SYLLABUS OF ZOOLOGY (MAJOR)

For 4-Year Undergraduate Programme Under NCCF, 2023

Cooch Behar Pancahanan Barma University
Panchanan Nagar, Vivekananda Street, Cooch Behar,
West Bengal – 736 101

1st Semester

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

MAJOR-1

Animal Diversity: Non-Chordates and Chordates

OBJECTIVES:

- Study the detailed scheme of classification of the animal world to gain deep insight regarding the unique characteristic features representing each phylum.
- To study some of the unique features of each taxonomic group of non-chordate and chordates for better understanding of the structural and functional patterns based on their evolutionary relationship.

DIFFICULTY LEVEL: 100 MODE OF INSTRUCTION: LPT

THEORY
(CREDITS 4)

Group A: Non chordates

1. Body symmetry in invertebrates; Coelom: origin and types.
2. Classification with reasons and examples- Protozoa: up to phyla, other non-chordates (upto Phylum Echinodermata): from phyla to living sub-classes.
   [*Classification of invertebrates to be followed from Invertebrate Zoology by Ruppert and Barnes VI edition (1987, 1994) Saunders College Pub, except for Protozoa (American Association of Protozoologist ref: Levine 1980) and Porifera (Brusca and Brusca 2002; IV edition. Invertebrate Zoology)*].
3. Reproduction in *Paramoecium* sp. with special reference to conjugation.
4. Canal system in Porifera.
5. Coral reef: Types, coral reef formation, distribution, importance,and conservation of coral reefs.
6. Respiration in Arthropoda: Structure and mechanism of respiration through gills, book lungs and trachea.
7. Onychophora: Affinities, systematic position and evolutionary significance.
8. Nervous system in *Pila* and the significance of torsion on it. Nervous system in *Aplysia* and the significance of detorsion on it.

9. Water vascular system in *Asterias* sp.

Group B: Chordates

1. Basic body plan in chordates.
2. Basic concept of chordate classification. Classification up to living subclasses of Fish, up to living orders of Amphibia, Reptilia, and Mammals

   [according to J. Z. Young 1981 except fish (Talwar and Jhingran,1991)]
3. Salient features of *Balanoglossus* sp. and its affinities.
4. Retrogressive metamorphosis in *Ascidia* – justification in the light of survival of the species.
5. Structure of pharynx and feeding mechanism in *Branchiostoma* sp.
6. Agnatha: General characteristics and classification of cyclostomes up to classes.
7. Accessory respiratory organs in fishes.
8. Neoteny and paedomorphosis with special reference to Axolotl larva.
9. Non-poisonous and poisonous snakes; Poison apparatus and biting mechanism of poisonous snake; Dos and don'ts after snake bite; types of venom; antivenom-Indian perspective.
10. Feather of birds-types; Principles of aerodynamics in bird flight.
11. Dentition in mammals-types, structure, and cycle of replacement; Echolocation in bats.

PRACTICAL
(CREDITS 2)

1. Identification with reasons following specimens (Preserved specimens/models/photographs as available to be used)**:**

Non-Chordates: *Amoeba*, *Paramoecium, Euglena*, *Scypha*, *Hydra, Obelia*, *Aurelia*, *Metridium*, *Taenia solium, Fasciola, Ascaris lumbricoides, Nereis, Pheretima, Chaetopterus, Hirudinaria, Macrobrachium*, *Squilla*, *Hippa*, *Balanus*, *Lepas*, *Cyclops*, *Daphnia*, *Periplaneta*, *Locust*, *Leptocoriza*, *Scorpion*, *Limlus*, *Julus*, *Scolopendra*, *Peripatus*, *Chiton*, *Aplysia*, *Pila*, *Achatina*, *Lamellidens, Loligo, Sepia*, *Octopus*, *Asterias*, *Echinus*, *Cucumaria*.

Chordates*:Balanoglossus, Branchiostoma*, *Ascidia*, *Petromyzon*, *Myxine*, *Scoliodon*, *Trygon, Narchine*, *Labeo*, *Catla*, *Cirrhina*, *Channa*, *Anabus*, *Heteropneustes*, *Clarias*, *Ichthyophis*, *Necturus*,*Bufo, Hyla, Tylototriton*,*Hemidactylus*, *Chamaeleo*, *Draco*, *Naja*, *Columba, Ornithorhynchus, Cavia*.

2. Study of following Permanent Slides (Permanent slides/photographs as available to be used)**:**

CS of sponges (syconioid and leuconoid), LS of *Metridium*, CS of *Ascaris* (male &female) through gonadal region, CS of *Pheretima.*
Larvae: trochophore, glochidium, nauplius, echinopluteus, axolotl.

3. Staining/slide Preparation/dissection/mounting:
Hydra, *Obelia* colony, *Cyclops*, *Daphnia*, *Tubifex*, digestive system of cockroach, mouth parts of cockroach, cycloid and ctenoid scales, hyoid apparatus and pecten of fowl.

4. Key for Identification of poisonous and non-poisonous snakes.

PROJECT

Suggestion: Students can submit insect box or bone box (disarticulated)- It can be assigned as a group activity.

2nd Semester

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

MAJOR-2 - FUNDAMENTALS OF CELL BIOLOGY

(Difficulty Level-100)

Objectives:

- To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
- To understand the functioning of cellular components to generate and utilize energy in cells.
- To list the distinguishing properties of cell adhesion molecules and cytoskeletons.
- To describe the major events of cell division that enable the genome of one cell to be passed on to two daughter cells.
- To understand the signalling pathways in cellular communication.

Mode of Teaching: LPT (L = Lecture, P = Practical, T = Tutorial)

THEORY
(CREDITS 4)

1. Structural organisation of Prokaryotic and Eukaryotic cells; Fluid-mosaic model of plasma membrane structure; Cell junctions (Tight junctions, Desmosomes, Plasmodesmata, Gap junctions).
2. Structure and Function of intra-cellular organelle: Nucleus, Mitochondria, Lysosome, Peroxisome, Endoplasmic Reticulum, Golgi Apparatus & Ribosome.
3. Concept of: Chemi-Osmotic Hypothesis, Nuclear Pore Complex, Vesicular transport mechanism, Nucleosome & Membrane Transport (Active & Passive).
4. Cell Adhesion molecules (CAMs): Cadherins, Integrins, Immunoglobulin Superfamily & Selectins.
5. Cell Division: Mitosis, Meiosis, Cell cycle and its regulation.
6. Cytoskeleton: Microtubules, Microfilaments and Intermediate filaments.
7. Cell Signalling: Pathways (Membrane receptor & Nuclear receptor).

PRACTICAL
(CREDITS 2)

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis.
2. Study of various stages of meiosis in Grasshopper testis.
3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.
4. Study of human karyotype (normal and abnormal).

SUGGESTED READINGS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.

2. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. Sinauer Associates, MA.

3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
Type your text

3rd Semester

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

MAJOR-3: Biochemistry

About the Course: The course affords an introduction to the structure of biomolecules with importance on the techniques used for structure determination and analysis. The course covers basic aspects of sample preparation for analysis and aims to enlighten the students how structural information can be utilized for better understanding of biological processes.

Learning Outcomes: - After successfully completing this course, the students will be able to

- Understand major biomolecules namely carbohydrates, lipids, proteins and nucleic acids which are imperative for the structural organization and functions of the cells.
- Learn about enzymes, the mechanism of catalysis and enzyme kinetics.
- Accomplish biochemical tests for identification of sugars and amino acids.

Difficulty Level: 200, Mode of Instruction: Lecture, Practical and Tutorial

Theory (Credit-4)

Unit 1: Molecules and Their Interactions

Basic concepts of pH; Buffers; Biological buffer systems; Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.)

Unit-2: Carbohydrates

Definition and Classification of carbohydrates, Isomerism and mutarotation, Formation of Glycosidic bonds, Carbohydrate metabolism (pathways): Glycolysis, TCA Cycle, Electron Transport Chain, Gluconeogenesis, Glycogenesis, Glycogenolysis

Unit-3: Lipids

Definition and classification of fatty acids, Physiologically important saturated and unsaturated fatty acids, tri-acylglycerols, phospholipids, glycolipids, sphingolipids, steroids, eicosanoids; Beta-oxidation of saturated fatty acids, Brief idea of alpha-oxidation and omega-oxidation.

Unit-4: Proteins

Structure, classification and general Properties of α - amino acids, Concept of pKa and pI, Bond stabilizing protein structure, levels of organization in Proteins, Introduction of simple and conjugate proteins; Protein metabolism: Transamination, Deamination and Urea Cycle.

Unit-5: Nucleic Acids

Structure of Purine and Pyrimidines, Nucleosides, Nucleotides, Types of Nucleic acids; cot curves: base pairing, denaturation and renaturation of DNA, Hypo and Hyperchromacity of DNA.

Unit-6: Enzymes

Nomenclature & Classification, Co-factors; Isozymes, Enzyme Kinetics: Derivation of Michaelis Menten Equation, significance of Km and Vmax, Lineweaver-Burk plot; Enzyme inhibition – Competitive, Non-competitive, Uncompetitive; Concept of Allosteric enzymes; Regulation of enzyme action.

Practical (Credit-2)

1. Qualitative Test of Carbohydrate, Proteins (Biuret) and lipids.
2. Quantitative estimation of Protein using Lowry's method.
3. Estimation of Glucose by GPD-POD method.
4. Action of Salivary amylase under optimum condition and effect of Temperature on enzyme activity.
5. Paper Chromatography
6. Demonstration of hyper chromic or Hypo chromic effect of DNA sample.

Suggested Readings:-

- Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York

- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry,* VI Edition, W.H. Freeman and Co., New York.
- Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry,* XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry,* II Edition, BIOS Scientific Publishers Ltd., U.K
- Paul F Cook & W.W. Cleland. Enzyme Kinetics & Mechanism, 2007. Garland Science.

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

Major-4: ANIMAL PHYSIOLOGY

Difficulty level: 200

Mode of instruction: LPT

Course Objective

Theory:

1. To become familiar with the structure of different organs of the body
2. To form the concept of the functional mechanism of different systems
3. Learn an integrative approach to understand the interactions of various organ systems resulting in the complex overall functioning of the body.

Practical:

1. To expose students to the histology of different glands/organs of the body
2. To provide students hands-on training on the use of various instruments/apparatus used in the physiological examinations
3. To measure various physiological aspects of the body and understand their biological reference ranges

Syllabus

THEORY (Credit: 4)

Unit 1: Tissues
Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue

Unit 2: Bone and Cartilage
Structure and types of bones and cartilages; Bone growth and resorption

Unit 3: Nervous System
Structure of neuron, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Synaptic transmission; Physiology of vision.

Unit 4: Muscle
Types of muscles; Ultrastructure of skeletal muscle; Molecular basis of muscle contraction

Unit 5: Digestive system
Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins.

Unit 6: Physiology of Respiration
Mechanism of respiration with pulmonary ventilation; Respiratory volumes

and capacities; Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves and the factors influencing it; Carbon monoxide poisoning.

Unit 7: Circulatory System
Components of blood and their functions; Structure of Haemoglobin; Blood coagulation pathways, Structure of mammalian heart; Origin and conduction of cardiac impulses; Cardiac Cycle; Cardiac output, Frank-Starling Law

Unit 8: Excretion and Osmoregulation
Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance; Concept of osmoregulator and osmoconformer; Osmoregulation with special reference to freshwater and marine animals.

Unit 9: Thermoregulation
Definition and examples of endotherm, ectotherm, homeotherm, poikilotherm, heterotherm; Brief idea of adaptive hypothermia, adaptive hyperthermia, thermal neutral zone and evaporative cooling; Desert adaptation in camel; Thermoregulation of whales with special reference to blubber and counter-current heat exchanger

PRACTICAL (Credit: 2)

1. Estimation of haemoglobin using Sahli's haemoglobinometer
2. Determination of clotting & bleeding time
3. Histological study of transverse sections of the mammalian spinal cord, stomach, duodenum, ileum, liver, lung, and kidney from permanent slides (preferable)/ photomicrograph
4. Recording of human blood pressure using a sphygmomanometer (Demonstration)
5. Preparation of temporary mounts of Squamous epithelium.
6. Microtomy: Permanent slide preparation of any two mammalian (goat/white rat) tissue sections by double staining (H/E Staining)

Note: The use of animals should conform to the existing guidelines of UGC and other relevant bodies regarding the use of laboratory animals.

SUGGESTED PROJECT:

1. Preparation of a Project Report on various types of blood cells, their morphology and functions

Suggested reading:

1. Ganong W.F. (2019). Review of Medical Physiology 26th ed McGraw-Hill
2. Guyton, A.C & Hall, J.E. (2006).Textbook of Medical Physiology, XI Edition. Hercourt Asia PTE Ltd/W.B. Saunders Company
3. Mescher A.L., Junqueira's Basic Histology: Text and Atlas, 17th Edition. McGraw Hill LLC
4. Tortora, G.J. and Grabowski, S. (2006). Principles of Anatomy & Physiology. XI edition.John Wiley & Sons

4th Semester

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

MAJOR-5: Ecology & Animal Behaviour

Mode of Instruction: LPT

Difficulty: 200

Objective:

1. To form an understanding about the different ecological levels, components, and their functioning through the study of basic concepts, experiments, and laws.
2. To sensitize students about biodiversity and conservation of wildlife resources.
3. To form a preliminary idea about animal behaviour through the study of different modes of behaviour including behavioural patterns, social behaviour, communication, and biological rhythms.
4. To train students to perform calculations of selected biodiversity indices, identification of zooplanktons and determination of selected parameters from water samples.
5. To give a cursory idea of the selected methods of the study of animal behaviour.

Theory (Credit-4)

Group A: Ecology

Unit 1: Introduction to Ecology

Definition; Scope; Levels of organization; Laws of limiting factors: Liebig's Law of Minimum, Shelford's Law of Tolerance, Blackman's Law of Limiting factors; Basic concept of phenotypic plasticity; Ecological Niche: Definition and types; Faunal make up of major biomes: Savannah, Tropical Rainforest, Desert biome.

Unit 2: Biogeochemical cycles

Carbon cycle and Nitrogen cycle.

Unit 3: Population

Population attributes: Density, natality, doubling time, mortality, life tables, survivorship curves, age pyramids, exponential and logistic growth, r and k strategies, density dependent and density independent population regulation; Population interactions; Gause's Principle of competitive exclusion.

Unit 4: Community

Community characteristics: Species richness, dominance, diversity, abundance; Ecotone and Edge effect; Ecotype; Concept of ecological succession with hydrosere as example; Theories pertaining to climax community- monoclimax, polyclimax and climax pattern theory.

Unit 5: Ecosystem

Definition of ecosystem; Food chain: Detritus and Grazing food chains; Food web; Energy flow models: Single channel, Y shaped and Universal; Ecological pyramids-pyramid of number, biomass and energy.

Unit 6: Biodiversity & Wildlife Conservation

Definition of biodiversity; Levels of biodiversity (genetic diversity, species diversity and ecosystem diversity); Values of biodiversity; Biodiversity Hotspots, India as a mega-diversity country; Wildlife conservation (ideas of in-situ and ex-situ conservation): National Park, Wildlife sanctuary, Biosphere reserve; Project Tiger; Wildlife Protection Act, 1972.

Group B: Animal Behaviour

Unit 1: Introduction to Animal Behaviour

Origin, history, and scope of ethology; Proximate and ultimate causes of behaviour; Analysis of behavior (Ethogram).

Unit 2: Patterns of Behaviour

Innate behaviour: Concept of sign stimulus, Fixed action pattern, Innate releasing mechanism; Study of egg rolling behaviour of greylag geese; Learnt behaviour: Classical conditioning (Pavlov's experiment), Operant conditioning, Habituation, Imprinting (Lorenz's experiment).

Unit 3: Social Behaviour

Altruism and kin selection, Hamilton's rule; Eusociality in honey bees; Territoriality.

Unit 4: Animal Communication

Signals and their roles in communication; Brief idea of channels of communication (Vision, audition, chemical touch and electric field); Round dance and waggle dance in honey bees; Communication by pheromones in insects; Echolocation in marine mammals.

Unit 5: Reproductive behaviour

Definition and types of mating systems: Monogamy, polygyny, polyandry; Brief idea on sexual selection.

Unit 6: Biological Rhythms

Types: Circadian rhythms, tidal rhythms, lunar rhythms, circannual rhythms; Hibernation and

aestivation(brief discussion); Biological clocks: concept of entrainment, *zeitzeber*, free running period, significanceof biological clocks.

Practical (Credit-2)

Group A: Ecology

1. Calculation of Sorenson's Similarity & Shannon-Weiner diversity indices for a natural /hypothetical community.
2. Determination of population density in a natural/ hypothetical community by quadrat method.
3. Estimation of pH, dissolved oxygen content (Winkler's method) and free CO_2 of water sample.
4. Estimation of Primary productivity by light & Dark bottle method.
5. Report on field observations: Study at National Park/ Biodiversity Park/ Zoological Park/ Wildlife Sanctuary/ Sea Shore.

Group B: Animal Behaviour

1. Identification of different types of bird nests (from field study/photographs): Cup nest, cavity nest, pendant nest, platform nest, floating nest.
2. Study of aggressive behaviour in *Betta* sp. (live demonstration/videographs).
3. Study of learning behaviour in mice through T-maze (live demonstration/videographs).

References:

- Smith and Smith (2012) Elements of Ecology. Pearson
- Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
- Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
- Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
- Robert Leo Smith Ecology and field biology, Harper and Row publisher
- Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Pres
- David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.
- Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge,University Press,UK.
- John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
- Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc.,Massachusetts, USA.
- Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

Major 6: Developmental Biology

Difficulty: 200 Mode of Instruction: LPT

Objective:

- The syllabus aims in providing general concepts regarding the fundamental process and diversities of gametogenesis, fertilization and embryonic development.
- The syllabus also provides basic idea regarding the phenomenon supporting and modulating the embryonic development.
- The syllabus also provides basic idea for the modern concepts and technological applications in developmental biology.

THEORY (Credit-4)

Unit 1: Early Embryonic Development

Gametogenesis: Spermatogenesis and Oogenesis in mammals; Types of eggs, Egg membranes; Fertilization: External (in Sea Urchin) and Internal (in Mammals) fertilization with special reference to prevention of polyspermy, activation of egg metabolism; capacitation in mammals.

Planes and patterns of cleavage; Types of blastulae; Fate map in frog and chick, fate map construction techniques; Gastrulation in frog and chick; Embryonic induction and organizers in *Xenopus* (Spemann & Mangold's experiment).

Unit 2: Late Embryonic Development

Extra-embryonic membranes in Chick; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)

Unit 3: Organogenesis & Post Embryonic Development

Development of eye in Chick. Molecular Induction in Eye development.

Metamorphosis: Changes, hormonal regulation in amphibians; Regeneration: modes of regeneration - epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and theories.

Unit 4: Implications of Developmental Biology

Stem cell: Concept of potency, types, markers and applications of stem cell therapy in bone marrow transplantation, Amniocentesis.

Teratogenesis: Teratogenic agents and their effects on embryonic development.

Unit 5: Parthenogenesis

Definition, types (Facultative, obligatory, cyclic and complete, arrhenotoky, thelytoky and artificial) and significance.

PRACTICAL (Credit-2)

1. Study of whole mounts and sections of developmental stages of frog through permanent slides/photomicrographs: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages).

2. Study of whole mounts of developmental stages of chick through permanent slides/photomicrographs: Primitive streak (13 and 18 hours), 24, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages).

3. Preparation of whole mounts of chick embryo: 24, 48, 72 & 96 hrs (Demonstration Only)

4. Study of different sections of placenta (photomicrograph/slides) (based on histological classification).

5. Study of the developmental stages and life cycle of Drosophila from stock culture.

SUGGESTED PROJECT

Project report on *Drosophila* culture/chick embryo development.

SUGGESTED READINGS

- Gilbert S.F. 2010. Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers,
- Carlson BM. 2014. Human Embryology and Developmental Biology. 5th Edn. Elsevier.
- Das N. 2012. Fundamental Concept of Developmental Biology. New Central Book Agency
- Gardner DK. 2006. In Vitro Fertilization: a Practical Approach. CRC Press.
- Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press

5th Semester

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

MAJOR-7

PRINCIPLES OF GENETICS

Objectives:

- To provide foundational knowledge of the principles of heredity and variation, including Mendelian inheritance & extensions of Mendelian laws.
- To develop an understanding of the gene mutation & different sex determination processes.
- To cultivate analytical and problem-solving skills through genetic crosses, pedigree analysis, and Chi-square analysis.
- To understand the concept of polygenic inheritance and methods of determining gene number involved in polygenic traits using suitable examples.
- To define and classify heritability, and understand its types, significance, and limitations in genetic studies.
- To apply quantitative approaches in analysing traits influenced by multiple genes and the environment.

[Difficulty Level- 300 **Mode of Instruction:** Lecture, Practical and Tutorial**]**

THEORY

(CREDITS 4)

Unit 1: Mendelian Genetics and its Extension:

Principles of Mendelian inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis (Dominant & Recessive), Pleiotropy, Sex-linked, sex-influenced and sex-limited inheritance, Concept of allele: Multiple allele (ABO blood group), Pseudoallele, Isoallele.

Unit 2: Linkage and Crossing Over:

Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over (Holliday Model), Recombination frequency as a measure of linkage intensity.

Unit 3: Mutations and chromosomal aberrations:

Types of gene mutations, Types of chromosomal aberration (with one suitable example of each), Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method.

Unit 4: Sex Determination:

Types of sex determination with examples (Chromosomal, Haplodiploidy, Environmental and Genic Balance) Mechanisms of sex determination in *Drosophila* and Human; Dosage compensation.

Unit 5: Extra-chromosomal Inheritance:

Types of extra-chromosomal inheritance, Infective heredity in *Paramecium* and Maternal effects (Shell coiling in snail).

Unit 6: Quantitative genetics:

Polygenic inheritance with examples; Determining gene number for polygenic characteristics, Heritability: Definition, types (broad sense and narrow sense heritability), calculation & limitation.

Unit 7: Recombination in Bacteria and Viruses:

Concept of Conjugation, Transformation, Transduction, Complementation test in Bacteriophage (Benzer's experiment on rII locus).

Unit 8: Transposable Genetic Elements:

Transposons in bacteria, Ac-Ds elements in maize and P elements in Drosophila, LINE, SINE, and Alu elements in human.

PRACTICALS

(CREDITS 2)

1. Common mutants in *Drosophila*.

2. Chi-square analyses: Test for goodness of fit for Mendelian monohybrid and dihybrid ratios.

3. Linkage maps based on data from *Drosophila* crosses (Two point and three point)

4. Pedigree analysis of autosomal, X-linked & Y-linked traits.

SUGGESTED READINGS

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India

- Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc

- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings

• Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition. Benjamin Cummings

• Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co

• Fletcher H. and Hickey I. (2015). Genetics. IV Edition. GS, Taylor and Francis Group, New York and London.

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

MAJOR-8

IMMUNOLOGY

Course Description Immunology is the branch of biology which deals with the human body's defence mechanisms. This course aims to provide an overview of Immune Systems and it works to keep our body healthy and disease free. This course also emphasizes on the applications of various immunological tools.

Course Outcome: After completion of this Course students will be able to

- Obtain basic knowledge about the immune system, organs and cells associated with the immune system.
- Know how immune system works to keep our body healthy and disease free.
- Learn about the basis of antigen recognition, hypersensitivity reaction, antigen-antibody reactions
- Learn about Application of Immunology in treating and diagnosis of disease.

[Difficulty Level- 300 **Mode of Instruction:** Lecture, Practical and Tutorial**]**

THEORY

(CREDIT 4)

Unit 1: Introduction to Immunology

Introduction – Historical perspective of Immunology; Cells and organs of the Immune system

Unit 2: Innate and Adaptive Immunity

Barriers of Innate Immunity with special reference Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Humoral and Cell mediated), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity, basic concept of Tolerance and Autoimmunity.

Unit 3: Antigens

General character: Antigenicity and immunogenicity, Adjuvants and haptens, Superantigen, Factors influencing immunogenicity, B and T-Cell epitopes.

Unit 4: Immunoglobulins

Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions (Precipitation and Agglutination).

Unit 5: TCR and BCR

Structure of B Cell Receptor and T Cell Receptor; Maturation, activation, and differentiation of T Cell and B Cell.

Unit 6: Major Histocompatibility Complex

Structure and functions of MHC molecules, MHC Haplotypes in Human, Endogenous and exogenous pathways of antigen processing and presentation

Unit 7: Cytokines and Complement System

Properties and functions of cytokines, Components and pathways of complement activation. (Classical, Alternative and Lectin Pathway)

Unit 8: Hypersensitivity

Gell and Coombs' classification and brief description of various types of hypersensitivities

Unit 9: Applied Immunology

Vaccine – Different types of vaccines; Hybridoma technology for production of monoclonal antibodies; Immunoassays- ELISA and RIA

PRACTICAL

(CREDIT 2)

1. Demonstration of lymphoid organs of Rat (Through Photograph/ Dissection).
2. Identification of Histological Sections of spleen, thymus, lymph node, Tonsil and Bone Marrow through slides/ photographs
3. Preparation of stained blood film to study various types of blood cells. (Leishman Stain)
4. Lymphocyte separation from spleen (demonstration)
5. ABO blood group determination.
6. Demonstration of ELISA

Suggested Readings:

1. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2015). *Basic immunology: functions and disorders of the immune system*. Elsevier Health Sciences.
2. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2021). *Cellular and Molecular Immunology, 10e, South Asia Edition*. Elsevier Health Sciences.
3. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2017). *Roitt's essential immunology*. John Wiley & Sons.
4. Owen, J. A., Jones, P. P., Kuby, J., Punt, J., & Stranford, S. A. (2013). *Kuby immunology* (7th ed.). New York: W.H. Freeman.

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

MAJOR-9

EVOLUTIONARY BIOLOGY & TAXONOMY

Objective

The objective of studying concepts and theories of evolution, the origin of life, mechanisms of evolution, and the diversification of organisms is to understand the processes that have shaped the biodiversity and complexity of life on Earth.

Course outcome

- By studying these topics, students can gain a deeper understanding of the history, diversity, and interconnectedness of living organisms.
- The outcome of such studies is to provide insights into the mechanisms of evolution, the origins of life, and the relationships between different species.
- Students will have acquired a strong foundation in animal taxonomy, enabling them to understand and apply systematic principles, perform taxonomic procedures, and classify various organisms accurately. They will also gain insight into the diversity of life and the evolutionary significance of different animal groups.

[Difficulty Level- 300 **Mode of Instruction:** Lecture, Practical and Tutorial**]**

THEORY

(CREDITS 4)

Group-A (Evolutionary Biology)

Unit 1: Origin of Life

Theories of origin of life; Chemogeny, Biogeny, RNA world, Evolution of eukaryotes.

Unit 2: Sources of variations

Heritable variations and their role in evolution.

Unit 3: Historical review of evolutionary concepts

Historical review of evolutionary concepts (Concepts and criticism): Lamarckism, Darwinism, Neo-Darwinism

Unit 4: Evidences of Evolution

Fossil record (geological time scale, horse evolution), molecular evolution, molecular clock.

Unit 5: Population genetics

Hardy-Weinberg Law; selection (concept of fitness, selection coefficient, types of selection (stabilizing, directional and disruptive), density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon); Role of Migration and Mutation in changing allele frequencies.

Unit 6: Product of evolution

Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, parapatric and peripatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches).

Unit 7: Extinction

Extinctions, Back ground and mass extinctions (causes and effects), detailed example of K-T extinction.

Unit 8: Human Evolution

Origin and evolution of man, unique hominid characteristics, primate phylogeny from *Dryopithecus* leading to *Homo sapiens sapiens*, molecular analysis of human origin (based on cytochrome analysis).

Group-B (Taxonomy)

Unit 1: Basics of Taxonomy and Systematics

Taxonomy and Systematics: Definition and importance; Rules of nomenclature (Binominal and trinomial); Law of Priority; ICZN; Homonymy and Synonymy; Definition with suitable examples. Mention 4 taxonomic aids (museums, zoological parks, botanical gardens and keys).

Taxonomic Types: Holotype, Paratype, Allotype, Lectotype, Neotype, Syntype: Definition with suitable examples; Linnaean hierarchy; Concepts of different conventional taxonomy [alpha (α) beta (β) and gamma (γ) taxonomy].

Unit 2: Character and Character states

Types of Characters with examples: Primitive, Advance, Convergence, Parallelisms, reversal of characters, Outgroup and Ingroup; Homology vs Analogy; Monophyly, Polyphyly and Paraphyly; Definition with examples.

Unit 3: Approaches in Classification

Classification: Definition; Phenetics: Definition, OTU, Single linkage clustering and construction of Phenogram; Cladistics: Definition, Brief concept of Parsimony; DNA Bar coding and its application.

Unit 4: Taxonomic Procedures

Collection, Preservation (wet, dry and slide) and Curation; Identification and Description; Classification (Grouping and Hierarchical ranks), Publication.

PRACTICAL

(CREDIT 2)

1. Study of population genetics problems using Hardy-Weinberg principle.

2. Study and verification of Hardy-Weinberg Law by chi square analysis.

3. Study of human fossils specially skull from models/ pictures.

4. Morphometric and meristic study of locally available fish.

5. Study of homology and analogy from suitable specimens.

Suggested readings

- Futuyma DJ. (2009) Evolution. Publisher Sinauer Associates is an imprint of Oxford University Press; 4th edition.
- Dobzhansky Th., FJ. Ayala, GL. Stebbins and JM. Balentine (1976) Evolution. Surjeet Publication, Delhi
- Smith JM. (1998) Evolutionary Genetics. Oxford University Press. Oxford.
- Rastogi VB. (2016) Organic Evolution. Publisher – MedTech, India
- Stearns SC. and RF. Hoekstra (2000) Evolution: An Introduction. Oxford University Press, Oxford.
- Strickberger MW. (1990) Evolution. Jones and Bartlett Publishers. Boston
- Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
- Kapoor VC (2019) Theory and Practice of Animal Taxonomy and Biodiversity, 8th Edition, Oxford & IBH Publishing

6th Semester

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

MAJOR-10

PARASITOLOGY AND ENTOMOLOGY

Course Description

The entire course is divided into two groups namely Group A: Parasitology and Group B: Entomology. As a course, Parasitology provides basic knowledge on general aspects like inter-specific relations among animal hosts and their parasites, host-parasite interactions, various diseases caused by parasites and their control measures. On the other hand, being a course curriculum, Entomology encompasses basic understanding of insect diversity, insect systematics and classification, insect structure and function, control of insect pests, medical importance of insects and role of insects in forensic science.

Course Objectives

- To study the basic, applied and emerging areas of Parasitology and Entomology
- To understand health, economic and medico-legal issues related to parasitological and entomological phenomena and find out the scientific strategies to resolve the problems in order to bring about wellbeing of animals and humans to a greater extent

Course Outcomes

After completion of this course, students will be able to

- Obtain knowledge about the general aspects of parasitism and host-parasite interaction
- Know about the different disease-causing parasites, their impact on human health and control measures of the diseases
- Understand the insect diversity, general morphology and physiology of insects
- Analyse the economic and medical importance of insects
- Comprehend the pest status and different approaches to control insect pests
- Identify the stages of different disease-causing parasites, vectors and the insect pests of agricultural importance and build the skills to know morphological differences and various physiological systems of insects through dissection in the practical session

[Difficulty Level- 300 **Modes of Instruction:** Lecture, Practical and Tutorial**]**

THEORY

(CREDITS 4)

Group A

PARASITOLOGY

Unit 1: Introduction to Parasitology

1. Brief introduction to Parasitism, 2. General Characters of Parasites, 3. Definitions Host, Parasite, Parasitoid, Hyperparasite, Vector (Mechanical and Biological), 4. Host-Parasite Interaction: Negative Coactions and Parasitic Adaptation

Unit 2: Parasitic Protists

Morphology, Life Cycle, Transmission of Diseases, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis, and Treatment of *Entamoeba histolytica, Plasmodium vivax and Leishmania donovani*

Unit 3: Parasitic Helminths

Morphology, Life Cycle, Transmission, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Fasciola hepatica, Schistosoma haematobium, Ancylostoma duodenale* and *Wuchereria bancrofti*

Unit 4: Parasitic Arthropods

Morphology, Transmission of Diseases and Control of *Pediculus humanus* (Head Louse), *Xenopsylla cheopis,* Ticks (Including Differences between Soft Ticks and Hard Ticks) and Mites

Group B

ENTOMOLOGY

Unit 1: Outline of Entomology

Insect Systematics: I. Outline Classification of the Class Insecta up to the Extant Major Orders with Examples (Classification to be followed from Gullan, P. J. and Cranston, P. S. (2005). *The Insects: An Outline of Entomology*. 3rd Ed. Blackwell Publishing)

External Anatomy: External Organs of Insects and their Modification: Cuticle, Head (Types of Mouth Parts and Feeding Mechanism), Antenna (Modification and Sensory Structures), Eye (Compound)

Internal Anatomy and Physiology: I. Muscles and Locomotion, II. Digestive System and Nutrition, III. Tracheal System and Gas Exchange, IV. Reproductive System

Insect Development: Types of Metamorphosis, Hormonal Regulation and Significance of Metamorphosis

Communication in Insects: I. Sound Production and Sound Reception, II. Light Production (Bioluminescence)

Social Organisation in Insects: Colony, Caste and Nesting in Termites

Unit 2: Economic Entomology and Recent Advances in Entomology

Agricultural Entomology: I. Life Cycle, Nature of Damage and Control of *Tryporyza incertulas* and *Sitophilus oryzae*, II. Classification of Pesticides, General Concept of Integrated Pest Management, Economic Injury Level, Economic Threshold Level.

Medical Entomology: Life Cycle, Control of *Anopheles sp., Aedes sp*. and *Musca sp.* and Diseases Caused by these Vector Species

Forensic Entomology: I. Ecological Succession of Forensic Important Insects, II. Investigation Methodology

PRACTICAL

(CREDITS 2)

1. Identification with Reasons of Life Stages of *Entamoeba histolytica, Leishmania donovani* and *Plasmodium vivax* through Permanent Slides/Micro Photographs

2. Identification with Reasons of Adults and Life Stages of *Fasciola hepatica,* and *Schistosoma haematobium,* through Permanent Slides/Micro Photographs

3. Identification with Reasons of Adults and Life Stages of *Ancylostoma duodenale* and *Wuchereria bancrofti* through Permanent Slides/Micro Photographs

4. Identification with Reasons of Insect Vectors: *Anopheles sp., Aedes sp., Musca sp.* through Specimens/Micro Photographs

5. Identification with Reasons of Common Pests: Paddy (*Tryporyza incertulas*); Stored Grains (*Sitophilus oryzae*) through Specimens/ Micro Photographs

6. Dissection of Nervous System and Male and Female Reproductive Systems of *Periplaneta americana*

7. Dissection and Mounting of Mouth Parts and Wings of *Anopheles sp. and Aedes sp.*

SUGGESTED READINGS:

1. Arora, D. R and Arora, B. (2001) *Medical Parasitology.* 2nd Ed. CBS Publications and Distributors
2. Bogitsh, B. J., Carter, C. E. and Oletmann, T. N. (2013). *Human Parasitology*. 4th Ed. Academic Press, New York
3. Chandra, G. (2000). *Mosquito*. Sree Bhumi Publication Co., Kolkata
4. Chapman, R. F., Simpson, S. J. and Douglas, A. E. (2012). *The Insects: Structure and Function*. 5th Ed. Cambridge University Press
5. Chatterjee, K. D. (1981). *Parasitology (Protozoology and Helminthology*). 13th Ed., CBS
6. Cheng, T. C. (1986). *General Parasitology*. 2nd Ed. Academic Press, Inc. Orlando. U. S. A.
7. Das, N. (2018). *Advanced Parasitology*. New Central Book Agency (P) Ltd., Kolkata
8. Dorothy, E. G. (2006). *Forensic Entomology*. Wiley
9. Gennard, D. (2012). *Forensic Entomology: An Introduction*. 2nd Ed. Wiley-Blackwell
10. Gullan, P. J. and Cranston, P. S. (2005). *The Insects: An Outline of Entomology*. 3rd Ed. Blackwell Publishing
11. Hati, A. K. (2001). *Medical Entomology*. Allied Book Agency, Kolkata
12. Hati, A. K. (2001). *Medical Parasitology*. Allied Book Agency, Kolkata
13. Kettle, D. S. (1995). *Medical and Veterinary Entomology*. 2nd Ed. CAB International
14. Pedigo, L. P. and Rice, E. M. (2009). *Entomology and Pest Management.* Pearson/Prentice Hall
15. Rechcigl J. E. and Rechcigl, N. A. (1998). *Biological and Biotechnological Control of Insect Pests.* Lewis Publishers
16. Roberts, L. S., Janovy, J. and Nadler S. (2013). Gerald D. Schmidt and Lary S. Roberts' *Foundation of Parasitology.* 9th Ed. McGraw-Hill International
17. Sastry, A. S., and Bhat, S. (2018). *Essentials of Medical Parasitology*. JP Medical Ltd.
18. Service, M. (2012). *Medical Entomology for Students.* 5th Ed. Cambridge University Press, New York
19. Tembhare, D. B. (2012). *Modern Entomology*. 2nd Ed. Himalaya Publishing House, Mumbai

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

MAJOR-11

MOLECULAR BIOLOGY

Objective:

The objective of this course is to provide students with a comprehensive understanding of the fundamental principles and concepts in molecular biology. By the end of the course, students will have acquired a comprehensive understanding of the history, development, and scope of molecular biology. They will be able to explain the nature of genetic material, including DNA and RNA, understand the processes of DNA replication, transcription, and translation, and comprehend the concepts of gene expression and gene regulation.

[Difficulty Level 300 **Modes of Instruction:** Lecture, Practical and Tutorial**]**

THEORY

(CREDITS 4)

Unit 1: Introduction:

Central dogma of molecular biology, one gene one enzyme hypothesis, one genome polypeptide hypothesis

Unit 2: Nucleic acids:

Watson - Crick Model of DNA, Chargaff's Rule; Hypo and Hyperchromic shift and Cot curve, Different types of DNA, and Different types of RNA (comparative overview), Clover leaf model of tRNA.

Unit 3: DNA replication:

Types of replication; Meselson & Stahl's experiment, General features of prokaryotes and eukaryotes replication; Mechanism of DNA replication in prokaryotes and eukaryotes, Proof-reading activity; End replication problem and replication of telomeres in eukaryotes.

Unit 4: Transcription:

RNA polymerases, transcription factors, mechanism of transcription in prokaryotes and eukaryotes.

Unit 5: Post-Transcriptional Processing

Processing of hnRNA, Split genes: concept of introns and exons, 5'-Cap formation; 3'-end processing and polyadenylation; splicing mechanisms; Trans splicing; RNA Editing, mRNA stability; Catalytic RNA.

Unit 6: Translation:

Translation machinery; Ribosomes; Composition and assembly; Genetic code and its properties; Iso accepting tRNA; Wobble hypothesis; Aminoacylation of tRNA, Mechanism of initiation, elongation, and termination of translation in prokaryotes and eukaryotes; co- and post-translational modifications.

Unit 7: Gene expression and regulation:

Operon concept: lac operon (including problem-solving exercises involving lac operon mutants), trp operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements, Epigenetic Regulation: DNA Methylation (by DNMT), Histone Methylation (by HMT) & Acetylation (by HAT and HDAC), RNA Interference, miRNA, siRNA.

Unit 8: DNA Repair mechanisms: Types of DNA repair mechanisms, Pyrimidine dimerization, mismatch repair and double strand break repairs.

PRACTICAL

(CREDITS 2)

1. Study of Polytene chromosomes from *Chironomous* / *Drosophila* larvae
2. Extraction of genomic DNA from mammalian tissue (Demonstration)
3. Models of ribosome structure (Photographs)
4. Demonstration of DNA by Feulgen reaction
5. Spectrophotometric analysis of DNA (Demonstration)
6. Agarose Gel Electrophoresis (Demonstration)
7. Study and interpretation of electron micrographs/photographs showing a) DNA replication b) Transcription
8. Instruments and accessories used to be shown by photographs for the following techniques: PCR, SDS PAGE, Western Blot, and Southern Blot (Principles, Procedures and Uses)
9. Submission of Project Report on Modern Molecular techniques on Zebra fish/ Transgenic Mice.

Suggested readings:

- Alberts, B. et al.(2002) Molecular Biology of the Cell. Garland Pubg. Inc., New York
- Karp G. (2005). Cell and Molecular Biology.4 e, John Wiley & Sons, Inc.
- Kleinsmith, L. J. & Kish, V. M. (1995). Principles of Cell and Molecular Biology. Harper Collins College Pubs
- Veera Bala Rastogi. (2006). Fundamentals of Molecular Biology 1 e. Ane Books, India
- Watson et al. 2014. Molecular Biology of the Gene, 7th edition ,Benjamin Cummings
- Lizabeth A. Allison et al. 2007. Fundamental Molecular Biology. 1st edition
- T.A. Brown. 2007. Genome 3. 3rd edition
- Robert F. Weaver. 2012. Molecular Biology. 5th Edition.
- Jocelyn E. Krebs et al. 2014. Lewin's GENES XI. 11th edition

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

Major-12

ENDOCRINOLOGY AND REPRODUCTIVE BIOLOGY

OBJECTIVES:

- The study aims to explore the structure and function of endocrine glands and the hormones they produce.
- It seeks to understand how hormones regulate various physiological processes such as growth, metabolism, reproduction, and homeostasis.
- The course examines hormonal disorders and the development of therapeutic strategies for managing endocrine diseases.
- To understand the anatomical features of the male and female reproductive systems in humans and to explain the hormonal regulation of gametogenesis (spermatogenesis and oogenesis).
- To describe the reproductive cycle in humans and its hormonal control and to analyze the role of hormones in implantation, gestation, and parturition.

[Difficulty Level 300 **Modes of Instruction:** Lecture, Practical and Tutorial**]**

THEORY

(CREDITS 4)

Unit 1: Unit 1: Introduction to Endocrinology

General idea of Endocrine systems; Classification and Characteristic of Hormones.

Unit 2: Epiphysis, Hypothalamo-hypophysial Axis

Structure of pineal gland; secretions and their functions in biological rhythms and reproduction. Structure of hypothalamus; Hypothalamic nuclei and their functions; Regulation of neuro-endocrine glands, Neuro Endocrine integration; Feedback mechanisms. Structure of pituitary gland; pituitary hormones and their functions; hypothalamo-hypophysial portal system; Disorders of the pituitary gland.

Unit 3: Peripheral Endocrine Glands

Structure, Hormones, Functions of Thyroid, Parathyroid, Adrenal, Pancreas, Ovary and Testis. Hormones in mammalian calcium and glucose homeostasis; Disorders related to Hypo and hypersecretion of endocrine glands.

Unit 4: Mechanism of Hormone Action

Mechanism of action of steroidal and non-steroidal hormones

Unit 5: Functional anatomy of reproduction

Hormonal regulation of spermatogenesis and oogenesis. Reproductive cycle (Oestrous and Menstrual) and its regulation, Mechanism of parturition and its hormonal regulation; Lactation and its regulation.

Unit 6: Reproductive Health

Infertility in male and female: causes, diagnosis and management. Assisted Reproductive Technology (ART): sex selection, sperm banks, Cryopreservation, IVF, IUI, ICSI. Modern contraceptive technologies.

PRACTICALS

(CREDITS 2)

1. Study of Endocrine glands in laboratory rat (Demonstration).
2. Identification of the histological features through slides/photomicrograph of Pituitary, Thyroid, Parathyroid, Adrenal, Pancreas, Ovary and Testis.
3. Estimation of plasma level of any hormone using ELISA (Demonstration)
4. Examination of vaginal smear from live rat / photomicrographs at different stages of oestrous cycle.
5. Identifications of sperm structure in Human/Rat through (slide/microphotograph)

Suggested Readings

1. Guyton and Hall. Textbook of Medical Physiology. 13th Edition
2. Histology: A Text and Atlas. Sixth Edition. Ross & Pawlina. Lippincott Williams & Wilkins.
3. Vertebrate Endocrinology by David O. Norris,

4. Hadley, M.E. and Levine J.E. 2007. Endocrinology, 6th Edition. Pearson Prentice-Hall, Pearson Education Inc., New Jersey.
5. Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.
6. Sembulingam, K. and Sembulingam, P. 2023. Essentials of Medical Physiology, 9th Edition. Jaypee Brothers Medical Publishers, New Delhi.