

Department of Zoology

C.C.S. University, Meerut

(Courses prescribed for M.Sc. & M.Phil Degree 2008 onwards)

a. M.Sc.

First Semester

Course I : Economic Zoology and
Course II : Taxonomy
Course III : Evolutionary Biology
Course IV : Non-chordata
: Cell and Molecular Biology
Practicals based on above

Second Semester

Course V : Biostatistics and
Bioinformatics
Course VI : Genetics
Course VII : Mammalian Physiology
Course VIII : Biochemistry
Practicals based on above

Third Semester

Course IX : Chordata
Course X : [Developmental Biology](#)
Course XI : Environmental Biology
Course XII : Animal behavior
Practicals based on above

Fourth Semester : Specializations

A : Parasitology

Course XIII A : Biology of Parasite – II (Nematoda and Arthropoda)
Course XIV A : Physiology and Biochemistry of Parasites
Course XV A : Biology of Parasites – I (Protozoa, Trematoda and Cestoda)
Course XVI A : Immunoparasitology
Practicals based on above

B : Fish and Fisheries

Course XIII B : Gen. Fish Biology
Course XIV B : Morphology and Physiology of fishes
Course XV B : Fish Culture and importance of Fishery Science
Course XVI B : Applied Fisheries
Practicals based on above

C : Endocrinology

Course XIII C : General Endocrinology
Course XIV C : Neuro Endocrinology
Course XV C : Vertebrate Endocrinology
Course XVI C : Reproductive Physiology
Practicals based on above

D. Cytology and cytogenetics

Course XIII D : Advanced cell biology
Course XIV D : Chromosome and genomic organization
Course XV D : Genomic analysis, immunogenetics
Course XVI D : Human and Microbial cytogenetics and molecular biology
Practicals based on above

E: Entomology

Course XIII E : Morphology & Taxonomy of Insects
Course XIV E : Anatomy & Physiology of Insects
Course XV E : Applied Entomology I
Course XIII E : Applied Entomology II
Practicals based on above

F: Chronobiology and Mechanism of Animal Behavior

Course XIII F : Chronobiology
Course XIV F : Photoperiodism and Seasonal Breeding
Course XV F : Neuroendocrine control of behavior
Course XIII F : Applied Chronobiology
Practicals based on above

b. M.Phil.

Course I : Immunobiology
Course II : [Research Methods – I](#)
Course III : Research Methods – II
Course IV : Advance Zoology: Animal biotechnology

Note: Practical (both Internal & External) will be of 4 hours duration.

M.PHIL (ZOOLOGY)

COURSE I: IMMUNOBIOLOGY

1. a. Introduction to science of Immunology: Historical prospective, early theories of immunity, humoral and cellular immunity, components of immunity;
b. Immune system: Cells of immune system, lymphoid organs (thymus, bone marrow, lymph nodes, spleen), MHC complex (HLA class-I, HLA class-II, HLA class-III molecules), complements.
2. a. Immunoglobulins: Basic structure of immunoglobulins, fine structure of immunoglobulins IgG, IgM, IgD, IgA, IgE, hybridoma technology and monoclonal antibodies;
b. Antigen-antibody interactions: Exogenous antigens, endogenous antigens, concepts of immunology, epitopes, cross reactivity, precipitation, agglutination.
3. a. Immune-deficiency diseases: Phagocytic deficiency, humoral deficiency, cell mediated deficiencies, combined immunodeficiencies;
b. Immune system and AIDS: Acquired immune deficiency syndrome, human immune deficiency virus, diagnosis of AIDS, control of AIDS;
c. Immune system and cancer: Tumor antigens, immune response to tumors, tumor evasion, immunotherapy of cancer, transplantation immunology.
4. a. Immune Response to infectious diseases: Viral infection, bacterial infection, Protozoan disease, disease caused by parasitic worms, Mechanism of immune response, Genetic basis of immune response;
b. Vaccines: Active and passive immunization, whole organism vaccines, DNA vaccines recombinant vector vaccine.
5. Immunological techniques: Gel electrophoresis and SDS-PAGE, RIA, ELISA, western blotting, immunofluorescence, immunoelectron microscopy.

M.PHIL (ZOOLOGY)

COURSE II: RESEARCH METHODS – I

1. a. Preservation, fixation, fixatives, chemistry of fixation, freeze drying, cryopreservation; Stains and dyes, differential dyeing, chemistry of staining;
b. Microtomy, paraffin sectioning methods, cold knife (cryostat) sectioning ultra microscopy for TEM;
c. Microscopy- Light microscopy, phase contrast microscopy, dark field microscopy, fluorescent microscopy.
2. a. Microscopy- Light microscopy, phase contrast microscopy, dark field microscopy, fluorescent microscopy;
b. Electron microscopy, transmission electron microscopy (TEM), scanning electron microscopy (SEM).
3. a. Centrifugation-cell fractionation, high speed centrifugation, ultra centrifugation;
b. Spectrophotometry- Its principles, instrument design and applications.
4. a. Chromatography- adsorption chromatography, ion-exchange chromatography, gel fixation chromatography, affinity chromatography;
b. HPLC, GLC - Principles and practice.
5. Electrophoresis- Paper and gel electrophoresis, polyacrylamide gel electrophoresis (PAGE), SDS-PAGE.

M.PHIL (ZOOLOGY)

COURSE III: RESEARCH METHODS – II

1. a. Atomic absorption spectrophotometry-theory, instrument design, flame atomization method, electrothermal atomization, applications of AAS;
b. ESR & NMR spectroscopy-magnetic phenomenon, the resonance condition, principles, instrumentation and applications.
2. a. Enzyme linked assay (ELISA)-Principles, practical aspects and applications;
b. Radioimmunoassay (RIA)-Principles, practical aspects immunoradiometric assay (IRMA);
c. Radioisotope techniques – Nature of radioactivity, detection and measurement of radioactivity, applications in biological sciences, safety aspects.
3. a. X-ray diffraction-Principles, the concept of unit cell, Neutron diffraction, electron diffraction, symmetry, space groups and applications;
b. Autoradiography-History, scope, techniques of autoradiography, quantitative autoradiography and electron microscopic autoradiography.
4. a. Separation of nucleic acids- Electrophoresis of DNA, southern blotting-I, southern, blotting-II, Northern blotting, dot and slot blotting;
b. Polymerase chain reaction (PCR) – Principle, basic schemes of PCR, different schemes of PCR, applications of PCR.
5. a. Cell, tissue and organ culture, methods and applications;
b. Cell and tissue culture – Primary culture, cell lines, cell clones, micro-propagation embryogenesis, somatic hybridization, IVF – in vitro fertilization and embryo transfer.

M.PHIL (ZOOLOGY)

COURSE IV: ADVANCE ZOOLOGY: ANIMAL BIOTECHNOLOGY

1. a. Gene-Fine structure of gene, eukaryotic genome organization, satellite DNA, DNA damage and repair, DNA replication, amplification and rearrangements, DNA methylation, heterochromatinization, transposition;
b. Gene expression – Protein synthesis, regulation of gene expression in prokaryotes and eukaryotes.
2. a. Genetic engineering – Principles and methods of genetic engineering, application in health, agriculture and industry, transgenic animals;
b. Recombinant DNA technology in prokaryotes and eukaryotes.
3. a. Membrane biology – Ultra structure of the membrane, various models with special reference to membrane proteins, fluid mosaic model and functions of plasma membrane;
b. Cytoskeleton – Microtubules, structure and chemical composition of microtubules, action filaments, structure and chemistry of intermediate filaments.
4. a. Stem cell biology: Embryonic stem cells, adult stem cells, use of stem cells, recent researches on stem cells;
b. Cancer biology – Molecular biology of cancer, oncogene chemical carcinogenesis, environmental carcinogenesis.
5. Drug metabolism- Phase I and phase II reactions, common detoxication mechanisms i.e. conjugation, glucuronidation, sulfation.

M.Sc. (ZOOLOGY)

Course I : Economic Zoology and Animal Taxonomy

- Unit 1 a. Science of taxonomy- Definition, concepts, history, scope and applications of biosystematics.
b. Principles of Zoological Classification-Theories of biological classification and their history, hierarchies of categories and the higher taxa
- Unit 2 a. Concept of Species – Species category, different concepts and intraspecific categories.
b. Modern trends in taxonomy, Behavioural taxonomy, chemotaxonomy, cytotaxonomy and molecular taxonomy.
- Unit 3 a. Procedures in taxonomy- Taxonomic collections, process of identification, procedure of classifying, description and publication
b. Principles and application of zoological nomenclature- origin of code, Rules of zoological nomenclature (ICZN), interpretation of rules of nomenclature
- Unit 4 a. Animals as food – Fish products, dairy products, piggery, pearl, leather and wool industry.
b. Domestic animals- Poultry, cattle and Pisciculture
- Unit 5 a. Economic insects – Apiculture, sericulture, insect pests and integrated pest management.
b. Biological control and biological indicators

Course II : Evolutionary Biology

- Unit 1 a. Origin of Life including aspects of pre-biotic environment, Abiotic and Biotic Evolution, Theories of Organic Evolution, Emergence of Evolutionary Thoughts.
b. Origin and evolution of economically important microbes and animals (Horse & Elephant).
- Unit 2 a. Distribution of Animals: Distribution with Space, Distribution with Time.
b. Dispersal of Animals: Means, Barriers, Migration
- Unit 3. a. Concepts of Evolution: Micro Evolution, Macro Evolution, Phylogenetic Gradualism.
b. Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks; molecular tools in phylogeny; origin of new genes and proteins; gene duplication and divergence.
- Unit 4 a. Mechanism of Evolution: Isolating Mechanism, Speciation, Alopatricity and Sympatricity; Convergent Evolution; Sexual Selection; Co-evolution, Natural Selection.
b. Adaptation – Introduction, Adaptive Radiation and Modifications, Coloration & Mimicry
- Unit 5 a. Evidences in favour of organic evolution.
b. Evolution of Horse, Elephant and Man.

Course III: Non- Chordata

- Unit 1 a. Protozoa: General characters, outline classification, organelles in protozoa, locomotion in protozoa and reproduction in protozoa.
b. Porifera: Important features, outline classification, structural peculiarities, skeleton and regeneration in sponges.
- Unit 2 a. Cnidaria: Important features, outline classification, polymorphism in cnidarians coelenterates, gradation of mutagenesis, skeleton in coelenterates and coral reefs.
b. Ctenophora: Important features, outline classification, general organization and affinities.
c. Helminths: Important features, outline classification platyhelminths and nemathelminthes.
- Unit 3 a. Annelida: Important features, outline classification, segmentation and coelome, excretory system and regeneration.
b. Arthropoda: Important features, outline classification, Integumentary system, respiratory system and larval forms in crustacean.
c. Onychophora: Important features, outline classification, general organization and affinities.
- Unit 4 a. Mollusca: Important features, outline classification, shell, foot and its modifications, torsion and detorsion in gastropoda.
b. Echinodermata: important features, outline classification, body wall and skeleton, larval forms and regeneration.
- Unit 5 a. Minor non coelomata phyla: General organization, classification and affinities of phylum rotifera and acanthocephalan.
b. Minor coelomate phyla: General organization, classification and affinities of phylum chaetognatha, pogonophora, phoronida and brachiopoda.
c. Hemichordata: General organization, classification and affinities.

COURSE IV : Cell and Molecular Biology

- Unit 1 a. Introduction to the cell, cell theory, ultrastructure of the cell, prokaryotic vs eukaryotic cells, organization of eukaryotic cells, cell cycle, cyclin dependent kinases (Cdks) regulation of Cdks, cell cycle and cancer.
b. Cell membrane – Models on the fine structure of biomembrane including detailed fluid mosaic model, organization of lipids & proteins, specific membrane proteins, functions of plasma membrane (transport, diffusion, active transport, pumps, uniports, symports and antiports).
- Unit 2 a. Cytoskeleton, structure and dynamics of microtubules, actin filaments (microfilaments), intermediate filaments, cilia & flagella.
b. Cell organelles- origin, structure and function of mitochondria, endoplasmic reticulum and ribosomes, Golgi complex, endosome, lysosomes, peroxysomes, centrosome.
c. The nucleus- Nuclear envelope, nucleolus, Chromosomes, type, structure, chemical composition and functions of chromosomes.
- Unit 3 Prokaryotic and eukaryotic genome, fine structure of DNA, DNA Replication, Biosynthesis of DNA, protein synthesis (Transcription, translation and regulation of gene expression Genetic code).
- Unit 4 a. Cell communication – cell-cell signaling, cell surface receptors, second messenger system, kinase pathways, signaling from plasma membrane to nucleus (signal transduction).
b. Cell adhesion & cell junctions- cellular affinity, cell adhesion molecules (CAMs), Ca⁺⁺ dependent cell-cell adhesion, Ca⁺⁺ independent cell-cell adhesion, cadherins, selectins, integrins, cell junctions.
- Unit 5 a. Cell division – Mitotic & meiotic cell division, the central cell cycle control system, feedback signals. Cell death – Necrotic cell death, programmed cell death (apoptosis) and their mechanisms.
b. Cell commitment- (Specification of cell-fate by progressive cell-cell interaction): Regulative development, germ plasm, theory, regulation in sea urchin egg, of *Caenorhabditis elegans*, Regulation in Amphibian development, molecular basis of organizer, Competence and secondary induction in development.

COURSE V: Biostatistics and Bioinformatics

- Unit 1 a. Biostatistics – Basic concepts, Fundamentals of measurements, Qualitative & Quantitative Variables, Collection, Classification, Tabulation & Presentation of data.
b. Measures of Central Tendency – objectives of Averages, Various Measures of Central Tendency (Mean, Median, Mode) and their Merits & Demerits, Choice of suitable Averages.
- Unit 2 a. Measures of Dispersion – Objective of measuring variability, Properties of good measure of dispersion, Types of measure of dispersion, Merit & demerits of Standard Deviation.
b. Correlation Analysis – Importance of Correlation Analysis, Types of Correlation, Measures of Correlation, Regression Analysis, Difference between Correlation & Regression, Regression of Y on X and X on Y.
c. Test of Significance – Testing of Hypothesis, Errors in Hypothesis Testing, Level of Significance, Chi-square test, 'Z' test & 't' test, Analysis of variance, Probability Distribution (Poisson, Binomial & Normal).
- Unit 3 a. Bioinformatics – Introduction, Components of Computer, Number System, Logic Gates, Flow Chart, Comprehension of C & its programming.
b. Basics for operating system (Windows), MS-Word, Power Point, Introduction of Data Base Management System (DBMS).
c. Internet – Basics for Biologists (Electronic mail, Electronic Mail Servers, Downloading files with anonymous File Transfer Protocol, Gopher, WWW, Mosaic).
- Unit 4 Primary Database, Secondary Database, Sequence Databases (European Molecular Biology Laboratory, GenBank, DNA Data Base of Japan (DDBJ), SWISS-PORT, Protein Information Resource, TREMBL), Protein Family/Domain Databases (Prosite, Pfam & Prints), Submitting sequence to Database and information retrieval through ENTREZ.
- Unit 5 Sequence Database – Collecting & Storing Sequences, Local alignment, Global Alignment, BLAST (BLASTP, BLASTN, BLASTX, TBLASTN, TBLASTX), Phylogenetic Prediction, Gene Prediction & Analysis

Course VI: Genetics

- Unit 1 a. Mendelian principles- Dominance, segregation, independent assortment, deviations from mendelian inheritance.
b. Methods of genetic transfer-Transformation, conjugation, transduction, bacteriophages-types, structure and morphology of T₄ phage
- Unit 2 a. Chromosomes- structural and numerical alterations of chromosomes, Molecular anatomy of eukaryotic chromosomes, heterochromatin and euchromatin, giant chromosomes, polytene and lampbrush chromosomes, sex chromosomes
b. Gene-mapping- Concept of recombination, linkage map, cytogenetic map, physical maps, molecular maps, levels of genome mapping, significance of genome mapping.
- Unit 3 a. Population genetics- Gene pool and gene frequencies, Hardy-weinberg law of genetic equilibrium and changes in gene frequencies
b. Somatic cell genetics- cell fusion and hybrids-agents and mechanism of fusion, heterokaryon
- Unit 4 a. Genetic techniques- Cloning, PCR, DNA sequencing FISH, GISH, DNA-fingerprinting, Chromosome walking and applications of genetic engineering
b. Genetic code- Properties of genetic code, codon assignments, chain initiation and termination, mutations and the genetic code
- Unit 5 a. Genetic disorders- chromosomal disorders, inborn errors of metabolism, tay-sachs disease, albinism, phenylketonuria, lesch-nyhan syndrome
b. Organization of genetic material- packaging of DNA as nucleosomes in eukaryotes, repetitive and unique DNA sequences, split genes, overlapping genes and pseudogenes

Course VII : Mammalian Physiology

- Unit 1 a. Blood and circulation: Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis.
b. Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.
- Unit 2 a. Nervous system: Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture
b. Sense organs: Vision, hearing and tactile response
- Unit 3 a. Respiratory system: Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration
b. Excretory system: Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance
c. Digestive system: Digestion, absorption, energy balance, BMR
- Unit 4 a. Thermoregulation: Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization
b. Stress and adaptation
- Unit 5 Endocrinology and reproduction: Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, neuroendocrine regulation

Course VIII: Biochemistry

- Unit 1 a. Structure of atoms, molecules and chemical bonds
b. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).
- Unit 2 a. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).
b. Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).
- Unit 3 a. Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds)
b. Conformation of nucleic acids (A-, B-, Z-,DNA), t-RNA, micro-RNA).
c. Stability of protein and nucleic acid structures.
- Unit 4 Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins
- Unit 5 a. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes
b. Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.

Course IX: Chordata

- Unit 1 a. Protochordata : Origin & Evolution of Chordate, General Organization & Affinities of Larvacea, Thaliacea and Cephalochordate.
b. Vertebrate Ancestry : Introduction, Origin and Evolution of Vertebrates.
c. General and Comparative Account of Integumentary System and Urinogenital System.
- Unit 2 a. Fish : General Characters, Special Characters, General Organization and Affinities of Obstracoderm & Coelacanthiformes
b. Amphibia : General Characters, Special Characters, Parental Care, Neoteny
- Unit 3 Reptiles: General Characters, Special Characters, Types & Peculiarities of Dinosaurs, General Organization of Chelonia.
- Unit 4 Birds: General Characters, Special Characters, Flight Adaptation, Migration and Territorial Behavior
- Unit 5. a. Mammals: General and Special Characters Of Mammals, Organization & Affinities of Prototheria.
b. Mammals: General Organization and Affinities of Marsupialia
c. Mammals: Aquatic Mammals With Reference to Cetaceae.

Course X: Developmental Biology

- Unit 1 a. Introduction- History background and theories of development, theory of preformation, epigenetic theory, theory of pangenesis, recapitulation theory, germplasm theory, mosaic theory, regulated theory, gradient theory and theory of organizers.
b. Parthenogenesis- Natural parthenogenesis, arrhenotoky, thelytoky, accidental parthenogenesis, rudimentary parthenogenesis, artificial parthenogenesis, parthenogenesis in human being, gynogenesis, androgenesis and significance of parthenogenesis.
c. Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.
- Unit 2 a. Gametes and fertilization- Spermatogenesis, oogenesis and fertilization.
b. Early development- Cleavage and blastula, Pattern of cleavage, laws of cleavage, types of cleavage, effect of yolk on cleavage, physiology of cleavage, morula and blastula.
- Unit 3 Gastrulation- Process of gastrulation, invagination, involution, infiltration, delamination and mechanisms, accessory processes of gastrulation concrescence and convergence.
- Unit 4 a. Metamorphosis- metamorphosis in insects and amphibians, biochemical and morphological metamorphic changes and hormonal control of metamorphosis.
b. Regeneration- Regenerative potentials in different animal groups, mechanism of regeneration in amphibian and *planeria*.
- Unit 5 a. Aging- Introduction, consequences of aging, causes of aging, control of aging through genes and aging of cells *in vitro*, Carrel's immortal cells.
b. Abnormal development
(i) Teratology- Causes of abnormal development, therapeutic drugs as teratogens, drug testing, experimental teratology.
(ii) Neoplasia- Etiology, growth and differentiation of tumor cells, cell growth and oncogenesis, loss of homeostatic control, growth and invasiveness of placenta.

Course XI: Environmental Biology

- Unit 1
- The Environment: Physical environment; biotic environment; biotic and abiotic interactions.
 - Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement
 - Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.
- Unit 2
- Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.
 - Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.
 - Community ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
- Unit 3
- Ecosystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).
 - Ecological succession: Types; mechanisms; changes involved in succession; concept of climax.
- Unit 4 Applied ecology: Environmental pollution; global environmental change; biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.
- Unit 5 Conservation biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Course XII: Animal Behaviour

- Unit 1
- Stereotyped behaviour- Taxes, reflexes, instinct and motivation.
 - Individual behavioural patterns- Conflict behaviour
- Unit 2
- Learning and memory- Definition, forms, development and mechanism of learning, neural basis of learning, memory in animals
 - Communication- Study of communication, messages and their meanings, the forms of signals, communication in animals as language.
- Unit 3
- Environmental perceptions- Mechanical, electrical, chemical, olfactory, auditory and visual.
 - Biological rhythms- Circadian and circannual rhythms, biological clocks, migration, orientation and navigation.
- Unit 4
- Neural and hormonal control of behaviour- Neural structures, general pattern of nervous system in animals, hormones in relation to different behavioural patterns.
 - Pheromones and behaviour- Introduction, definition, classification and role of hormones behavioural patterns.
 - Neuroendocrine control of behaviour- Endocrine secretions, neuroendocrine control mechanism in certain behavioural patterns.
- Unit 5 Social behaviour- Social structures, social dominance, domestication, advantages of groupings, development, social organization in insects and primates.

COURSE XIII A: Biology of Parasite - I

- Unit 1 **a. Animal Associations & Categories:** Introduction, Basic Principles & Concepts, Symbiosis, Parasitism, Commensalisms, Types of Parasites.
- b. Parasitic Adaptation:** Evolution of Parasitism, Fate of Parasite, Adaptation to Parasitism,
- Unit 2 **Host Parasite Relationship:** Host specificity {(Ectoparasite: i. Larval stages parasitic & adult free living, ii. Adult parasitic & larval stages free living, iii. Both larva & adult parasitic), (Endoparasite: i. Larval stages parasitic & adult free living; ii. Adult parasitic & larval stages free living)}, Action of Parasite upon their Hosts (Effects of parasites upon Invertebrates, Effects of parasites upon Vertebrates).
- Unit 3 **Parasitic Protozoa:** Introduction, General Classification, *Trypanosoma gambiense*, *Leishmania donovani*.
- Unit 4 **a. Trematoda:** Introduction, General Classification, Types of Trematodes, Larval forms.
- b. Trematoda:** *Paragonimus westermani*
- c. Trematoda:** Blood flukes (*Schistosoma haematobium*, *S. mansoni* & *S. japonicum*).
- Unit 5 **a. Cestoda:** Introduction, General Classification.
- b. Cestoda:** Larval forms.
- c. Cestoda:** *Echinococcus granulosus*, *Hymenolepis nana* & *H. diminuta*

COURSE XIV A: Biology of Parasite–II

- Unit 1 **a.** General Organization, Classification & General Pattern of life cycle of Nematodes (animals, plant parasitic & Entomopathogenic), Parasitic Adaptation.
- b.** Introductory Nematology : Introduction, General Morphology, Economic importance, Types of Plant nematodes, Host Range, Biology
- Unit 2 **a.** Family - Strongyloidea : *Strongyloides stercorales*
- b.** Family – Ancylostomatidae : *Ancylostoma duodenale*;
- c.** Family - Filaridae : *Wuchereria bancrofti*.
- Unit 3 **a.** Techniques in Nematology : Methods of sampling (soil & plant samples), Methods of extracting nematodes from soil & plant samples, Methods of processing nematodes for observation.
- b.** Plant Nematode Relationship : Host parasite relationship, Mechanism involved in injury & histopathology of infected tissue, Interaction with other microorganism, Brief Structure, Life Cycle, Epidemiology, Pathogenicity and Control of Root knot & Cyst Nematodes.
- Unit 4 **Acanthocephala – General Organization and Classification**
- Unit 5 **a.** Medically Important Insects : Arthropods and vectors of human diseases (mosquitoes, lice, flies and ticks); Mode of transmission of pathogens by vectors, Chemical, biological and environmental control of arthropod vectors.
- b.** Insects carrying Vesication, Urtrication and Venomenization

Course XV A: Physiology and Biochemistry of parasites

- Unit 1 a. Nutrition- Uptake and digestion in protozoa, trematoda, cestoda and nematode. Metabolism- Carbohydrate, metabolism and energy.
b. Parasitic reproduction- Asexual, sexual, reproduction, synchronization of parasite with host reproduction, *in vitro* cultivation of parasites.
c. Nucleic acids in parasites- Composition, synthesis and catabolism.
- Unit 2 a. Parasitic reproduction- Asexual, sexual, reproduction, synchronization of parasite with host reproduction, *in vitro* cultivation of parasites.
b. Egg shell- Formation in helminthes, chemistry of egg shell formation, role of mehli's glands
- Unit 3 Excretion- Nitrogen excretion and water and ionic regulation in parasites
- Unit 4 a. Parasite transmission- Mechanim of host selection, penetration and circadian rhythm.
b. Ecology of parasitism- How parasite find their host, host selection and its consequences, negative interaction, problems of escape and dispersal, problem of mate finding, niche biology, population dynamics
c. Growth and establishment of parasite- Hatching, establishment, site selection, migration.
- Unit 5 Nervous system and sense organs- Morphology of nervous system and sense organs, nervous transmission and neurosecretion and behavioral coordination

Course XVI A: Immunoparasitology

- Unit 1 a. Introduction: Early theories of immunity, historical prospective, recognition, kinds of immunity, normal immune response.
b. An overview of immune system: Innate immunity, acquired immunity (Humoral & cell mediated immunity)
c. Cells of immune system: Lymphoid cells (T-lymphocytes, B-lymphocytes), null cells, mononuclear cells, granulocytic cells, mast cells, basophils, dendritic cells, MHC molecules and compliments.
- Unit 2 a. Immune system: Lymphoid organs of the body, thymus, bone marrow, lymphnodes spleen, GALT, MALT, CALT
b. Immunoglobulin: Basic structure of immunoglobulin, fine structure of IgG, IgM, IgA, IgE, IgE, monoclonal antibodies, parasite antigen.
c. Antigen antibody interactions: Strength of antigen-antibody interactions, cross reactivity, precipitation reaction, agglutination reaction.
- Unit 3 Immunobiology of Protozoans: Malaria (Host response against Plasmodium infection, design of malaria vaccine), African sleeping sickness.
- Unit 4 Immunobiology of trematodes: General considerations, immunological problems of trematode infection, immunological response against trematode infection, Schistosomiasis, fascioliasis, immunodiagnosis of trematodes.
- Unit 5 a. Immunobiology of cestodes: general consideration, immunity to adult cestodes, immunity to travel castodes, imunodiagnosis.
b. Vaccines: Passive immunization active immunization, designing of vaccines for active immunization, whole organism vaccines, recombinant vactor vaccines, DNA vaccines synthetic vaccines.

GROUP B: FISH AND FISHERIES

Course XIII B: General Fish Biology

- Unit 1 a. Classification of fishes - Origin and affinities, general characters & important examples of Cyclostomata, Elasmobranchii, Bradyodonti, Actinopterygii, Crosspterygii and Dipnoi
b. Geographical distribution of fishes- In marine and fresh water habitats, fresh water fish fauna of India, Marine fish fauna of India.
- Unit 2 a. Migration in fishes- Types of migration, courses of migration, catadromous, anadromous, fishes, homing and territorial recognition, schooling
b. Locomotion in fishes - Locomotor muscles, red and white muscle types, organization of myonemes, types of swimming and hydromechanics of propulsion, significance of swimbladder in swimming
- Unit 3 a. Body form and its diversity- Types of fins, origin of n & paired fins, modifications and functions of fins
b. Integument and exoskeleton- Types of scales.
- Unit 4 a. Biological significance of endoskeleton and musculature- Vertebral column, types of jaw suspension in fishes, structure arrangement and homology of Weberian ossicles, lateral musculature and respiratory musculature
b. Coloration in fishes- Chromatophores, types of chromatophores, morphological, physiological and biological significance of coloration in fishes.
- Unit 5 a. Electric organs in fishes - Types of electric fishes, origin, structure and function of electric organs, location of electric organs, evolution of electro-receptors and electric organs
b. Luminescent organs in fishes - Location, structure and control of luminescent organs, physiological and biological significance of luminescence.

Course XIV B: Morphology and Physiology of fishes

- Unit 1 a. Food, digestion and nutrition –Food, feeding habits, feeding adaptations, alimentary canal in fishes, physiology of digestion
b. Blood Vascular system- Heart and circulatory vessels, Blood, tissue fluids and blood forming organs, structure of the heart and body temperature
- Unit 2 a. Respiratory System- Structure and function of gills, morphology of the gill epithelia, gaseous exchange at the gill surface, fish blood as gas carrier, water and ion transport across the gills
b. Air breathing in fishes - Causes, adaptation for air breathing, accessory respiratory organs, morphology & function of pseudobranch
- Unit 3 a. Excretion- Structure and function of the kidney, osmoregulatory and excretory organs, excretory products, endocrine control of excretion and osmoregulation
b. Nervous system & sense organs – Nervous system, Spinal cord, spinal nerves, autonomic nervous system, supporting tissues of CNS and sense organs in fishes
c. Reproduction & development – Types of reproduction, Reproductive system, reproductive cycles and breeding, parental care and development
- Unit 4 Endocrine glands in fishes - Pituitary, thyroid, gonads, adrenal, corpuscles of stannious, pancreas, ultimobranchial
- Unit 5 a. Adaptations in fishes - Deep sea adaptations, cave adaptations, hill stream fishes, freezing avoidance, symbiosis and parasitism
b. Fish venoms - Poisonous fishes, venom apparatus, pharmacology & toxicology of fish venoms

Course XV B: Fish culture and importance of fishery science

- Unit 1 a. Introduction & history of fishery science - In India, Inland, marine, capture and culture fisheries. Indian fisheries, World fisheries.
b. Cultivation of fish - Fresh water fish culture in India, culture of Indian major carps (Rohu Catla & Mrigal) exotic carps (Common carp, Grass carp, Silver carp), tilapia, Culture of air breathing fishes (*Heteropneustis*, *Clerias*, *Channa* & *Anabas*).
- Unit 2 a. Riverine fisheries - Ecology and fisheries of the major river systems of India, Production and potential of riverine fisheries.
b. Reservoir fisheries - Ecology of lakes and reservoirs, development, exploitation and management of reservoir fisheries.
- Unit 3 a. Cold water fisheries - Ecology of high altitude streams, lakes and reservoirs, important cold water fisheries, present status and scope of development in India.
b. Marine Capture fisheries - Capture fisheries of Sardines, Mackerel; Bombay duck, Ribbon fish, Pomfret, Tuna and Sole. Culture of pearl oyster & bivalves, present status & potential of mariculture in India.
c. Crustacean fisheries - Prawn fisheries, lobster fisheries and crab fisheries, development and exploitation of crustacean fishery resources.
- Unit 4 a. Ecology and Productivity - of a fresh water, pond lake and river, Biota, algal blooms, benthos, macrovegetation, nutrient cycle and productivity.
b. Methods of fishing - Fishing effort, crafts and gears used in India for fishing. Recent advances in fishing methods-electrical fishing, light fishing, fish finders (echosounder and sonar) and their uses.
- Unit 5 Environment & Fish - Environmental factors in relation to life of fishes, pollution of aquatic ecosystems, effects of water pollution on fishes, EEZ, Indian Antarctic Expedition & relevance to fishing.

Course XVI B: Applied Fisheries

- Unit 1 a. Pisciculture - Objectives in south East Asia, India.
b. Fish Breeding & Hatchery Technology – Induced Breeding, Types of Hatchery and their Operation.
- Unit 2 a. Fish Pathology - Symptoms, Etiology, Prophylaxis and Treatment of common diseases of cultivable fishes.
b. Fish Processing Technology: Methods of Preservation of fish and prawn (chilling, freezing, quick freezing, salting, drying, freeze-drying, smoking, canning), Rigor mortis in fish, fish spoilage - bacterial & chemical.
c. Quality Assurance: Value Added Products (Fish Fingers, Fish Flakes, Soup, Powder), Byproducts (Fish Meal, Fish Oil, Surgical Sutures).
- Unit 3 a. Fish Genetics & Biotechnology: Genetic Improvement (Inbreeding & Cross Breeding), Chromosome Manipulation, Transgenic fish & Shellfish.
b. Fish Nutrition & Feed Technology: Feed formulation strategies & Methods, Types of feed & their ingredients, Formulation of feed for larvae, fry, fingerlings, adults & brood stock, formulation of nutritionally balanced & cost effective diets.
c. Ornamental Fishes: Types of ornamental fishes, Aquarium manufacturing and their accessories.
- Unit 4 Fish Transport & Marketing – Handling & Transportation of Fresh Water Fish, Whole sale and Retail markets, Fishery cooperatives.
- Unit 5 Fishery Education & Management - Objectives & function of Central Institute of Fishery Education (CIFE), Central Inland Captured Fisheries Research Institute (CICFRI), Central Institute of Freshwater Aquaculture (CIFA), Central Marine Fisheries Research Institute (CMFRI), Fisheries legislation for resource management.

GROUP D: Cytology and Cytogenetics

Course XIV D : Chromosomes and genomic organization

Unit I Nucleus

- a. Chromosomes (Ultrastructure: Nucleosome and solenoid model, nuclear scaffold)
- b. Molecular structure of telomeres (structure, synthesis and significance of telomere length); Kinetochore and centromere (yeast centromere, alpha-satellite DNA, other centromere sequences).
- c. Reassociation kinetics and "Cot" curves (chemical complexity and kinetic complexity); Sat-DNA (including in-situ hybridization)
- d. Molecular structure of euchromatin and heterochromatin.
- e. Molecular structure of an eukaryotic gene.

Unit II Functional genomics

- a. Concept of totipotency vis-a-genome constancy.
- b. Amphibians: Serial nuclear transplants
- c. Developmental-significance of fluctuations in genomic DNA content (rDNA amplification).

Unit III Genome organization

- a. Chromosomal organization of genes and non-coding DNA
- b. Mobile DNA
- c. Morphological and functional elements of eukaryotic chromosomes

Unit IV Genetics of cell cycle

- a. Genetic regulation of cell division in eukaryotes
- b. Molecular basis of cellular check points
- c. Molecular basis of neoplasia (cancer). Oncogenes and tumour suppressor genes.
- d. Conversion of proto-oncogenes into oncogenes

Unit V Cytogenetics of Sex determination and sex differentiation

- a. Genic balance theory of sex determination (*Drosophila*, *Lymantria* and *Caenorhabditis elegans*), X/A ratio, multiple numerator elements, sex linked master control genes and autosomal regulatory genes.
- b. Sex determination and sex differentiation in mammals (including human)
- c. Dosage compensation in organisms with heterogametic males
- d. Genetic imprinting

References:

- a. Lodish et al. : Molecular Cell Biology, Scientific American Books
- b. De Robertis and De Robertis: Cell and Molecular biology Saunders College Publ
- c. Alberts et al.: Molecular Biology of Cell Garland Publishing, USA
- d. Strickberger : Genetics Macmillan
- e. Atherly et al.: The Science of Genetics, Saunders College Publ. N.Y.
- f. Snustad, D.P. and M. Simmons: Principles of Genetics, John Wiley & Sons, N.Y.
- g. Brooker, R.J.: Genetics Benjamin/Cummings USA
- h. Gupta P.K.: Genetics Rastogi Publ., Meerut
- i. Farnsworth: Genetics Harper & Row
- j. Gardner, E.J., M.J., Simmons & D.P. Snustad. Principles of Genetics, John Willey and Sons. Inc. N.Y.

Course XV D : Genomic analysis, immunogenetics

Unit I Genome analysis

- a. C-value paradox, detailed account of various models of prokaryotic genomes, viral genome and eukaryotic genomes. Organization of genes in organelle genomes.
- b. Molecular analysis of genomic DNA in yeast or any other eukaryote.
- c. Transposable elements in prokaryotes and eukaryotes. Role of transposable elements in genetic regulation.
- d. Genome analysis- Microbial genomes, *Drosophila*, yeast.

Unit II Molecular cytogenetic techniques

- a. Automated Karyotyping
- b. Chromosome banding and chromosome painting
- c. Construction of a restriction map
- d. Restriction fragment length polymorphism (RFLPs)

Unit III Molecular mapping of genomes

- a. Choice of mapping population: Simple sequence repeat loci
- b. Southern and fluorescence in situ hybridization for genome analysis
- c. Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis.
- d. Molecular markers linked to disease genes.
- e. Applications of RFLP in forensics, disease diagnosis, genetic counseling, germplasm maintenance and toxinomy.

Unit IV Immunogenetics

- a. Immunoglobulin gene structure
- b. Multigene organization of Ig genes
- c. Mechanisms of DNA rearrangements and generation of antibody diversity
- d. DNA rearrangements and expression of T-cell receptors.

Unit V Human genetics

- a. Genetic screening, prenatal diagnosis and genetic counseling
- b. Prenatal screening methods; foetal screening; new born screening; carrier screening; pre-implantation screening
- c. History and methods of genetic counseling; need to seek genetic counseling, ethical and legal aspects

References:

- a. Lodish et al. : Molecular Cell Biology, Scientific American Books
- b. De Robertis and De Robertis: Cell and Molecular biology Saunders College Publ
- c. Alberts et al.: Molecular Biology of cell Garland Publishing, USA
- d. Strickberger : Genetics, Macmillan
- e. Atherly et al.: The Science of Genetics, Saunders College Publ. N.Y.
- f. Snustad, D.P. and M. Simmons: Principles of Genetics, John Wiley & Sons, N.Y.
- g. Brooker, R.J.: Genetics, Benjamin/Cummings USA
- h. Gupta P.K.: Genetics, Rastogi Publ., Meerut
- i. Farnsworth: Genetics, Harper & Row
- j. Gardner, E.J., M.J., Simmons & D.P. Snustad. Principles of Genetics, John Willey and Sons. Inc. N.Y.

Course XVI D : Human and Microbial cytogenetics and molecular biology

Unit I Chromosome

- a. Molecular anatomy of eukaryotic chromosomes
- b. Metaphase chromosome, centromere, kinetochore, telomere and its maintenance
- c. Heterochromatin and Euchromatin
- d. Giant Chromosome: Polytene & Lamp brush Chromosome, Somatic cell genetics
- e. Heterokaryon-selecting hybrids and chromosome segregation

Unit II Human cytogenetics

- a. Techniques in human chromosome analysis- molecular cytogenetics approach
- b. Numerical and structural abnormalities of human chromosome – syndromes
- c. Human genetics
- d. Cytogenetics implications and consequences of structural changes and numerical alterations of chromosomes

Unit III Microbial Genetics

- a. Bacterial transformation, transduction, conjugation, bacterial chromosome
- b. Bacteriophage: Types, structure and morphology of T4phage, morphogenesis
- c. Cytogenetic effects of ionizing and non-ionizing radiation
- d. Genetics of cell cycle and cyclin independent kinases

Unit IV Molecular Biology

- a. DNA synthesis
- b. DNA replication in prokaryotic and eukaryotic cell
- c. Genetic code
- d. DNA damage and repair

Unit V Transcription and Translations

- a. Transcription in prokaryotic and eukaryotic cell
- b. RNA & DNA polymorphisms
- c. Regulation of gene expression in prokaryotes and eukaryotes
- d. The translation machinery in prokaryotes and eukaryotes
- e. Post transcriptional modification in polypeptide

References

- a. Molecular Cell Biology. J. Daenell, H. Lodish and D. Baltimore, Scientific American Book, Inc., USA
- b. Molecular Biology of the Cell. B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J.D. Watson, Garland Publishing, Inc., New York.
- c. Lewin, B. Genes, VI. Oxford University Press, Oxford, New York, Tokyo.

Course XIII D : Advanced cell biology

Unit I Cell Biology

- a. Circadian rhythms in cells, i.e. from human supra chiasmatic nucleus and peripheral oscillators and cyanobacteria.
- b. Membrane transport, cell to cell communication and its importance
- c. Transmembrane proteins and receptors
- d. Signal transduction pathways
- e. Cell adhesion and cell functions, Ca⁺⁺ independent cell-cell adhesion, Cadherins, etc.

Unit II Cytogenetics and genome of pro and eukaryotes

- a. Hierarchy in organization of cells
- b. Prokaryotic and eukaryotic genome
- c. Regulation of gene expression

Unit III Modern cytogenetics and instrumentation

- a. Flow cytometry
- b. Ageing in cells
- c. Necrosis and apoptosis (Programmed cell death)

Unit IV Cytology of Extremophiles

- a. Tag polymerase production by *Thermus aquaticus*
- b. Cytology of flora and fauna of thermophilic areas like hot sulphuric springs and novel genes carrying forms living in cold deserts

Unit V Cytology and biotechnological techniques

- a. Cloning
- b. DNA sequencing
- c. FISH, GISH
- d. RFLP in forencis, disease diagnosis

References

- a. Molecular biology : Prescott
- b. Benjamin Leivis: Genes VIII
- c. Cell physiology- Grise
- d. Cell Biology – Townsend
- e. Molecular cell biology: H. Lodish, J. Daenell, and D. Baltimore, Scientific American Book Inc., USA

Course XIII E : Morphology & Taxonomy of Insects

- Unit I General Principles of insect taxonomy
- Unit II General characters, classification (up to families) & affinities of different order of Apterygota and Pterygota (Exopterygota & Enopterygota)
- Unit III Collection and preservation of insects – Methods of insect collection, different methods of insect rearing, methods of insect preservation & maintenance of insect museum
- Unit IV Insect Integument – Structure & function
- Unit V Segmentation & body regions – Head, thorax & abdomen – structure & appendages

Course XIV E : Anatomy & Physiology

- Unit I Physiology of various systems (Digestive system, respiratory system, excretory system, circulatory system, nervous system & Sense organs)
- Unit II Effector organs (Sound producing organs & light producing organs)
- Unit III The endocrine system – Organization, structure of glands and their hormones, endocrine functions (In metamorphosis, reproduction, metabolism & osmoregulation)
- Unit IV Reproductive system – Male and female reproductive organs and genitalia hermaphroditism, mating and transfer of sperms.
- Unit V Embryology – Gametogenesis, embryonic & post embryonic development, embryonic dynamics.

Course XV E : Applied Entomology I

- Unit I Origin, evolution & distribution of insects in time and space (Oriental region).
- Unit II Insects & the abiotic environment – Effect of temperature, humidity & light.
- Unit III Symbiosis, parasitism, social life, adaptation in insects migration and phase theory of locusts.
- Unit IV Insect population & pest out break.
- Unit V Insect plant interaction – Theory of co-evolution, role of allelo-chemicals in host plant mediation, tritrophic interaction host plant selection by phytophagous insects, establishment of insect population on a plant surface.

Course XVI E : Applied Entomology II

- Unit I Beneficial Insects – Apiculture, sericulture & Lac culture.
- Unit II Insect pests of crops – Pests of cotton, pests of sugar cane pests of paddy, pests of fruits & vegetables, pests of stored grains, pests of forest.
- Unit III Insects injurious to man and livestock – Importance, appearance, life cycle & control measures.
- Unit IV Insect control measures – Natural control, applied control, integrated pest management-history, different phases of pest control.
- Unit V Different types of insecticides – Their chemistry, action and application.
Insecticide resistance.
Insect Pheromones and its role.

GROUP F: Chronobiology and mechanisms of behavior

Course XIII F : Chronobiology

Unit 1: Introduction to biological clocks: Temporal organization. Evolution and adaptive significance; Types of Rhythms - Ultradian, Tidal/ Lunar, Circadian and Circannual rhythms. Chronobiology in the 21st century.

Unit 2: Geophysical environment—Organisms in the cyclic environment; Proximate and Ultimate factors. Role of proximate factor in regulation of physiology and behavior.

Unit 3: Formal properties of biological clocks: Characteristics, Phase shift, phase angle difference, Phase response curve (PRC). Masking and concept of zeitgeber. Entrainment-parametric and non-parametric entrainment.

Unit 4: Clock system in prokaryotes/invertebrates: Clock in bacteria with example *Cyanobacteria*. Circadian pacemaker system in invertebrates with *Drosophila* as example.

Unit 5: Vertebrate Clock System: Suprachiasmatic nucleus (SCN), Molecular biology of the circadian pacemaker system with examples from birds and mammals.

Suggested Readings:

1. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
2. Insect Clocks. D.S. Saunders, C.G.H. Steel, X., afopoulou (ed.)R.D. Lewis. (3rd Ed). 2002, Barends and Noble Inc. New York, USA

Course XIV F : Photoperiodism and Seasonal Breeding

Unit 1: Photoreception: The eye as organ of photoreception. Extra-retinal photoreception. Pineal as photoreceptive structure in non-mammalian vertebrates.

Unit 2: Seasonality: Concept of seasonality, Role of photic and non-photoc cues in regulation of seasonality; Cues- principal and supplementary cues, Seasonal migration in fishes and birds. Hibernation.

Unit 3: Circannual rhythms: Circannual rhythm in regulation of seasonally breeding animals with examples from subtropical birds. Circannual rhythms in sheep. Frequency demultiplication hypothesis.

Unit 4: Photoperiodic time measurement in vertebrates: Hourglass mechanism, internal and external coincidence models. Lighting protocols to test the photoperiodic time measurement- night break, T-cycle, and resonance cycles.

Unit 5: Hormonal control of seasonal reproduction: Regulation of testicular functions. Regulation of reproductive cycle in male & females. Mechanism of action of reproductive hormones. Melatonin and seasonal reproduction.

Suggested Readings:

1. The Physiology of Reproduction, Vol 1 and 2, Ernst Knobil and Jimmy D. Neil, (ed), Raven Press.
2. Biological Rhythms: Vinod Kumar (ed 2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

Course XV F : Neuro-endocrine control of behavior

Unit 1: Basic neurobiology: Structure and properties of neurons; Propagation of nerve impulses; Different types of synapse and synaptic transmission. Neurotransmitter and its release.

Unit 2: Hypothalamus and Pituitary gland: The hypothalamus and hypothalamic hormones: an overview of releasing and release inhibiting hormones. Structure and development of pituitary gland.

Unit 3: The hypothalamo-hypophyseal control of hormone secretion: Hypothalamo-hypophyseal axis. Regulation of thyroid, adrenal and gonadal secretion. Regulation of oxytocin and vasopressin. Concepts of feed-back in regulation of hormone secretion.

Unit 4: Neuroendocrine regulation of behaviors: Regulation of motivational system. Control of feeding and drinking. Hormonal influence of activity behaviour.

Unit 5: Principles and application of techniques in Neuro endocrinology: Electrophysiology, immunocytochemistry, *in situ* hybridization, autoradiography.

Suggested Readings:

1. An Introduction to Neuroendocrinology, Brown R., (1994), Cambridge University Press, Cambridge, UK
2. Psychoneuroimmunology, Ader R, Felten D.L. and edited by Nicholas C. (4th Ed., 2007), Academic Press, UK

Course XVI F : Applied Chronobiology

Unit 1: Methods for the study of rhythms in humans: Measurement of rhythms in physiology and metabolism (e.g. heartbeat), blood pressure, body temperature, liver metabolism.

Unit 2: Circadian clock in humans: Organization of clock system in humans. Central and peripheral clock.

Unit 3: Clocks and metabolism: Clock regulation of metabolism. Disruption of clocks and diseases viz. Diabetes, Cardiovascular diseases. Ageing and sleep disorders.

Unit 4: Melatonin and human physiology: Bio-synthesis and regulation of melatonin, role of melatonin in regulation of diseases. Sleep and diseases in human.

Unit 5: Biological clocks in human welfare - Clock and Human health, Chronopharmacology, Chronomedicine and Chronotherapy.

Suggested Readings:

1. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
2. Biologic Rhythms in Clinical and Laboratory Medicine. Touitou, Yvan; Haus, Erhard (Eds.) Springer-Verlag, 1992

PRACTICALS:

1. To study the phototaxis and geotaxis behaviour of earthworm.
2. Demonstration of methods of recording activity rhythms in fishes/birds/mammals.
3. Assay of daily activity in human.
4. Ambulatory blood pressure monitoring and circadian rhythm analysis.
5. Quantifying oscillations from sample recorded data: phase, period and amplitude.
6. Recording of body temperature (T_b) of human.
7. Human chronotypes- MCTQ questionnaire and analysis.

MSc Zoology IV semester- Chronobiology and mechanisms of behavior

Marks Distribution

Duration: 5 hours

M.M.: 80 Marks

- 1. Major Dissection: Labelling brain areas- 4 labels (01) 08 Marks**
- 2. Working Principle: ABPM, Actigraphy, Thermoscan (02) 06 Marks**
- 3. Actogram Analysis: Phase angle/shift, LD bar, ZT (01) 06 Marks**
- 4. Spotting: (1-10) 20 Marks**
 - Neuro endocrine pathway/ mechanisms (04)
 - Histological slides (04)
 - Micrographs (02)
- 5. Exercise on circannual rhythms/ photoperiodism: models; photo-inducible phase and tau (01) 05 Marks**
- 6. Identify chronotype: prefilled MCTQ questionnaire provided 05 Marks**
- 7. Phototaxis/ geotaxis 05 Marks**
- 8. Equipment and Apparatus: ELISA, Orientation funnel 05 Marks**
- 9. Viva-voce 10 Marks**
- 10. Practical Class records 10 Marks**