisms
3. Study of biotic components of a pond ecosystem and description of morphological adaptations of the collected organisms
4. Estimation of autotrophs in a terrestrial ecosystem
5. Frequency of different species
6. Abundance of species in the community
7. Density of different species in the community by quadrat method
8. Estimation of heterotrophs in a terrestrial ecosystem
9. Determination of texture, pH, carbonate, nitrate and base deficiency in different soil samples
10. Measurement of chlorophyll content per unit area of a grass field
11. Estimation of grasshopper population density of an area by capture-recapture Method
12. Measurement of oxygen change and productivity differences in a pond ecosystem by Winkler's method

**Biological tools**

1. Study of different components of student's microscope and its assembly
2. Study of different components of stereobinocular microscope and its assembly
3. Study of different parts of binocular research microscope
4. Measurement of microscopic object using ocular and stage micrometers
5. Setting up of darkfield and phase contrast microscope
6. Demonstration of working of fluorescence, confocal and electron microscopes

**Distribution of marks:**

1. Spotting (10) (Protochordate to Mammal; Histology; Osteology)	20
2. Exercise on Ecology	10
3. Exercise on Biological tools	10
4. Microtomy of fish/Insect tissue or	15
5. Comment upon dissected Chordates	05
6. Record and collection	10
7. Viva Voice	10
8. Sessional Marks	20

**Total**

**100**

Duration 5 hrs.

**M.Sc. Final (Zoology) 4<sup>th</sup> Semester**  
**Lab Course LC 04**

**Animal Behaviour**

1. Study of habitat selection in spiders or larvae of *Drosophila melanogaster* or woodlice
2. Study of learning behaviour in mice by using a zigzag or T-shaped maze
3. Study of wall-seeking behaviour in mice
4. A field study of foraging or trail making behaviour in a seed harvester or predatory ant species
5. Study of nest building behavior in birds

**Endocrinology**

1. Study of histological slides of TS/ LS of major endocrine glands of frog and mammal
2. Comment upon the photographs of patients suffering from various endocrine disorders

**Biochemistry**

1. Preparation of buffer and measurement of pH using pH meter
2. Demonstration of separation of subcellular organelles by differential centrifugation
3. Verification of Beer's law and preparation of absorption spectrum of riboflavin
4. Demonstration of separation of protein by native and SDS-polyacrylamide gel Electrophoresis
5. Separation of amino acids by paper chromatography
6. Studies on quantitation of proteins by various methods : Biuret, Lowry, Bradford, and UV spectrophotometry

**Fish biology/ Entomology/**

1. Study of external morphology and internal anatomy of common fishes/insects.
2. Taxonomic identification of locally available common fishes/insects.
3. Dissection of accessory respiratory organs and Weberian ossicle of locally available food fishes
4. Permanent preparation of material/tissues from common fishes/insects
5. Study of histological slides of different organ systems of fishes/insects
6. Determination of Age in Fishes by Scale, otolith and vertebrae methods.
7. Estimation of fecundity, Measurement of egg size(Fish/insect) by micrometry

**Environmental biology**

(Exercise on environmental biology based on theory paper E03c and E04c)  
Water quality analysis: Measurement of dissolved oxygen, free carbon dioxide, pH, turbidity, hardness, alkalinity, BOD, COD, dissolved nutrients (Nitrates, phosphates, sodium, potassium, chloride, etc.), Sampling of terrestrial flora and fauna by quadrat method and their population study. Sampling and study of aquatic fauna and flora (plankton, periphyton, micro and macroinvertebrates, nekton, etc.). Measurement of soil pH, water holding capacity, organic matter, soil nutrients (nitrate, nitrite, calcium and magnesium),

**Distribution of marks:**

	Duration 5 hrs.
1. Spotting (10)	20
2. Exercise on Anatomy (Fish/Insect)/ or /Exercise on environmental biology based on theory paper 15c	10
3. Exercise on Identification (Fish/Insect) or Exercise on environmental biology based on theory paper 16c	10
4. Exercise on Endocrinology	10
5. Exercise on Biochemistry/Animal behaviour	10
6. Record and collection	10
7. Viva Voice	10
8. Sessional Marks	20
<b>Total</b>	<b>100</b>

