

**M.Sc. Zoology 1st Semester
Core Course
Paper-I: Biosystematics and Taxonomy**

Course Code: ZYM-1001

**Credit: 04
Sessional: 30 Marks
End Term Exam : 70 Marks**

Unit – I

- Basic concept of animal taxonomy. Classical taxonomy to systematic: A historical review; taxonomic terms; taxonomy; classification and nomenclature; phenon, taxon and category; α , β and γ taxonomy
- Modern concepts and recent trends: chemotaxonomy, cytotaxonomy, serotaxonomy and molecular taxonomy
- Importance of application of systematics in biology
- Taxonomy vis-a-vis biodiversity conservation

Unit – II

- Microtaxonomy: species concepts; typological species concept, nominalistic species concept, biological species concept and evolutionary species concept.
- Polytypic and monotypic species; species category; subspecies and other infra-specific categories; Infra-subspecific categories and intra-population variants
- Origin of reproductive isolation and mechanism of speciation
- Macrotaxonomy; Theories and practice of biological classification: some basic principles of classification: The three schools of macrotaxonomy: Phonetics, cladistics and phylogenetic classification and their comparison
- Variations and their importance in systematics

Unit – III

- Taxonomic characters, Kinds and functions of taxonomic characters; plasmorphic and apomorphic characters.
- Taxonomic procedures – collection, preservation and process of identification of Biological species.
- Taxonomic keys – different kinds of taxonomic keys, their merits and demerits
- Systematic publication – different kinds of publication
- Process of typification of different zoological types

Unit – IV

- International Code of Zoological Nomenclature (ICZN), its operative principles; history of rules of Zoological nomenclature
- Interpretation and application of important rules. Criteria of publication, criteria of availability of names, principles of priority, homonymy, synonymy, type concept.
- Zoological nomenclature, formation of scientific names of different taxa. Regulations governing this code and code of ethics
- Taxonomy, the present scenario and the global taxonomic initiatives

Books recommended

1. Principles of Systematic Zoology by Ernst Mayr
2. Principles of Systematic Zoology by ErntsMayr& Peter D. Ashlock
3. Principles of Animal Taxonomy by G. G. Simpson
4. Animal Taxonomy by H. E. Goto
5. International Code of Zoological Nomenclature official publication

**M.Sc. Zoology Ist Semester
Core Course
Paper- II: Animal Ecology**

Course Code: ZYM 1002

**Credit: 04
Sessional: 30 Marks
End Term Exam : 70 Marks**

Unit - I Definition and scope of ecology in modern perspective. Climatic factors: Temperature, light, precipitation with special reference to biomes. Climate diagrams. Animals' adaptations and performance in response to extreme climatic variables (ecto-, endotherms; dark and light adaptations). Water budget; water conservation and regulation in terrestrial and aquatic environments. Biogeographical zones of India; theory of island biogeography.

Unit - II Ecosystem: Types of ecosystem: terrestrial and aquatic ecosystems with species reference to India. Flux of matter (biochemical cycles) and energy flow in the ecosystem. Patterns of terrestrial and aquatic primary productions. Trophic levels and their Interpretations. Feeding guilds. Trophic level, food chain, food web and food web complexity; keystone species. Stability and resilience of the ecosystem. Stable and unstable ecosystem. Ecosystem modelling and simulation. Sampling methods in ecological studies.

Unit - III Population characteristics: distribution (small and large scale distribution) and abundance. Organism size and population density. Birth and death rates. Patterns of survival and life tables. Age and sex ratio distribution. Factors regulating population dispersal and growth. Metapopulations, demes and interdemec extinction. Life history strategies: reproductive effort, offspring size and cost-benefit ratio. Patterns of population growth. Human population and carrying capacity. Changing relations of human and environment since prehistoric times.

Unit - IV Community characteristics; interactions: Positive interactions; commensalism, proto-cooperation and mutualism. Negative interactions: parasitism and allelopathy; predation and predator-prey dynamics; herbivory. Interspecific competition and coexistence, niche overlap and segregation Lotka-Volterra-competition theory. Principles of competition exclusion. Ecological succession. Biodiversity: status, monitoring and documentation; major drivers of biodiversity change; Biodiversity using GPS, GIS and remote sensing.

Books recommended

1. Odum E. P., 1983. Basic Ecology, Saunders College Publishing
2. Stiling, P. 2002. Ecology: Theories and Applications. Prentice Hall of India Pvt. Ltd.
3. Begon, M. Harper, J. L. & Townshend C. R. 1996. Ecology. Blackwell Science Ltd.
4. Kormondy, E. J. 1996. Concepts of Ecology. 4th Edition. Prentice-Hall, In

**M.Sc. Zoology I Semester
Core Course
Paper-III Endocrinology**

Course Code: ZYM 1003

Credit:	04
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit – I: Meaning, Aims, Scope and Methods in Endocrinology

Chemical integration & homeostasis. Classification of hormones. Autocrine/Paracrine signals. Miscellaneous regulatory substances (erythropoietin, somatomedin growth factors, eicosanoids etc). Neuroendocrine system. Hormonogenesis. Transport and Distribution. Mechanism of hormone action. Cell surface receptors and intracellular signalling.

Unit – II: General Organisation of Endocrine Structures and Function – I

General organization and interrelationship of endocrine glands and their secretions. **PITUITARY GLAND:** Comparative morphology and anatomy of adeno- and neurohypophysis, Adenohypophyseal and Neurohyphyseal hormones (NP): structure and biological role, Phyletic distribution of NP. Hypothalamic control of hypophyseal hormones.

Unit –III: Endocrine Glands-structure and function - II

THYROID: Comparative gross anatomy, Thyroid hormones-synthesis, secretion and transport. Physiological and metabolic functions of thyroid hormones, Thyroid hormone related disorders. Parafollicular C-Cells.

PARATHYROID: Structure and function of parathyroid hormone.

ENDOCRINE PANCREAS: Anatomy and cytology, Insulin: structure, biosynthesis, regulation of insulin secretion and functions, Glucagon:structure, biosynthesis and function, Diabetes mellitus-types and management.

Unit – IV: Endocrine Glands-structure and function - III

ADRENAL GLAND: Gross comparative anatomy, corticosteroids and catecholamine: structure, nomenclature and function. Renin Angiotensin System. **GONADAL HORMONES:** Male and female sex steroids: structure and functions. **GI TRACT HORMONES** – types and functions. **Pineal, Principal invertebrate hormones. Ultimobranchial body, Corpuscles of stannius, Urophysis.** Multihormonal regulation of calcium homeostasis.

Books recommended

1. Comparative Endocrinology by Gorbman, Dickhoff, Vigna, Clark & Ralph (John Wiley & Sons)
2. Vertebrate Endocrinology by Norris (Lea and Febigar)
3. Comparative Vertebrate Endocrinology by Bentley (Cambridge University Press)
4. Basic & Clinical Endocrinology by Greenspan and Strewler

BOS: 02.06.2018

**M.Sc. Zoology 1st Semester
Core Course
Paper - IV Gamete Biology**

Course Code: ZYM 1004

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit - I Scope of Gamete Biology; Heterogamy in animals and its significance; Gonadal differentiation in a mammal and an invertebrate: comparative account of sex-specific changes and genetic basis of its regulation.

Unit - II Ovarian follicular growth and differentiation: structural and hormonal changes during major developmental events; Biochemical changes in ovum during vitellogenesis, Ovulation, process and types; ovum transport in mammals.

Unit - III Leydig cells: morphology and differentiation; Hormones released by Leydig cells, their function and feedback regulation with special reference to testosterone, spermatogenesis in a mammal, morphological basis of the stages involved.

Unit - IV Fertilization: process and events; Pre-fertilization events; biochemistry of fertilization, role of enzymes, physical and chemical changes at fertilization, capacitation, acrosomal reaction and penetration, activation of oocyte, amphimixis; post-fertilization events, pathological polyspermy.

Books recommended:

1. An introduction to Embryology by B.I. Balinsky, Publisher - Thomas Asia Pvt. Ltd
2. Developmental Biology by Berril, N.J. Mc. Graw Hill, New Delhi
3. Gene Activity During Early Development by Davidson, E.H. Academic Press, New York
4. Principles of Development by Lewis Wolpest, Oxford University Press

**M.Sc. Zoology 1st Semester
Core Course
Paper-V: Essentials of Biological Chemistry**

Course Code: ZYM 1005

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit – I: Carbohydrates

Classification, nomenclature and functions. Glycosidic linkages. Structures: Open chain forms, asymmetric carbons, isomers, epimers, enantiomers, cyclic hemiacetal and hemiketals- ring structures. Anomeric carbons, mutarotation. Structural and storage polysaccharides. Synthesis and breakdown of glycogen. Glycoproteins and blood group antigens. Quantitative and qualitative analysis of carbohydrates.

Unit – II: Enzymes

General characteristics of enzymes, their nomenclature, distribution in sub-cellular compartments and assays. Ribozyme. Quantitative assays of enzyme: End point and continuous. Factors affecting the enzyme activity- pH, temperature, substrate and product concentration. Free energy changes, energy of activation. Enzyme specificity. Enzyme kinetics: Michaelis-Menten kinetic theory, Michaelis-Menten equation and plot. Lineweaver – Burk plot. Enzyme Inhibition: competitive (reversible and irreversible) and non-competitive inhibition, medical relevance of enzyme inhibition. Isozyme profile and its significance.

Unit –III: Amino acids and proteins

Structures, classification and properties of amino acids. Chemical bonds involved in protein structure. Characteristics of peptide bond. Primary, secondary, tertiary and quaternary structure of proteins. Metabolism of amino group (Transamination and oxidative deamination) and carbon skeleton in brief. Transport of ammonia.

Unit – IV: Lipids

Structures and types of saturated and unsaturated fatty acids. Lipid metabolism: Biosynthesis of fatty acids (saturated and unsaturated). Mobilization of stored fats, oxidation of fatty acids (β -oxidation) and carnitine shuttle. Ketogenesis: biosynthesis and utilization of ketone bodies. Regulation of ketogenesis.

Books recommended

1. Lippincott's Illustrated Reviews: Biochemistry by Pamela C. Champe and Richard A. Harvey
2. Principles of Biochemistry by Lehninger
3. Fundamentals of Biochemistry by J. L. Jain, S. Chand & Company Ltd.
4. Biochemistry by Stryer

**M.Sc. Zoology IInd Semester
Core Course
Paper – I: Molecular Biology**

Course Code: ZYM 2001

Credit:	04
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit – I Maintenance of Genome: Structure of DNA, RNA, chromosome diversity (circular, linear) and level of chromosomes structure, chromatin structure (nucleosome, solenoid, super solenoid). DNA self-propagation: origin of replication, new strand formation, chemistry of DNA synthesis (Deoxynucleoside and hydrolysis of pyrophosphate); Significance of anti-parallel arrangement of DNA strands, role of primer, exonuclease activity of DNA polymerase III, End replication problem. Quantitative analysis of nucleic acids.

Unit – II Transcription and Translation: Transcription and post-transcriptional modifications, self-splicing. Translation and post-translational modifications. Regulation of gene expression in prokaryotes (lac, trp operon) and Eukaryotes.

Unit – III Cancer, Aging and Apoptosis: Cancer: Fibrosis, cirrhosis, characteristics of transformed cells, protooncogene, c-oncogenes, angiogenesis and metastasis. Tumour suppressor gene (p53) and Two-Hit hypothesis. Brief account of human tumorigenic viruses. Molecular biology of aging and senescence. Apoptosis: definition, intrinsic and extrinsic pathway.

Unit – IV Recombinant DNA Technology and Applications: Introduction of rDNA technology: Vectors and enzymes used in gene manipulation. Molecular cloning: History, various steps in cloning a eukaryotic gene in plasmid, identifying the gene of interest. cDNA construction and its screening. PCR and its variants. Application of rDNA technology: recombinant proteins, transgenic organisms. Agarose gel electrophoresis.

Books recommended

1. Genes VIII by Lewin
2. Molecular Biology of the Gene by Watson et al.
3. Molecular Biology and Biotechnology by Walker and Rapley

**M.Sc. Zoology II Semester
Core Course
Paper - II Cell Biology**

Course Code: ZYM 2002

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit - I Cell structure and functions: Introduction to Cell biology. Basic properties of cells. Structural organization and function of intracellular organelles: Nucleus, Mitochondria, Golgi bodies, Endoplasmic reticulum, Lysosomes, Peroxisomes. Protein sorting and transports. Bioenergetics and metabolism.

Unit - II Cellular membrane and cytoskeleton: An overview of membrane functions. Chemical composition of cell membrane. Structure and functions of membrane proteins: Integral protein, peripheral membrane proteins and lipid-anchored membrane proteins. Membrane models. Movement of substances across cell membranes: Diffusion, active transport, uniport, symport and antiport. Overview of the major functions of the cytoskeleton. Structure and organization of Microtubules, Intermediate filaments and Microfilaments and their role in cell motility.

Unit - III Cell Regulation and Cell signalling: Signalling molecules and their receptors. Functions of cell surface receptors. Regulation of signalling pathway. Cell cycle: Eukaryotic cell cycle. Stem cell: Embryonic stem cells (ESC) and Adult stem cells (ASC).

Unit - IV Methods in Cell Biology: Microscopy: light, dark field, phase contrast, differential interference contrast, fluorescent. Bright field, Phase contrast, fluorescence and confocal microscopy. Electron Microscopy: Transmission electron microscopy (TEM) and scanning electron microscopy (SEM). Cell culture: Introduction and historical background of animal cell culture. Types of cell culture. Basic characteristics of tissue culture media. Basic equipments and facilities in animal cell culture. Types of culture media and culture wares. Sterilization methods for culture wares and culture media. Maintenance of a cell line and storage of cells. Subcellular fractionation by differential centrifugation. Somatic cell hybridization. Flow cytometry: Basic principle and application.

Books recommended

1. Cell Biology by Gerald Carp
2. The Cell by Cooper and Hausman
3. Molecular Biology of Cell by Lodish
4. Cell and Molecular Biology by De Robertes
5. Molecular Cell Biology by Alberts
6. Culture of Animal Cells by Freshney

**M.Sc. Zoology IInd Semester
Core Course
Paper - III Reproductive Technologies**

Course Code: ZYM 2003

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit - I Scope of reproductive technologies. Induced release of gametes and its significance; Biochemistry of semen composition and formation; Assessment of sperm functions.

Unit - II Multiple ovulation, superovulation; *In vitro* oocyte maturation; cryopreservation of gametes and embryos.

Unit - III *In vitro* fertilization, embryo transfer. Gamete intrafallopian transfer (GIFT); Zygote intrafallopian transfer (ZIFT); Intracytoplasmic sperm injectin; Transgenic animals and their uses.

Unit - IV Contraception; immunocontraception, antibody mediated fertilization block and termination of gestation, other contraceptive technologies, surgical methods, hormonal methods, physical barrier, intrauterine contraceptive devices.

Books recommended

Human Reproductive Biology (Third Edition) by Jones, R. E. And Lopez, K. H

**M.Sc. Zoology II Semester
Core Course
Paper – IV: Environmental Toxicology**

Course Code: ZYM-2004

Credit:	04
Sessional:	30 Marks
End Term Exam :	70 Marks

UNIT I: Introduction to Environmental toxicology: Definition, History and Scope. **Air Pollution:** Types, Effects and Remediation. Photochemical smog. Acid Rain. Ozone hole. **Water Pollution:** Sources (Sewage, Industrial, Thermal, Surface Runoff, Oil spills), Effects and Remediation. Solid Waste: Sources, effects and management. Bio-indicators of pollution.

UNIT II: Noise Pollution: Introduction, hearing mechanism, decibel scale etc. Sources, Effects and Control of Noise Pollution. **Environmental carcinogens** : Categories, Examples, Exposure and Effects. **Radioactive Pollution:** Radioactivity (Nuclear disintegration series, nuclear energy and its uses). Radio-isotopes and their uses. Radioactive pollution and its effects. Classification and safe disposal of radioactive waste.

UNIT III: Pesticides: Types and formulations. Target and mode of action of some common pesticides (Organochlorines, Organophosphates and Pyrethroids). Pesticide exposure and adverse effects. **Nanotoxicology:** Types, Sources, exposure and Impacts of Nanoparticles. Endocrine disruptors.

UNIT IV: Toxicokinetics : metabolism and fate of toxicants. Biotransformation. **Toxicodynamics** : Toxicant interaction with major body systems. **Ecotoxicology:** Bioconcentration and Biomagnification. Sub-lethal and Lethal effects of toxicants to individuals, populations, communities and ecosystem. Environmental Laws and Policies: Indian Perspective.

Book Recommended:

1. Ecology and Environmental Biology by Sharma, P.D., Rastogi Pub
2. Environmental Pollution Health and Toxicology by SVS Rana; Norasa Pub House
3. The Pesticide Book by GW, Ware; W.H. Freeman & Company
4. Appropriate online available material
5. Pesticides by R. Cremllyn; John Wiley & Sons

**M.Sc. Zoology IInd Semester
Core Course
Paper – V: Vertebrate Immune System**

Course Code: ZYM 2005

Credit:	04
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit – I Introduction to immunology and characteristics of immune responses.. Cells of the immune system. Organs of the immune system (primary and secondary lymphoid organs). Elements of innate and acquired immunity. Types of barriers. Induction of CMI and HI. T cells receptors (TcR). Differentiation and maturation of T & B lymphocytes. Recognition of antigen by T and B cells.

Unit – II Major histocompatibility complex (MHC): Organisation, structure and their role in immune response. Antigen processing and presentation. Mechanism of action of cytotoxic T cell (CTL). Complement system and its activation. Basic concepts of hypersensitivity reactions. Types of graft and mechanism of rejection. Immunogen and antigen. Factors that influence immunogenicity (molecular basis of immunogenicity).

Unit – III Immunoglobulins, classes, sub-classes and their physico-chemical properties. Gross and molecular structure of the antibody molecules. Antigenic determinants of immunoglobulins. B-cell receptors (BcR). Antibody mediated effector functions. Molecular basis of class switching. Theories of antibody formation. Antigen preparation and production of polyclonal antibodies

Unit – IV Strength of antigen-antibody interactions. Immunoprecipitation reactions. Basic immunological techniques: radial, double immunodiffusion, rocket, counter-current and immuno-electrophoresis. Immunoblotting. ELISpot. ELISA. Formation and selection of hybrid cells and production of monoclonal antibodies and their application. Recent approaches to the production of vaccines.

Book Recommended:

1. Cellular & Molecular Immunology by Abbas, Lichtman, Pillai
2. Immunology – A short Course by Benjamin et al.
3. Essentials of Immunology by Roitt
4. Immunology by Lal and Kumar
5. Kuby Immunology by Glodsy, Kindt and Osborne

**M.Sc. Zoology III Semester
Core Course
Paper - I Pest, Parasites and Vectors**

Course Code: ZYM 3001

Credit:	04
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit – I Introduction to parasites. Mode of transmission, portal of entry and implications of parasitism. Life cycle patterns in different group of parasites and factors influencing their establishment. Morphological adaptation in different group of parasites. Zoonosis and larva migrans. Parasitic infections and their monitoring.

Unit – II Pathobiology: Life cycle and pathogenicity of the following parasites; Protozoa: *Trypanosoma spp.*, *Plasmodium spp.*, Trematode: *Schistosoma haematobium*, Cestode: *Taenia solium*, *Echinococcus granulosus* Nematodes: *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wucheria bancrofti*. Diagnostic techniques for protozoan and helminth infections.

Unit – III Introduction to vectors. Arthropod vectors and their role in transmission of diseases. Mosquitoes: dengue, yellow fever, chikungunya, Zika fever, Japanese encephalitis. Blood sucking flies: Onchocerciasis, Loiasis Bugs, Chagas disease. Fleas: Plague, Rickettsiosis. Lice: Typhus fever. Ticks: Lyme disease, relapsing fever, spotted fever. Mites: scrub typhus, scabies.

Unit – IV Introduction and types of pests:- insects, mites, nematodes, fish, birds and rodents. Insect pests: Attainment of pest status and factors causing pest outbreaks. Categorization of insect pests based on damage to plants; viz., borers, defoliators, miners. Recent advances in insect pest management. Important nematode pests:- stem nematodes, burrowing nematodes, lesion nematodes, citrus nematodes, root knot nematodes and cyst nematodes. Pest/noxious fish species. Birds and rodent pests. Microbial pests.

Books recommended:

1. Medical Entomology for students by Mike W. Service
2. Agricultural pest of India & South East Asia by A. S. Atwal
3. Parasitology (Protozoology and Helminthology) in relation to clinical medicine by K.D. Chatterjee
4. Introduction to Parasitology with special reference to parasites of man by Asa C. Chandler
5. Plant Nematology by Jenkins & Taylor
6. Web Resources

**M.Sc. Zoology III Semester
Core Course
Paper – II Aquaculture**

Course Code: ZYM 3002

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit I: Aquaculture: status and prospects; role of aquaculture in food supply; agencies involved in promoting academic, research and entrepreneurship. Types of farming systems: extensive, semi intensive and intensive culture; cage culture; integrated fish farming.

Unit II: Fish ponds: types and management; chemical analysis of water sample. Age and growth estimation and its significance in aquaculture. Induced breeding: hypophysation and use of different synthetic hormones, significance of induced breeding; nutritional and feeding strategies in aquaculture; composite fish farming with special reference to Indian major carps.

Unit III: Mariculture: present status and prospects; sea ranching practice and its significance; commercially important marine prawns and lobsters; culture method of tiger prawn, *Penaeus monodon*; culture method of giant freshwater prawn, *Macrobrachium rosenbergii*; farming of pearl oyster, *Pinctada fucata*; culture of mullet, *Mugil cephalus*.

Unit IV: Fish feeds; fish feed ingredients, their proximate composition and energy content estimation. Feed formulation, square method of feed formulation. Types of feeds and feeders used in aquaculture. Sustainable aquaculture and environmental degradation; ornamental fish culture; commercially important freshwater and marine ornamental fish species, culture method of an ornamental fish, maintenance of aquaria.

Books Recommended:

1. Aquaculture: Principles and Practices By: T.V.R. Pillay
2. Introduction to Aquaculture By: Matthew Landau
3. Aquaculture By: John E. Bardach
4. Textbook of Fish Culture By: Marcel Heut

M.Sc. Zoology III Semester
D.C.E.: Entomology
Paper - I Insect Morphology & Physiology

Course Code: ZYM 3011

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit - I General organisation of the insect body, head: sutures and area of the cranium, tentorium, gnathal appendages (antenna and mouth parts). **Thorax:** pterothorax, legs and its modification, wing and wing coupling.

Circulatory System: Structure of heart and mechanism of circulation, reversal of heart beat; Haemocytes.

Unit - II Digestive System: alimentary canal and its modification; salivary glands, nutritional requirements of insect, physiology of digestion, digestion of special food stuffs (wool, collagen, keratin, pollen, silk, wax), intermediary metabolism of carbohydrates, fats and protein, fat body. **Respiratory system:** general organisation; types of spiracles; respiratory adaptations in aquatic, terrestrial and endoparasitic insects. **Excretory system:** malpighian tubules and other organs of excretion; physiology of excretion, metabolic pathways of synthesis of uric acid, urea and ammonia.

Unit - III Nervous system: structure of brain and nerve chord. Sense organs: mechanoreceptors; chemo-receptors; auditory organs & hearing; sound and light producing organs and mechanism of sound and light production; visual organ (compound eye) and image formation. Male and female external genitalia and its modification.

Unit - IV Morphology of male and female reproductive system. Reproductive physiology: oogenesis; yolk formation; spermatogenesis and transfer of sperms; mating and fertilization; role of pheromones. **Endocrinology:** hormones of neurosecretory cells, corpus cardiacum, corpus allatum and prothoracic gland, cuticle and moulting.

Books Recommended:

1. Principles of Insect Morphology by R.E. Snodgrass
2. The Insect: Structure and Function by R.F. Chapman
3. The Principles of Insect Physiology by V.B. Wigglesworth

BOS: 02.01.2016

**M.Sc. Zoology III Semester
D.C.E.: Entomology
Paper - II Insect Systematics and Taxonomy**

Course Code: ZYM 3012

**Credit: 02
Sessional: 30 Marks
End Term Exam : 70 Marks**

Unit-I: Hexapoda: Characters, classification and phylogeny of Hexapoda. Salient features of Entognathushexapodes: Protura, Collembola, Diplura. Salient features of apterygotes: Microcoryphia and Thysanura.

Unit-II: Pterygote orders: Orthoptera, Hemiptera *(Mantodea, Blattodea, Isoptera, Phasmida, Dermaptera, Psocoptera, Thysanoptera, Phthiraptera).

Unit-III: Orders: Coleoptera, Hymenoptera *(Strepsiptera and Neuroptera)

Unit-IV: Order: Lepidoptera, Diptera, *(Trichoptera and Siphonaptera)

Note: Students are to be made familiar with the main diagnostic characters of some important families with respect to their economic importance. Orders marked with asterisk (*) need only be given diagnostic character and general account.

Books:

1. Introduction to the study of insects – 7th edition by Borror and Delong's.
2. A General Textbook of Entomology by Imms'.

**M.Sc. Zoology III Semester
D.C.E.: Entomology
Paper- III Insect Ecology and Behaviour**

Course Code: ZYM 3013

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit I

Scope of insect Ecology, ecosystem, structure and their function with particular emphasis on herbivory, entomophagy and haemophagy.

Unit II

Population ecology: Population dynamics, size fluctuation models; Community ecology: species interaction structure and successional changes, diversity versus stability.

Unit III

Fundamentals of insect ecology and its application: Pattern of behavior, periodicity and clocks. Functional aspects of behavior: displacement, orientation, communication, reproduction and defence. Polymorphic phases (swarms, outbreaks and migration). Locust in making and adaptive behavior.

Unit IV

Population ethology, behavioural genetics and evolution. Chromo-ecological and protective behavior. Insect behavior as control measures in plant protection.

Books Recommended:

1. Ethology (Animal Behaviour) by Satguru
2. Insect Ecology by Timothy D. Schowalter
3. Insect Ecology by Vijay Kumar

**M.Sc. Zoology III Semester
D.C.E.: Fishery Science and Aquaculture
Paper – I Fish Biology**

Course Code: ZYM 3021

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit I

Importance of fish biology; Rational exploitation of fishery resources; Significance of the study of food and feeding in fish culture; Methods of determining food and feeding habits of fishes; Analysis of gut contents; Food selectivity.

Unit II

Fish migration-types and patterns, spawning migration of salmon and European eel; Significance of age and growth studies; Methods of age determination and precise age estimation in fish; Fish growth: types and methods of assessments; Length-weight relationship.

Unit III

A general account of breeding cycle, breeding season and spawning; Determination of breeding season; Fractional spawning and its adaptive significance; Fecundity; determination of absolute and relative fecundity; Parental care: its significance, nest building and other means of protecting eggs and young ones; Induced breeding: its significance in aquaculture; methods of induced breeding.

Unit IV

Types of fishing nets and gears: methods of their operation; fishing crafts; Characteristics of fish populations; Methods of fish stock identification: use of classical and modern tools; Recent advances in fish stock assessment, Marking and tagging and its significance: types of marks and tags.

Books Recommended:

1. Biology of Fishes by Quentin Bone and Richard H. Moore
2. The Biology of Fishes by M. Harry Kyle
3. Handbook of Freshwater Fishery Biology by Kenneth D. Carlender
4. Stock Identification Methods by Steven X. Cadrin, K.D. Friedland and John R. Waldman

BOS: 02.01.2016

**M.Sc. Zoology III Semester
D.C.E.: Fishery Science and Aquaculture
Paper - II Fish Physiology**

Course Code: ZYM-3022

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit I

Physiology of digestion, gastric and intestinal enzymes and their mode of action; digestion in stomachless fishes; adaptation of digestive enzymes in fish to diets.

Unit II

Osmotic responses to salinity changes in fish, Nitrogenous excretion, salt and water balance in freshwater and marine fishes; control of excretion and osmoregulation; Chemoreception; reception of thermal and mechanical stimuli; Electrogenesis in fish and mechanism of electric discharge.

Unit III

Blood vascular system in fish; Chemical composition of blood; blood cell-types, function; Hemoglobin: structural details, multiplicity of hemoglobin, hemoglobinless condition; heart myogenic nature; pacemakers and ECG; regulation of heart activity; neural and aneural (chemical and mechanical; detailed account of Starling principle).

Unit IV

Photoreception; optical characteristics of fish eye; factors governing acuity of vision; photomechanical and photochemical responses; Types of chromatophores and significance of colour change; morphological and physiological changes; regulation of colour changes.

Books Recommended:

1. The Physiology of Fishes by David H. Evans and James B. Claiborne
2. Fish Physiology by W. S. Hoar, D. J. Randall and J. R. Brett
3. The Physiology of Fishes by Margaret E. Brown
4. Recent Advances in Hormonal Physiology of Fish and Shelfish Reproduction by B. N. Singh & A.K. Pandey
5. Fish Endocrinology by B. N. Yadav

BOS: 02.01.2016

**M.Sc. Zoology III Semester
D.C.E.: Fishery Science and Aquaculture
Paper - III Fish Limnology and Oceanography**

Course Code: ZYM-3023

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit I

Morphology and morphometry of inland waters; Light conditions: factors influencing light penetration. Thermal stratification: its terminologies and modifications; Thermal classification of inland waters and heat budget; Classification and zonation of aquatic environment; Physiology and general environmental features of Indian ocean; Exclusive economic zone.

Unit II

Dissolved gases: DO and CO₂, their solubility, sources and reduction processes in Inland and marine waters; Composition of oceanic water: salinity range and distribution in oceans; Nutrients: nitrogen and phosphorus cycle in inland water; Minerals in ocean and their mining.

Unit III

Plankton: classification and terminologies, diel vertical migration of zooplankton in lakes and oceans, factors influencing diel vertical migration; Periphyton and method of their collection; Benthos: classification, distribution in lakes and oceans, benthic communities; Microbial loop in ocean.

Unit IV

Aquatic macrophytes and their distribution; productivity in aquatic environment: primary productivity and secondary productivity, measurement of phytoplankton productivity, indices of productivity; Mangroves: ecological features and significances; Corals and coral reefs.

Book Recommended

1. Limnology by P.S. Welch
2. Textbook of Limnology by G. A. Cole
3. Limnology by R.G. Wetzel
4. Biological Oceanography: An Introduction by C.M. Lalli and T.R. Parsons
5. Chemical Oceanography by J.P. Riley and G. Skirrow

BOS: 02.01.2016

**M.Sc. Zoology III Semester
D.C.E.: Genetics
Paper - I Population & Statistical Genetics**

Course Code: ZYM 3031

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit I - Genetic Variation

Genetic and molecular essentials in population genetics; Types of polymorphisms; DNA polymorphisms; Sex linked (X, Y-linked), mitochondrial, STR, VNTR, RFLP, AFLP, Indel basics and applications of DNA polymorphisms.

Unit II -Genetic Equilibrium and Statistics

Gene pool, gene, genotype and phenotype frequency, Hardy-Weinberg equilibrium, Equilibrium model for autosomal single gene locus-diallele and multiple alleles, sex linked locus, linked genes. Calculations of gene frequencies, Measures of central tendency, probability distributions, Regression and Correlation, ANOVA, MAVA.

Unit III -Change in Equilibrium

Models for mutations, migration, selection and drift, inbreeding in changing equilibrium. Field and laboratory illustrations, Natural selection models, adaptation and evolution, Kinship selection, meiotic drive, Inbreeding and consequences.

Unit IV - Evolutionary Genetics

Anagenesis and Cladogenesis; Speciation-geographic and quantum speciation; Genetic identity and genetic distance; Molecular tools in phylogeny; DNA hybridization, Protein sequence analysis, Immunology and electrophoresis; Neutrality theory of molecular evolution; Molecular clock; Evolution of genome size; Structural verses regulatory evolution.

Books Recommended:

1. Modern Genetics by F.J. Ayala and J.A. Kiger
2. A primer of population Genetics by D.L. Hartl
3. Statistical methods in biology by Norman T.J. Bailey

M.Sc. Zoology IIIrd Semester
D.C.E.: Genetics
Paper - II Microbial Genetics

Course Code: ZYM 3032

Credit -2
Sessional/Assignment: 30 Marks
End Term Exam (2 hr): 70 Marks

Unit I

Basic methods in microbial genetics: culturing bacteria in different media purification of strains and various methods of short and long term storage, mutations in bacteria and isolation of mutants. Ames's test. Repair mechanism of mutational damage, role of RecA protein. SOS system in *E. coli*

Unit II

Bacterial Genetics: Bacterial genome, *E. coli* genome, genome complexity and gene density, Supercoiling, Levels of packaging of genome and the proteins in a typical bacterium, extra-chromosomal genetic elements, F-plasmids and their role in conjugation mapping, *E. coli* as a cloning host.

Unit III

Viruses and Phages, types of phages, Phage Genetics: Importance of bacteriophages in genetics and molecular biology, Fine structure of bacteriophage lambda, life cycle of bacterio-phages, lysogeny and lytic options, transduction, generalized and specialized transduction.

Unit IV

Prokaryotic gene regulation: Bacteria as a model for prokaryotic gene regulation, principles of transcriptional regulation, regulatory proteins-activator and repressor, interaction of regulatory proteins with RNA polymerase, allosteric interaction and transcriptional initiation, allostery in gene regulation, DNA looping, antitermination. Operon model, Lac operon, role of activator and repressor in Lac operon, effect of CAP and Lac repressor on RNA polymerase, activator Bypass experiments, Jacob, Monod and the ideas behind gene regulation, NTRC and MerR transcriptional activators, AraC and control of the araBAD operon by anti-activation. Amino acid biosynthetic Trp operon and attenuation.

Books Recommended:

1. Microbial Genetics by Maloy *et al.*
2. Molecular Biology of Gene Watson *et al.*
3. Genetics by Stickberger
4. Applied Microbiology by Kale and Bhusari
5. Microbial Genetics by David Freifelder

M.Sc. Zoology III Semester
D.C.E.: Genetics
Paper – III Genomics & Proteomics

Course Code: ZYM 3033

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

- Unit I** Genome and its origin, Acquisition of new genes and gene families- (types, pseudogenes, origin of gene families). Genomics, importance, General features, C-value paradox. Gene identification, Genome databases. Brief outline of Genome diversity (bacteria, yeast, *Caenorhabditis*, rat, *Homo sapiens*) and its significance. Concept of intron, exon, UTR, regulatory sequence. Non-coding RNAs.
- Unit II** Structural and functional Genomics. Need to study whole genome. Methods to study alterations of gene expression in cancer (through microarray). DNA markers- SSLPs, SNPs; restriction mapping, Sequence tagged site mapping. The Human genome project, HapMap project, The 1000 genome project, The ENCODE project. Amino acid data base searching.
- Unit III** Proteome and Proteomics: Definition. Brief account of post-translational modifications. Types of proteomics: Protein expression proteomics, Structural proteomics, functional proteomics. Proteins functions, Protein modifications and Protein localization, Extraction and separation of proteins: Salt fractionation, Dialysis, Electroelution. Separation of proteins by one and two-dimensional gel electrophoresis (IEF and 2D electrophoresis)
- Unit IV** Protein identification with antibodies, Protease digestion. Mass spectrometry: principle, working and relevance. Analysis of phosphopeptides by MALDI-TOF, hybrid technology, protein chips. Reverse-phased protein microarrays. Peptide mass fingerprinting database searching. Proteome mining. Applications of proteomics. Protein engineering.

Books Recommended:

1. Gene XI by Lewin B.
2. Genetics by Benjamin A. Pierce
3. Cell & Molecular Biology by PK Gupta
4. Introduction to Proteomics by Daniel C. Liebler
5. Purifying proteins for proteomics by Richard J. Simps

BOS: 02.01.2016

**M.Sc. Zoology III Semester
D.C.E.: Nematology
Paper – I Nematode Structure**

Course Code: ZYM 3041

**Credit: 02
Sessional: 30 Marks
End Term Exam : 70 Marks**

- Unit I** The nematode and its body wall: Definition of nematodes and their significance. Basic organization of nematode: body form, size and symmetry. The body wall: cuticle structure and diversity in various groups; the hypodermis and its structural characteristics; somatic musculature, variability of cell types and their organization.
- Unit II** Sense organs digestive system: Cuticular sense organs, their structure, diversity and occurrence on the nematode body. The feeding apparatus: types and structural diversity. Structure, organization and diversity of pharynx and its importance in taxonomy. The pharyngeo-intestinal junction. The intestine, prorrectum and rectum. The tail.
- Unit III** The pseudocoelom and its organs: The pseudocoelom its origin, pseudocoelomic fluid, pseudocoelomic structures and coelomocytes. Excretory system: its structure, diversity and importance in nematode classification. Nervous system: central and peripheral; ganglia and nerves.
- Unit IV** The reproductive system: male and female gonads, organization and structural diversity. The copulatory structures: spicules, gubernaculum guiding and accessory pieces. The genital/caudal papillae and bursa. Hermaphrodites, intersexes.

Books Recommended:

1. General Nematology by Maggenti
2. Nematode Structure by Jairajpuri
3. Tylenchida: Parasites on plants and insects by Siddiqi
4. Dorylaimida by Jairajpuri & Ahmad
5. Mononchida: The Predaceous Nematodes by Ahmad & Jairajpuri
6. Plant parasites Nematodes Vol. I by Zuckerman
7. Principles of Nematology by Thorne
8. Nematode Diversity by Jairajpuri

**M.Sc. Zoology III Semester
D.C.E.: Nematology
Paper – II Nematode Diversity - I**

Course Code: ZYM 3042

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

- Unit I** Outline classification of the phylum Nematoda, Taxonomy of class Secernentea: Suborder Tylenchina: Superfamily Tylenchoidea, Family Tylenchidae: *Tylenchus*, *Aglenchus*, *Malenchus*, *Basiria*. Family Psilenchidea: *Psilenchus*. Family Anguinidae: *Anguina*, *Ditylenchus*. Superfamily Dolichodoroidea, Family Tylenchorhynchidae: *Tylenchorhynchus*, *Merlinius*, *Trophurus*, *Macrotriphurus*.
- Unit II** Taxonomy of Class Secernentea (contd.). Family Dolichodoridae: *Dolichodorus*. Family Belonolaimidae: *Belonolaimus*, *Trichotylenchus*. Superfamily Hoplolaimoidea, Family Hoplolaimidae: *Hoplolaimus*, *Scutellonema*, *Helicotylenchus*, *Rotylenchus*, Family Rotylenchulidae: *Rotylenchulus*. Family Pratylenchidae: *Pratylenchus*, *Hirschmanniella*, *Radopholus*.
- Unit III** Taxonomy of class Secernentea (contd): Family Heteroderidae: *Heterodera*, *Meloidogyne*, *Meloidodera*. Family Nacobbidae: *Nacobbus*. Suborder Criconematina: Superfamily Criconematoidea, Family Criconematidae: *Criconema*, *Ogma*, *Hemicriconemoides*, *Hemicylichophora*. Family Paratylenchidae: *Paratylenchus*, *Gracilacus*, *Tylenchulus*.
- Unit IV** Taxonomy of class Secernentea (contd): Order Aphelenchida, Superfamily Aphelenchoidea, Family Aphelenchidae: *Aphelenchus*. Family Apelenchoididae: *Aphelenchoides*. Order Rhabditida, Suborder Rhabditina: Family Rhabditidae: *Rhabditis*, Family Steinernematidae: *Steinernema*. Family Heterorhabditidae: *Heterorhabditis*. Suborder Diplogastrina: *Diplogaster*; Suborder Cephalobina: *Cephalobus*, *Acrobeles*. Order Chromadorida: *Achromadora*. Order Enoplida: *Tobrilus*, *Triplyla*. Order Monhysterida: *Monhystera*. Order Araeolaimida: *Plectus*.

Books Recommended:

1. *Tylenchida: Parasites on plants and insects* by M. R. Siddiqui
2. *Principles of Nematology* by G. Thorne
3. *Soil and Fresh Water Nematodes* by Goodey, J. B.
4. *Plant parasitic nematodes of India – An identification manual* by Ahmad, W.

**M.Sc. Zoology III Semester
D.C.E.: Nematology
Paper – III Nematode Ecology**

Course Code: ZYM 3043

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit I

Soil: Introduction and concepts. Top soil and subsoil. Soil profile and horizons. Mineral and organic soil. Components of mineral soils. Soil texture: particle size and their characteristics; textural classes. Effect of soil types on nematode activity and distribution. Soil structure: soil aggregates and types. Crumbs, their formation and significance. Soil pores and estimating pore space. Pore size and nematode movement. Soil moisture potential. Moisture characteristic; field capacity; wilting point and hygroscopic potential. Available and unavailable water. Saturated and unsaturated soils; hydraulic conductivity. Relationship between soil moisture and nematode activities. Osmotic potential.

Unit II

Soil temperature; Soil pH; Soil aeration; Chemicals in soil; Soil organic matter; Soil amendments, microbial decomposition products, animal and plant exudates, their sources and influence on nematodes. Influence of soil organisms on nematodes: predacious and parasitic fungi, predacious nematodes, tardigrades, collembolans, turbellarians, mites and protozoa. Parasitic viruses, bacteria and protozoa.

Unit III

Population structure. Horizontal and vertical distribution of nematodes. Structure of nematode populations. Population characteristics and growth curve/s. Effect of agriculture practices on nematode populations; cropping systems, cultivations and grazing. Dissemination of nematodes.

Unit IV

Habitat-wise distribution of nematodes: terrestrial and aquatic types and their adaptations. Ecological classification of nematodes: trophic groups, ecological niche and feeding guilds. Community analysis; various parameters used and their significance. Environment indicators: c-p value; Maturity Index (MI and MI-25), Enrichment Index (EI) and Structure Index (SI).

Books Recommended:

1. Ecology of Plant Parasitic Nematodes by Norton
2. Biology of Nematodes by Wallace
3. Plant Parasitic Nematodes Vol I, II, III by Zuckerman
4. Nematology by Sasser & Jenkins
5. Plant Nematology by Southey
6. Nematodes as environmental indicators by Wilson & Kakouli-Duarte

BOS: 02.06.2018

M.Sc. Zoology III Semester
D.C.E.: Parasitology
Paper – I Medical and Veterinary Protozoology

Course Code: ZYM-3051

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

- Unit I:** Classification of sarcomastigophora. Various parasitic amoebae of man and their diagnostic features, intestinal and metastatic amoebiasis. Primary amoebic meningo-encephalitis (PAME). Morphology and pathobiology of oral, intestinal and genital flagellates. Cutaneous and visceral leishmaniasis: pathology, diagnosis and treatment.
- Unit II:** Morphological peculiarities of Apicomplexa; Toxoplasmosis; acute, sub-acute and chronic forms of disease. *Toxoplasma* IgG avidity test. Pathology and treatment of congenital and acquired toxoplasmosis. Life cycle and disease relationship of pathogenic species of *Babesia*, *Theilaria*, and *Eimeria*.
- Unit III:** Morphological peculiarities and prevalence of different species of malaria parasite. Ultrastructure of invasive stages of *Plasmodium*. Clinical phases of benign and malignant malaria. Impact of falciparum malaria in pregnant women. Protective antigens of sporozoites, merozoites, trophozoites, schizont and gametocyte stages of *Plasmodium falciparum* and *Plasmodium vivax*. Diagnostic tests for malaria. Molecular markers for drug resistance.
- Unit IV:** Pharmacological basis of parasite control; Principles of drug action; pharmacokinetics and pharmacodynamics. Disposition and fate of drugs, absorption, distribution, binding, biotransformation, metabolic excretion. Available antiprotozoal drugs, their targets and mode of action. Role of synergistic/combined drug therapy in control and prevention of drug resistance.

Books Recommended:

- | | |
|--|---------------------|
| 1. Text book of Clinical Parasitology | - Belding |
| 2. Parasitology: Protozoology and Helminthology | - K. D. Chatterjee |
| 3. Introduction to Parasitology | - Chandler and Read |
| 4. Parasitology: the biology of animal parasites | - Noble and Noble |
| 5. The fine structure of parasitic protozoa | - Scholtyseck |

BOS: 02.06.2018

M.Sc. Zoology IIIrd Semester
D.C.E.: Parasitology
Paper – II Medical and Veterinary Entomology and Vector Control

Course Code: ZYM 3052

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit I

Introduction to medical entomology. General features, life cycle patterns and classification of Diptera. Morphological peculiarities, life cycle and disease relationship of *Anopheles*, *Culex*, *Phlebotomus*, *Simulium* and *Tabanus*.

Unit II

Brief account of non-blood sucking flies: Eye fly, Blow fly and Flesh fly. Morphology, life cycle and disease relationship of blood sucking flies: *Stomoxys*, *Glossina* and *Hippobosca*. Flies as vector of diseases. Types of myiasis and maggot therapy. Morphology and disease relationship of lice, bugs and fleas.

Unit III

General account of Acarina. Morphology, life cycle and disease relationship of different genera belonging to the families of Ixodidae and Argasidae. Brief account of Mites (i.e. *Trombicula*, *Dermanyssus*, *Tyroglyphus*, *Sarcoptes* and *Demodex*) and their disease relationship.

Unit IV

Vector control: chemical control, available adulticides and larvicides and their mode of application. Relevance of residual insecticides, treated bed nets/curtains and fumigations in vector control. Biological control through the use of fungi, bacteria, nematode and larvivorous fishes.

Books Recommended:

1. Clinical Parasitology by Belding
2. Introduction to Parasitology by Chandler and Read
3. Entomology by Roy and Brown
4. Medical Entomology by Herms

BOS: 02.06.2018

M.Sc. Zoology IIIrd Semester
D.C.E.: Parasitology
Paper – III Principles of Parasitology, Immunology and *In vitro* Culture

Course Code: ZYM-3054

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

- Unit I.** Parasite and parasitism. Hyperparasitism. Origin of parasite: ecto, endo and haemoparasites. Host-parasite relationship, Parasitic adaptations: digestive and reproductive. Factors influencing parasitic fauna: age , food and mode of life of the host. Influence of parasite on the host.
- Unit I** Introduction and scope of immuno-parasitology. Types of immune responses against parasites including the innate and acquired. Immune evasion strategies of parasites. Immunity against malaria parasite: species specificity. Antigenic variation in *Trypanosomes* and its significance. Immunomodulation by the parasites.
- Unit II** Immunity against Schistosomes – target of immunity and immune evasion strategies by the adult worms. Immune responses in intestine. Immunity against *Trichinella*, and Ticks. Progress in the development of vaccine against malaria, schistosomiasis, gastro-intestinal helminthes and ticks.
- Unit III** *In vitro* culture and its importance. Terminologies used. Basic problems of *In vitro* culture of parasites. Parameters of *In vitro* growth and morphogenesis of parasites. Axenic and polyxenic culture. *In vitro* culture of protozoan parasites: *Entamoeba*, and *Plasmodium* spp., helminthes: *Schistosoma*, *Schistocephalus*, *Echinococcus*, and the filarial worms.

Books Recommended:

1. Immunity to Parasites by Derek Wakelin
2. Immunology of Parasitic Infections by Cohen and Warren
3. Immunology by Kuby
4. Tissue culture techniques by Freshney
5. *In vitro* methods of cultivating parasites by Taylor & Baker
6. Tissue culture by Parker
7. General parasitology by Dogiel

BOS: 02.06.2018

M.Sc. Zoology IIIrd Semester
Open Elective
Recent Trends in Zoology

Course Code: ZYM 3091

Credit: 04
Sessional: 30 Marks
End Term Exam : 70 Marks

- Unit I** Origin of life, Diversity and zoogeographic distribution, Species concept, Recent trends in taxonomic identification and classification, Genomic diversity and barcoding, Phylogenetic analysis softwares, ICZN and phylocode.
- Unit II** Animal models in experimental studies and research: *C. elegans* – Biology and life cycle, cell lineage, cell death pathway, RNAi and *C. elegans*, *Drosophila*- Biology and life cycle, polytene chromosome, sex determination. Zebra Fish - application in scientific research, model characteristics, regeneration and genetics. *Mus musculus*- Biology and embryonic development, transgenic mice, gene knockout, epigenetic inheritance in mice.
- Unit III** Insect based industries: Honey Industry: Different species of honey bees, bee keeping and management practices, bee products, processing and composition of honey. Silk Industry- Different silkworm species and their host plants, mulberry silkworm rearing and management practices, silk farming, forms of silk. Lac Industry- Life cycle and host plants of lac insect, methods of production, composition and properties of lac, uses of shellac. Advances in insect-based industries in India and their business potential.
- Unit IV** Fishing Industry- Marine, inland, prawn culture. Composite fish culture, induced breeding and hybridization. Poultry Industry: Commercial breeds in India, poultry breeding and rearing, egg industry. Meat, Industry in India- antemortem examination of animal meat, scientific techniques of slaughtering, dressing postmortem, inspection, storage and packaging; production and export scenario, Production and export scenario. Dairy industry: Breeds of dairy castles, dairy farming in India, milk production and pasteurization. Current status of animal-based industries in India and their future prospects.

Books Recommended:

1. Systematics and origin of species by Ernst Mayr
2. Molecular Biology of the Gene by Watson
3. Economic Zoology by Sobti and Sharma
4. Applied and Industrial Zoology by Saleem Mustafa
5. Economic Zoology by Shukla

**M.Sc. Zoology IVth Semester
Core Course
Paper- I Elements of Biotechnology**

Course Code: ZYM 4001

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit – I Animal and Medical Biotechnology:

Introduction and scope of Animal Biotechnology, Transgenic and knockout animals and their importance. Genome editing- CRISPR/Cas9, TALEN and ZEN. Nano-medicine, artificial blood, Vaccines and therapeutics, Monoclonal antibodies, Gene therapy.

Unit – II Stem cells and Regenerative Medicines:

Embryonic stem adult and Cancer stem cells. Stem cells and renewal in epithelial tissues, fibroblast and their reformation. Genesis and regeneration of skeletal muscle, blood vessels, lymphatics and endothelial cells. Regeneration and repair, cell reprogramming and pluripotent stem cells.

Unit – III Recombinant DNA, Genomics, DNA Fingerprinting and Forensic Analysis:

rDNA technology and its applications, Brief account of restriction endonucleases: types and classification. Cloning vectors, Difference in cDNA and genomic library, C-value paradox. Labelling of nucleic acids, DNA fingerprinting.

Unit – IV Aquatic Biotechnology, Biotechnological regulations and Bioethics:

Introduction. Transgenic fish-from Glofish to Giant Trout, Transgenic Salmon, Zebra fish, GFPs, Antifreeze proteins, Drugs and medicines from marine sources, FDA guidelines-phase testing. Introduction to patents. CPCSEA Regulations, Bioethical issues.

Books recommended

1. Biotechnology by Satyanarayana
2. Introduction to Biotechnology by Theinman&Palladino
3. Biotechnology for Beginners by ReinhardRenneberg
4. Biotechnology by Elleyln Daugherty
Principles and Techniques of Biochemistry and Molecular Biology by Wilson and Walker

**M.Sc. Zoology IVth Semester
Core Course
Paper - II Biological Models**

Course Code: ZYM 4002

**Credit: 02
Sessional: 30 Marks
End Term Exam : 70 Marks**

Unit - I Biological models. Model organisms (Prokaryotes and Eukaryotes). Animal models: characteristics of good model; Kinds of animal models; Maintenance and care of model animal, Ethics in animal research, Extrapolation from models: success and constraint.

Unit - II Invertebrate models. Nematode models: *Parascaris equorum* and *Caenorhabditis elegans*. Characteristics of nematode models; Nematodes as development models to study cell lineage, vulva formation and apoptosis; dauer larva, Ageing models to study symptoms of ageing; Nematodes as ecotoxicological models.

Unit - III Invertebrate models. Arthropod models: *Drosophila melanogaster*: Characteristics of arthropod models. *D. melanogaster* as development model to cell differentiation, body plan organization and genetic mechanism involved in wings, legs and eyes formation. *Drosophila* as human disease model with special reference to neurodegenerative disorders.

Unit - IV Vertebrate models. Popular models: Zebra fish, frogs, chicken, rats, mice, guinea pigs, hamsters, primates etc. Zebra fish (*Danio rerio*) as a developmental model, Chimaeric animals, knock-out animals. Models in stem cell research and pharmaco-genetic studies.

Books recommended

1. Development and Reproduction in Humans and Animal Model Species by Muller, Hassel and Grealy
2. *C. elegans* by Riddle, Blumenthal & Meyer
3. Nematodes as Biological Models vol. I & II by Zuckerman
4. Developmental Biology by Lewis Wolpert

**M.Sc. Zoology IV Semester
D.C.E. (Entomology)
Paper- I Economic Entomology**

Course Code: ZYM-4011

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit - I Introduction to Economic Entomology. Bionomics, distribution, mode of damage and suggestive control methods for pests of: Vegetables (summer and winter); Fruits (temperate, tropical and subtropical); Cereals; Fibrous crops.

Unit - II Bionomics, distribution, mode of damage and suggestive control methods for pests of; Sugarcane; Pulses; Plantation crops (Coconut, Tea, Coffee, Cashewnuts); Household pests. Introduction to Industrial Entomology. Sericulture (types of silkworm species with emphasis on mulberry Sericulture); Apiculture and Lac culture.

Unit - III Introduction to Forest Entomology. Key defoliators and borers of forest plants (Sal, Deodar, Kadam, Shisham, Teak). Timber Entomology (Borers of harvested wood, Bamboo). Forest pest management. Pests of stored grains.

Unit - IV Forensic Entomology. History; Importance of insects in medico-criminal investigation; stages of death and decomposition; Insects associated with dead body; Faunal succession; Estimation of time of death and post Mortem interval; Sampling and Preservation of insects used in Forensic studies; Case studies.

Books recommended

1. Agricultural Pests of South East Asia by A.S. Atwal
2. Insect Pest of Forest of India and Adjacent Countries by CFC Beeson
3. Forensic entomology: An Introduction (2nd Edition) by Dorothy Gennard
4. Science of Forensic Entomology by David B. Rivers

**M.Sc. Zoology IV Semester
D.C.E. (Entomology)
Paper- II Insect Toxicology and Pest Control**

Course Code: ZYM 4012

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit – I Definition and history of pest control. Methods of insect pest control: General methods (physical, mechanical, cultural) and special method (insecticides). Nomenclature and classification of insecticides. Types of formulations. Mode of action of conventional insecticides (organophosphates, carbamates and fumigants). Insecticide application appliances.

Unit – II Mechanism of insecticide resistance in insects. Non-conventional insecticides: definition, utilization and mode of action of chemosterilants, repellents. Hormones: juvenoids, ecdysteroids and anti-hormones. Pheromones: types and application.

Unit – III Biological control: definition, history. Biological control agents: parasitoids and predators. Mass production and release of commonly used parasitoids and predators. Advantages and disadvantages of biological control.

Unit – IV Integrated Pest Management (IPM): definition; logic and necessity of IPM; IPM components. Basic principles and evolutionary trends of IPM. Ecological basis of IPM. Legislative methods. Application of IPM in field (outline only) in relation to some important crops viz., paddy, wheat and cotton.

Books recommended

1. Applied Entomology by K. P. Srivastava
2. Insect Physiology, Biochemistry and Pharmacology Edited by Kerkut & Gilbert
3. Biological Control of Insects Pest by A. B. Saxena
4. Biological Control by Van Driesche, Bellows
5. Insect pest and Disease Management by D. Prasad
6. Insect Pest Management by David Dent

**M.Sc. Zoology IV Semester
D.C.E. (Entomology)
Paper- III Insect Embryology and Pathology**

Course Code: ZYM 4013

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit - I Introduction to insect Embryology; Early embryology of a generalized insect; Detailed account of cleavage and blastulation; Blastokinesis; Germ band types; Vitellophags; Oosome and primordial germ cells; Gastrulation including theories of gastrulation; Formation of mid gut; Embryonic envelopes: their types, formation and fate.

Unit - II Post-embryonic development: Metamorphosis, evolution of metamorphosis. Types of larvae and Pupae, mechanism of larval development and growth; Tissue metamorphosis. Special modes of reproduction: Parthenogenesis; Viviparity; Polymorphism.

Unit - III Insect pathology: Definition and scope. Major categories of entomopathogens-Bacteria, Fungi, Viruses, Protozoa and Nematodes with respect to classification, types, diseases, symptoms and mass production of pathogens of each category.

Unit - IV Commercial insect pathogens: formulations, field application and safety, GM crops. Genetic pathology: diseases and aberrations; malformations, sterility, sub-vital factors, semi-lethal factors and lethal factors.

Books recommended

1. Embryology and Insects and Myriapods – O.A. Johannsen & F. H. Butt
2. Principles of Insect Pathology – E.A., Steinhaus (TMH)
3. Entomology – C. Gillott (Springer)

**M.Sc. Zoology IV Semester
D.C.E. (Fishery Science and Aquaculture)
Paper – I Ichthyology and Fish Diseases**

Course Code: ZYM 4021

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit – I Introduction to Ichthyology; Tools of fish classification (Classical and Modern); Schemes of fish classification with special emphasis on Berg's scheme. Alimentary canal and feeding adaptations. Structural details of reproductive system.

Unit – II Axial firm and appendicular firm skeleton; Scales in fishes: structure and types; Structure of gills and air-breathing organs, Heart and blood vessels, Nervous system, Lateral line canal and neuromast.

Unit – III Importance of fish health in aquaculture. Factors influencing occurrence of fish disease; Commonly occurring fish diseases: affected fish species, causative agent, symptoms, prophylaxis and therapy; Epizootic ulcerative syndrome; White spot syndrome.

Unit – IV Methods of fish disease diagnosis: use of immunological and molecular tools; Immunostimulants: types and their use in aquafarming; Antibodies and herbal medicines in aquaculture.

Books recommended

1. Ichthyology by Lagler *et al.*
2. A textbook of Fish Biology and Fisheries by S. S. Khanna & H. R. Singh
3. Fish Pathology by R. J. Roberts
4. Textbook of Fish Diseases by Erwin Amlacher
5. Fundamentals of Ichthyology by S. P. Biswas

**M.Sc. Zoology IV Semester
D.C.E. (Fishery Science and Aquaculture)
Paper – II Fish Nutrition and Feed Technology**

Course Code: ZYM 4022

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit – I Introductory account and scope of the subject with emphasis on application of knowledge in fish culture. Protein and amino acids, lipid, carbohydrates, vitamin and mineral requirements of fish; Nutrients imbalance diseases.

Unit – II Energy requirements of fish; Factors affecting energy requirement; Energy budget: estimation using metabolic chamber; Dietary sources and energy measurement using Bomb calorimeter; Protein sparing effect of dietary energy; Dietary protein to energy ratio; Dietary energy and feeding levels.

Unit – III General consideration in feed formulation; Feed ingredients, anti nutritional factors, adventitious toxins, feed additives, feed categories, feed formulation; Evolution of feed ingredients and diet; Measurement of growth indices; Use of RNA/DNA ratio in evaluating performance of feeds.

Unit – IV Material flow in feed manufacturing; Steps in feed manufacturing; Quality control in fish feed manufacturing; Design of pellet manufacturing unit; Types of feed and their production technology; Wet or moist feeds, mixed or semi-moist feeds; Dry feeds: compressed dry pellets, extruded dry pellets, non-comparing pellets or rolled pellets; crumbles; flake feed; semi-purified diets; Larval diets or micro bound diets; Microencapsulated diets.

Books recommended

1. Fish Nutrition by John E. Halver
2. Nutrition and Feeding by Tom Lovell
3. Fish Nutrition in Aquaculture by De Silva and Trevor A. Anderson

**M.Sc. Zoology IV Semester
D.C.E. (Fishery Science and Aquaculture)
Paper - III Fish Processing Technology**

Course Code: ZYM 4023

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

- Unit - I** Introductory account and scope of subject; Fish as food; Role of fish in human nutrition; Surimi and diversified fish products; Fish by products and their preparation; Quality control in fish processing industry.
- Unit - II** Rigor mortis; Chemistry and factors influencing rigor in fish; Technological significance of rigor in fish processing; effects on frozen whole fish and fillets; Gapping and shrinkage, thaw rigor, spoilage of wet fish; spoilage agencies, Breakdown products indicative of spoilage, Rancidity, Spoilage characteristics of prawn, on boat and onshore handling and processing of fish.
- Unit - III** Shelf life, factors affecting shelf life, methods of extending shelf life; Preservation of fish; Canning of fish and prawn; Indigenous methods of fish preservation; Use of antibodies in fish preservation; Quick freezing.
- Unit - IV** Thermal processing of fish; Factors influencing thermal processing; Cold sterilization; Significance; Principles; Use of radioisotops in fish preservation, mechanism; Protein denaturation: its significance and evaluation.

Books recommended

1. Advances in Fish Processing Technology by D. P. Sen
2. Fish Processing Technology by George M. Hall
3. Introduction to fish Technology by J. M. Regenstein & C. E. Regenstein

**M.Sc. Zoology IV Semester
D.C.E. (Genetics)
Paper – I Human & Clinical Genetics**

Course Code: ZYM-4031

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

- Unit – I** Introduction and scope of Human Genetics, Gene Mapping: RFLP, Somatic cell hybridization, FISH, Positional cloning of disease loci (Huntington, Chronic Granulomatous, DMD, Cystic Fibrosis), Genomic imprinting and disorders.
- Unit – II** Human behaviour and Quantitative Genetics: Genes and behaviour, Neuropsychiatric disorders, Schizophrenia, Parkinson, Alzheimer, IQ, Quantitative traits, Quantitative trait loci (QTL).
- Unit – III** MHC locus, HLA typing and inheritance, Immune genes and proteins, Somatic recombination in antibody generation, HLA and disease association, Medico-legal importance.
- Unit – IV** Clinical Genetics: Background and scope. Cytogenetic and clinical background of autosomal (Marfan syndrome, Down's syndrome) and sex chromosomal disorders (Hemophilia, Turner's syndrome). Inherited liver diseases: Hemochromatosis, Alpha-1 antitrypsin deficiency, Congenital hepatic fibrosis. Prenatal and pre-implantation diagnosis (Triple Test, USG, Amniocentesis, chorionic villi sampling, Fetal blood sampling). Social and ethical issues in clinical genetics, Nanomedicine.

Books recommended

1. Human Genetics by McConky
2. Human Molecular Genetics by Pasternak
3. Human Molecular Genetics by Strachan & Read
4. Human Genetics by Vogel and Motulsky
5. Genetics in Medicine by Nussbaum
6. An Introduction to Medical Genetics by Roberts and Pembrey
7. New Clinical Genetics by Read & Donnai
8. Essentials of Medical Genetics by Ferguson Smith

BOS: 02.06.2018

M.Sc. Zoology IVth Semester
D.C.E. (Genetics)
Paper – II Developmental Genetics

Course Code: ZYM-4032

Credit 02
Sessional/Assignment: 30 Marks
End Term Exam (2 hr): 70 Marks

Unit – I History and basic concepts of Developmental Genetics: Potency, Commitment, Specification, Induction, Competence, Determination and Differentiation; Genomic equivalence; role of genes in pattern formation in amphibian and chick (body axes).

Unit – II *Drosophila* embryogenesis (genetic control): Life cycle, anterior-posterior axis patterning in *Drosophila*, role of Maternal genes, Additional segmentation genes, Genes in the formation of Dorsal-ventral axis. Translational regulation during sex-specific *Drosophila* development (*Musashi* gene family), gene expression in development of slime mold (*Dictyostelium discoideum*).

Unit – III Molecular biology of origin and specification of germ layers (xenopus); Organogenesis: vulva formation in *C. elegans*, eye development in *Drosophila*, limb development in chick. Role of genes in the regeneration in vertebrates.

Unit – IV Post embryonic development (genetic control): Growth and development of bones; molecular biology of osteogenesis, Growth and development of skeletal muscles; molecular biology of myogenesis, Programmed cell death, role of apoptosis in development.

Books recommended

1. Developmental Biology by Gilbert
2. Principles of Development by Lewis Wolpert
3. Advanced Molecular Biology Twyman
4. Developmental Genetics by G. S. Miglani

**M.Sc. Zoology IVth Semester
D.C.E. (Genetics)
Paper – III Molecular Mutagenesis**

Course Code: ZYM 4033

Credit	02
Sessional/Assignment:	30 Marks
End Term Exam (2 hr):	70 Marks

- Unit – I** Mutation: Spontaneous versus Induced mutation; Phenotypic effects of mutations: Somatic, Germinal, Mutant Haemoglobins, Back mutations and suppressor mutations; Molecular basis of mutations (tautomeric shifts). Radiation induced mutations: Ionizing radiation, Ultraviolet radiation, CIB method; DNA repair mechanisms: Photoreactivation, excision repair, post-replication recombination repair.
- Unit – II** Chemically induced mutation: Basic analogs, Nitrous acids, Acridines, Alkylating and Hydroxylating agents, Correlation between mutagenicity and carcinogenicity: Practical applications of mutations, beneficial mutations, High resolution dissection of biological processes via mutation analysis.
- Unit – III** Quantitative aspects of mutation: Mutation rate in germ cells, measurement of mutation rates: Indirect method, based on phenotypes and molecular assays, Mutation rates in male and female, impact of mutation on disease (genetic load, mortality and morbidity), Somatic mutations in humans. Epigenetics, Epigenetic Inheritance in mice, Polycomb and Trithorax proteins, CpG islands.
- Unit – IV** Qualitative aspects of mutation: Mutation involving one or a few nucleotides (Missense, Nonsense, Transcriptional, Splice sites, Consensus sequence substitutions, Mutation affecting translation). Mechanism of deletion and insertion, transposable elements; Chromosomal mutations (Polyploidy, aneuploidies and rearrangements).

Books recommended

1. Human Genetics by Edwin H. McConkey
2. Principles of Genetics by E. J. Gardener *et al.*
3. Molecular Biology of the Gene (Vth Edition) by J. D. Watson *et. Al*

**M.Sc. Zoology IV Semester
D.C.E. (Nematology)
Paper – I Nematode Diversity II**

Course Code: ZYM 4041

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

- Unit – I** Taxonomy of Dorylaimida. Suborder Dorylaimina, Superfamily Dorylaimoidea, family *Dorylaimidae*: *Dorylaimus*, *Mesodorylaimus*, *Thornenema*. Family Qudsianematidae: *Eudorylaimus*, *Discolaimus*. Family Aporcelaimidae: *Aporcelaimellus*, *Aporcedorus*. Family Nordiidae: *Longidorella*, *Cephalodorylaimus*, *Enchodelus*, Superfamily Belondiroidea, Family Belondiridae: *Belondira*, *Axonchium*. Family Dorylaimellidae; *Dorylaimellus*. Family Swangeridae: *Oxydirus*.
- Unit – II** Taxonomy of Dorylaimida (contd.). Suborder Dorylaimina, Superfamily Actinolaimoidea, Family Actinolaimidae: *Actinolaimus*, *Paractinolaimus*, *Neoactinolaimus*. Family Carcharolaimidae: *Carcharolaimus*. Superfamily Longidoroidea, Family Longidoridae: *Longidorus*, *Paralongidorus*. Family Xiphinematidae: *Xiphinema*, *Xiphidorus*. Superfamily Tylencholaimoidea, Family Tylencholaimidae: *Tylencholaimus*, *Metadorylaimus*. Family Leptonchidae: *Leptonchus*, *Proleptonchus*. Family Mydonomidae: *Dorylaimoides*. Family Tylencholaimellidae: *Tylencholaimellus*, Family Aulolaimoididae: *Aulolaimoides*.
- Unit – III** Taxonomy of Dorylaimida (contd.) Triplonchida and Alaimida. Suborder Nygolaimina, Superfamily Nygolaimoidea, Family Nygolaimidae: *Nygolaimus*. Family Aetholaimidae: *Aetholaimus*. Family Nygolaimellidae: *Nygolaimellus*. Family Nygellidae: *Nygellus*. Order Triplonchida: Superfamily Diptherophoroidea, Family Diptherophoridae: *Diptherophora*. Superfamily Trichodoroidea, Family Trichodoridae: *Trichodorus*, *Paratrachodorus*, *Monotrichodorus*, *Allotrichodorus*. Order Alaimida: Superfamily Alaimoidea, Family Alaimidae: *Alaimus*. Family Amphidelidae: *Amphidelus*.
- Unit – IV** Taxonomy of Monochida. Order Monochida: Superfamily Monochoidea, Family Monochidae: *Mononchus*, *Clarkus*, *Coomansus*, *Prionchulus*, Family Mylonchulidae: *Mylonchulus*, *Sporonchulus*. Family Cobbonchidae: *Cobbonchus*. Superfamily Anatonchoidea, Family Iotonchidae: *Iotonchus*, *Hadronchus*, *Parahadronchus*. Family Anatonchidae: *Miconchus*, *Anatonchus*, *Micatonchus* Superfamily Bathyodontoidea, Family Bathyodontidae: *Bathyodontus*, *Oionchus*.

Books recommended

1. Jairajpuri & Ahmad: *Dorylaimida: Free-living, Predaceous and Plant Parasitic nematodes*.
2. Ahmad & Jairajpuri: *Mononchida: The predaceous nematodes*.
3. Choudhary, Ahmad & Jairajpuri: *Alaimina: Free living soil inhabiting nematodes*.

**M.Sc. Zoology IV Semester
D.C.E. (Nematology)
Paper – II Nematode Biology, Diseases and Management**

Course Code: ZYM 4042

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit I

Plant parasites and their adaptations. Biology and disease of Seed gall nematode (*Anguinatritici*, *A. agrostis*); stem and bulb nematodes (*Ditylenchus dipsaci*, *D. destructor*, *D. angustus*, *D. myceliophagous*); foliar nematode (*Aphelenchoides fragariae*; *A. besseyi*; *A. ritzemabosi*; *A. composticola*); *Busraphelenchus* spp. (*B. cocophilus* and *B. xylophilus*). Virus transmission by nematodes *Xiphinema* spp., *Longidorus* spp., *Trichodorus* spp. and *Paratrichodorus* spp.

Unit II

Migratory and sedentary parasites: Biology and disease of Burrowing nematode (*Radopholus similis*); lesion nematode (*Pratylenchus* spp. Cyst nematodes (*Heterodera* and *Globodera* spp.); Root-knot nematodes (*Meloidogyne* spp.); False root-knot nematode (*Nacobbus* spp.); citrus nematode (*Tylenchulus semipenetrans*); Reniform nematode (*Rotylenchus* spp.)

Unit III

Nematode management: Cultural management: methods used and their merits and demerits. Enemy crops and trap cropping. Resistant varieties: mechanism and nature of resistance. Physical management: methods used and their merits and demerits. Regulatory control: quarantine, import and export regulations.

Unit IV

Nematode management (contd.): Chemical management: types of nematicides, methods of application, mode of action of nematicides. Plant chemotherapy and seed fumigation. Detrimental effects of nematicides and their detoxification. New approaches to control and alternate sites for nematicide action. Biological management: Parasitic/predacious microorganisms and invertebrates. Integrated nematode management.

Books Recommended:

1. Nematodes as Biological Models Vol I & II by Zuckerman
2. Plant Nematology by Southery
3. Principles Parasitic Nematodes Vol II & III by Zuckerman
4. General Nematology by Maggenti
5. Plant Nematology by Southey
6. Biological Control by Stirling
7. Principles of Nematology by Thorne

**M.Sc. Zoology IV Semester
D.C.E. (Nematology)
Paper – III Behaviour and Physiology of Nematodes**

Course Code: ZYM 4043

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit I

Nematode behaviour. Behavioural responses: kinesis and taxis. Movement of nematodes; wave form and propagation; influence of water film. Activity and aggregation. Responses of nematodes to light, temperature and chemicals.

Unit II

Feeding behavior of plant parasitic, bacteriophagous and predatory nematodes. Osmotic and ionic regulation. Ageing and its influence on nematode structure, behavior and physiology.

Unit III

Reproductive Physiology: Egg-laying; hatching and moulting processes and stimuli; dauer larvae and their physiological adaptation. Chemical communication in nematodes: Types of chemical cues: Pheromone, allomones, kairomones; their importance and applications.

Unit IV

Survival strategies of nematodes. Senescence. Quiescence: anhydrobiosis, anoxybiosis and cryobiosis. Structural modifications and ultrastructural changes during anhydrobiosis. Metabolic changes dehydration and rehydration. Resistance of anhydrobiotic nematodes to unfavourable conditions. Cryptobiosis. Diapause in nematodes.

Books Recommended:

1. The Behaviour of Nematodes by Croll
2. The Organization of Nematodes by Croll
3. Plant Parasitic Nematodes Vol. I, II & III by Zuckerman
4. Nematology by Sasser & Jenkins
5. Physiology of Nematodes by Lee & Atkinson

**M.Sc. Zoology IV Semester
D.C.E. (Parasitology)
Paper – I Medical and Veterinary Helminthology**

Course Code: ZYM 4051

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit I Introduction, brief history, geographical distribution and scope of helminthology. Platyhelminthes of humans and animals. Classification and general organization of helminthes.

Monogenea: Morphology, life cycle, ultra structure of tegument, reproductive system and economic importance. Type study: *Polystoma*, *Diplozoon*, *Gyrodactylus*.

Unit II Trematoda (Digenea): Hosts and habitats. General Morphology, biology and life cycle patterns. Ultra structure of tegument. Excretory system and its taxonomic importance. Reproductive system and egg formation and types of eggs. Larval forms, types of cercariae and metacercariae.

Type study in brief: Schistosomes: *S. Mansoni*, *S. Haematobium* and *S. japonicum* *Fasciolopsis buski*, *Paragonimus westermani*, *Chlonorchis sinensis*, *Heterophys* sp., Amphistomes, *Fasciola gigantica*, *Gastrodiscoides hominis*, *Dicrocoelium dendriticum*, and *Opisthorchis tenuicollis* – Disease etiology, Pathology, Diagnosis and the control measures. **Aspidogastrea:** Morphology, biology and life cycle of *Aspidogaster conchicola*.

Unit III Cestodaria: Morphology and life cycle of *Amphilina*, *Gyrocotyle*.

Cestoda: Systematic account and diagnostic features of various orders of Eucestoda (*Pseudophyllidea* and *Cyclophyllidea*). General morphology, biology and life cycle. Ultra structure of tegument.

Unit IV Life cycle, pathogenicity and control of some important cestode parasites of man and domestic animals. Parasitic zoonoses: Hydatidosis and neurocysticercosis.

Type study: *Diphyllobothrium latum*, *Echinococcus granulosus*, *Hymenolepis nana*, *Dipylidium caninum*.

Acanthocephata: General organization and morphology, larval forms, life cycle of *Moniliformis dubius*.

Books Recommended:

1. Clinical Parasitology by Belding
2. Medical Helminthology by Watson
3. Modern Parasitology by Cox
4. Parasites and Parasitism by Cameron
5. Human Helminthology by Faust
6. General Parasitology by Cheng
7. Foundation of Parasitology by Schmidt and Roberts
8. Principles of Parasitology by Smyth
9. Parasitology by Chatterjee

BOS: 02.06.2018

**M.Sc. Zoology IV Semester
D.C.E. (Parasitology)
Paper – II Medical and Veterinary Nematology**

Course Code: ZYM 4052

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Unit I: Introduction of nematode parasites of medical and veterinary importance. Classification of parasitic nematodes. Diagnostic features of superfamilies of orders rhabditida, ascarida, oxyurida, strongylida, enoplida and spirurida.

Unit II: Gross morphology and anatomy: Body wall, cuticle, sub cuticle and musculature. Cuticular specializations, Digestive system and feeding habits. Excretory system, reproductive system, nervous system and sense organs in nematodes.

Unit III: Life cycle patterns of nematode parasites, environmental factors affecting growth and development of free living stages. Types of ova, oviposition, mechanism of hatching and forms of juveniles in different groups of nematodes and their mode of transmission. Diagnostic methods: stool examination, blood examination, serological tests.

Unit IV: Disease relationship of nematode parasites: Pathology associated with different stages of nematode infection with particular reference to the following nematodes: *Enterobius vermicularis*, *Trichnella spiralis*, *Necator americaus*, *Dracunculus medinensis*, *Stroglyoides stercolaris*, and *Wucheria bancrofti*. Brief account of *Toxocara*, *Bunostomum*, *Loa loa* and *Onchocerca*.

Books Recommended:

1. Clinical Parasitology by Belding
2. The Invertebrate Vol. III by Hyman
3. Medical Helminthology by Watson
4. Modern Parasitology by Cox
5. Parasites and Parasitism by Cameron
6. Human Helminthology by Faust
7. General Parasitology by Cheng
8. Parasitic Nematodes: Molecular Biology, Biochemistry and Immunology – M. W. Kennedy and W. Harnett

**M.Sc. Zoology IVth Semester
D.C.E. (Parasitology)**

Paper – III Parasite Physiology, Biochemistry, Molecular Biology and Bio-informatics

Course Code: ZYM-4054

Credit:	02
Sessional:	30 Marks
End Term Exam :	70 Marks

Physiology and Biochemistry

Unit-I: Introduction, physiological basis of parasitism. Physico-chemical nature of different parasitic habitats. Absorptive, synthetic, secretory and excretory features of tegument. Autophagy. Metabolism of carbohydrate-PEP/PEPCK ratio. CO₂ fixation, volatile acid production.

Unit-II: Catabolism of protein, lipid and nucleic acids. Physiology of reproduction and egg shell formation. Factors influencing embryonation, hatching and excystation. Neurotransmitters and neurosecretion. Pathophysiological responses in helminthic infections. Generation of free radicals and role of anti-oxidant enzymes in the establishment of parasites.

Molecular Parasitology:

Unit-III: Scope of Molecular Parasitology. Quantitative and qualitative analysis of nucleic acids: Spectrophotometric and agarose gel electrophoresis. Gene expression. RNAi and its application. Application of molecular biology tools in identification, diagnosis and taxonomy of parasites. Molecular characterization of important model protozoan (*Plasmodium*) and some helminth parasites (*Haemonchus*, *Schistosoma*, *Echinococcus*).

Unit-IV: Bio-informatics: Background, various definitions, internet and Bio-informatics. Biological data bases. Sequence alignment tools-BLAST and FASTA. Data mining. Molecular phylogeny of parasites. Microarray technology in parasite diagnosis. Ethical issues in Bio-informatics.

Books Recommended:

1. Modern Parasitology by Cox
2. Biochemistry and Physiology of endoparasites by Von Brand
3. Biochemistry of Parasites by Barrett
4. Physiology of Trematodes by Smyth and Halton
5. Physiology of Cestodes by Smyth and MacManus
6. Molecular Medical Parasitology by Marr, Nilsen and Komuniecki
7. Molecular Parasitology by Hyde
8. Molecular approaches to Parasitology Bio-informatics by Boothroyd&Komuniecki
9. Bio-informatics – a practical guide to the analysis of genes and proteins by Baxevanis & Ouellette