

SYLLABUS OF ZOOLOGY (MAJOR)

For 4-Year Undergraduate Programme Under
NCCF, 2023



Cooch Behar Panchanan 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*, *Limulus*, *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*, *Tylotriton*, *Hemidactylus*, *Chamaeleo*, *Draco*, *Naja*, *Columba*, *Ornithorhynchus*, *Cavia*.

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

CS of sponges (syconoid 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: Chemo-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; Stabilizing 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 Hyperchromicity 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

Difficulty: 200

Mode of Instruction: LPT

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- monocl意思, 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, *zeitgeber*, free running period, significance of 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 CO₂ 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
- Colinviaux, 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., Kubly, 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.

7th Semester

SUBJECT ZOOLOGY
4 YEAR UG SYLLABUS_CBPBU

Major-13

RESEARCH METHODOLOGY AND ETHICS

Course Description

This course is designed to provide the student a comprehensive knowledge and understanding on various aspects of research methodology and Research along with its ethics. Through theory and practical sessions, students learn how to start research and develop research skills. Ultimately, students are equipped to conduct rigorous research in recent advances in the arena of Life sciences.

Course Objectives

- To familiarize individuals with different types of research, approaches, and research design principles.
- To equip individuals with the necessary skills to critically analyze scientific literature, effectively communicate research results, and adhere to ethical standards in scientific publishing.

Course outcomes

- Individuals will develop the ability to critically evaluate scientific literature, communicate research results through various scientific writing formats, and adhere to ethical guidelines and standards in scientific publishing.
- This knowledge and skill set will contribute to the advancement of scientific knowledge, promote intellectual honesty, and foster a culture of integrity in scientific research.

[Difficulty Level 400

Modes of Instruction: Lecture, Practical and Tutorial]

Theory
(Credits 4)

Unit I: Introduction to Research

Definition, objectives and significance of research;

Types of research – Descriptive vs Analytical, Fundamental vs Applied, Qualitative vs Quantitative, Conceptual vs Empirical;

Characteristics of good research;

Steps of working research.

Unit 2: Research Design

Definition, need and features of a good research design;

Types of research designs (exploratory, descriptive, diagnostic and hypothesis-testing) (brief account with examples);

Formulation of research problem, objectives, and hypothesis;

Developing a research plan: Problem identification, experimentation, determining experimental and sample designs;

Writing a research proposal: title, rationale, objectives, methodology, expected outcome, budget, and timeline.

Unit 3: Data Collection and Analysis

Types of data: Primary and secondary, qualitative and quantitative;

Methods of data collection: Observation, survey, interview, experiment, field sampling (brief idea);

Biological data recording, tabulation, and coding.

Unit 4: Scientific documentation:

Types of Research Publication/ reports (Books, Book Chapters, Government Reports, Journals Articles, Short Communications, Correspondence, Review articles, Thesis, Dissertations, Proceedings);

Structure of a scientific paper (Abstract, Keywords, Introduction, Methods, Results, Discussion, References);

Electronic sources of scientific information: Databases and search engines (PubMed, Scopus, Google Scholar etc.);

Referencing styles (Harvard, APA, Vancouver etc);

Citation management tools (Zotero, Mendeley)

Unit 5: Research Matrix

Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score

Metrics: h-index, g-index, i10-index, Altmetric

Unit 6: Research Ethics

Concepts and importance of research ethics;

Research misconduct: Falsification, Fabrication and Plagiarism (FFP)

Plagiarism detection tools (Turnitin, Urkund, DrillBit);

Ethical issues in animal experimentation and field research;

Institutional Animal Ethics Committee (IAEC) and CPCSEA guidelines;

Informed consent and confidentiality;

Intellectual Property Rights (IPR): patents, copyright, and fair use of published material

Practical (Credits 2)

1. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies.
2. Preparation of bibliography/references in different formats as per journal requirements using software tools (like Mendeley/EndNote/Zotero etc.)
3. Journal finder /journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc
4. Use of plagiarism software like Turnitin/Urkund and other open-source software tools.
5. Submission of report on Research Institute Visit/ Field visit for Data collection.

Suggested readings:

1. George, C.T. (2021). Research Methodology and Scientific Writing. Springer Publication. <https://doi.org/10.1007/978-3-030-64865-7>
2. Kothari, C.R., (2009). Research Methodology: Methods and Techniques. New Age International Publishers, New Delhi.

3. Oliver, P. (2005). Writing Your thesis. Vistar Publications. New Delhi.
4. Dunn, P. K. (2021). Scientific Research and Methodology: An introduction to quantitative research in science and health. *Australia: Sippy Downs*.
5. Creswell, J.W. and Creswell, J.D., (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. SAGE Publications, Thousand Oaks.
6. Flick, U., (2020). Introducing Research Methodology: A Beginner's Guide to Doing a Research Project. SAGE Publications, London.
7. Holmes, D., Moody, P., Dine, D. and Trueman, L., (2016). Research Methods for the Biosciences. Oxford University Press, Oxford.
8. Laake, P., Benestad, H.B. and Olsen, B.R., (2007). Research Methodology in the Medical and Biological Sciences. Academic Press, London.

Online Resources:

1. Inflibnet - <https://www.inflibnet.ac.in/library/>
2. UGC-CARE List - <https://ugccare.unipune.ac.in/apps1/home/index>
3. Web of Science- <https://mjl.clarivate.com/home>
4. Scopus- <https://www.elsevier.com/en-in/products/scopus/search>

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

MAJOR – 14

TOXICOLOGY AND APPLIED ZOOLOGY

Course Description

The entire course is divided into two groups namely Group A: Toxicology and Group B: Applied Zoology. Toxicology is a multidisciplinary field of science that deals with the study of the harmful effects of various chemical, biological, and physical agents on living organisms in the ecosystems, including humans. It contributes to the general knowledge of the harmful actions of chemical substances, to study their mechanisms of action, and to estimate their possible risks to humans on the basis of experimental work on biological test systems. On the other hand, being a course curriculum, Applied Zoology encompasses basic understanding of experimental techniques such as culture, management, harvesting, extraction, preservation and marketing of different products obtained from various economically important animals. It is commonly viewed as a branch of zoology that enterprises applicability of theoretical as well as practical knowledge in order to get viable economic return from a vast number of animal resources.

Course Objectives

- To study the basic, applied and emerging areas of Toxicology and Applied Zoology
- To understand health, environmental and economic issues related to toxicological and applied zoological 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 toxic substances and their mode of actions
- Know about different types of toxicity
- Understand environmental pollution and health hazards caused by toxicants
- Analyze the economic and financial importance of animal resources
- Comprehend the best practices and techniques to be adopted for getting better yields and returns from economically important animals
- Identify new scopes and methods for breeding improved varieties of animal species

[Difficulty Level 400

Modes of Instruction: Lecture, Practical and Tutorial]

THEORY (CREDITS 4)

Group A: TOXICOLOGY

Unit I: Introduction to Toxicology

Definitions and examples of various types of toxic substances (including natural toxins, concept of xenobiotics, mutagens, clastogens, teratogens, carcinogens)
Disposition and biotransformation (phase I and phase II reactions)
Drugs as toxic substance (Paracetamol)

Unit II: Toxicity and its Assay

Types of toxicity: acute, chronic, immediate and delayed.
Toxicity bioassays: static and continuous bioassay.
Quantal dose-response, statistical concepts in environmental toxicology: LD50, ED50, LC50.
Interaction of toxicants: synergism, antagonism, additive effect, potentiation.

Unit III: Environmental Pollution and Health Hazards

Point and Non-point Sources and circulating mechanisms of pollutants.
Degradable and non-degradable toxic substances.
Health hazards caused by arsenic, cadmium, lead, mercury, pesticides, carbon monoxide, carcinogens, food additives (Flavouring agents, colour and preservatives, artificial sweetening agents like saccharin and urea derivatives)
Food-borne moulds (*Aspergillus*, *Penicillium*) and mycotoxins (Aflatoxins, Ochratoxin A)

Group B: APPLIED ZOOLOGY

A. FISHERIES

Unit I: Fisheries in India

Types of fisheries- capture, culture, inland, marine, brackish water (brief idea).
Application of remote sensing and GIS in fisheries

Unit II: Aquaculture

Comparison among extensive, semi-intensive and intensive fish culture.
Monoculture and polyculture of fishes; composite fish culture.
Induced breeding of fishes
Preparation of compound diets for fish.
Water quality management.
Fish Diseases and control measures (Bacterial, fungal, protozoan, crustacean).
Fishery by-products and their uses.
Difference between penaeid and non-penaeid shrimp

B. APICULTURE

Unit I: Biology of Bees

Classification of honey bee (domesticable and non-domesticable)
Life cycle of *Apis indica*.
Social organization.
Bee plants of nectar/pollen and nesting
Composition of honey; Mechanism of Honey production by bees.

Unit II: Rearing of Honey Bees

Artificial bee rearing (Apiary) in beehives: Newton and Langstroth

Advantageous and disadvantageous characters of bee species (*A. mellifera*, *A. cerana indica*, *A. dorsata*, *A. florea*, *A. laboriosa*).

Bee keeping equipment's.

Apiculture by-products and their uses

Unit III: Diseases and Enemies of Honey Bees including Control Measures and other Issues

Pests and predators (Arthropods, amphibians, reptiles, birds, mammals).

Diseases and (Protozoans, bacterial, viral, fungal/mycosis) 3. Environmental hazards.

C. SERICULTURE

Unit I: Biology of Silkworm

Classification of silk moths based on voltinism.

Life cycle of mulberry silkworm (*Bombyx mori*).

Morphology of a mature silk gland; structure and characteristics of silk.

Unit II: Rearing of Silkworms and Silk Industries

Process of rearing; maintaining operations/techniques;

Silk reeling; uses of silk; sericulture industries in India and recent advancement.

Unit III: Moriculture

Types of mulberry plants; propagation and cultivation

Unit IV: Diseases and Enemies of Silkworm including Control Measures

Mode of transmission, symptoms, disease detection, prevention and control [Protozoan, bacterial, viral, fungal, uzi fly, dermestid beetles and vertebrates (amphibians, reptiles, birds and mammals)].

D. LAC CULTURE

Systematic position, types and distribution of lac insect.

Composition and properties of lac.

Strains of Lac crop; lac host plants.

Brief account on lac culture and lac processing technique.

Lac enemies and their control measures

Uses of lac shellac

PRACTICAL (CREDITS 2)

1. Study of bioassay of toxic agents (LC₅₀, LD₅₀) in aquatic and soil invertebrates (Demonstration).
2. Morphological deformities in biological organisms due to toxicant exposure (in any model organism as per availability).
3. Estimation of B. O. D. of polluted/contaminated water samples.
4. Study of crafts and gears used in fisheries specially in north Bengal by farm visit or photograph.
5. Water quality assessment for aquaculture: Turbidity (Secchi disk method), Alkalinity.
6. Study of induced breeding in fishes (Demonstration)

7. Study of pollen basket and sting apparatus of honey bee under microscope/ by photographs.
8. Identification of various equipment's of bee keeping from apiary farm or by photographs
9. Identification of mulberry, eri, muga, tasar silkworm moths; Identification of *Laccifer lacca* from specimen or photograph
10. Submission of report on a visit to any fish farm/apiary farm/sericulture centre/lac culture centre# #*To be submitted during practical examination*

Suggested readings:

1. Timbrell, J. (2002). Introduction to Toxicology. 3rd Ed., Taylor and Francis, London
2. Zakrzewski S, Environmental Toxicology, 3rd, Ed., Oxford Univ. Press
3. Wright D. A., Welbourn, P., Environmental Toxicology, Cambridge Univ. Press
4. Loomis & Hays, Loomi 's Essentials of Toxicology, 4th Ed., Academic Press
5. Klaassen, C. D., Amdur, M. D., Doull, J. (ed.), Toxicology, Mac Mijjan Pub. Company
6. Pandey K., Shukla J. P., Trivedi S. P. (2006) Fundamentals of Toxicology, New Central Book Agency (P) Ltd., Kolkata
7. Bone Q., Moore R., Biology of Fishes, Talyor and Francis Group, CRC Press, U. K.
8. Evans D. H., Claiborne J. D., The Physiology of Fishes, Talyor and Francis Group, CRC Press, U. K.
9. Srivastava C. B. L., Fish Biology, Narendra Publishing House
10. Jhingram V. G., Fish and Fisheries of India, Hindustan Publishing Corporation, Delhi
11. Pillay T. V. R., Aquaculture: Principles and Practices, Fishing News Books, Oxford
12. Sheikh M. S., Apiculture, Global Net Publication, New Delhi
13. Bisht D. S., Apiculture, ICAR Publication
14. Prost P. J. (1962). Apiculture. Oxford and IBH, New Delhi
15. Jolly M. S., Appropriate Sericulture Techniques, Ed., Director, CSR and TI, Mysore
16. Krishnaswamy S. (1986) Improved Method of Rearing Young Age Silkworm, CSB, Bangalore
17. Narasimhanna M. N. (1988) Manual of Silkworm Egg Production, CSB, Bangalore
18. Arumugam N., Murugan T., Johnson Rajeswar J. (2015). Applied Zoology, Saras Publication, Kanyakumari
19. Chattopadhyay D., Elementary of Applied Zoology, Book Syndicate Pvt. Ltd., Kolkata.

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

MAJOR – 15

SEMINAR

MODALITIES TO BE DECIDED

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

MAJOR – 16

ANIMAL BIOTECHNOLOGY AND MICROBIOLOGY (For B.Sc. Honours without research only)

Course Description

This course introduces the principles and techniques of animal biotechnology, including recombinant DNA technology and gene manipulation. It covers cloning vectors, genomic and cDNA library construction, and bacterial transformation methods. Students learn animal cell culture, stem cell technology, and cryopreservation techniques. The course also emphasizes molecular tools such as electrophoresis, blotting, PCR, RAPD, and RT-PCR. It examines bacterial nutrition, growth kinetics, and reproductive mechanisms. Students learn the mechanisms of antibiotic action and resistance. Applications of microbiology in probiotics, food fermentation, biofertilizers, biofuels, and genetically modified crops are also discussed.

Course Objectives

- To gain basic understanding of recombinant DNA technology, animal cell culture and various molecular techniques used in biotechnology.
- To understand microbial diversity, physiology, and nutrition while critically analyzing the molecular mechanisms of targeted antibiotic inhibition and the modern applications of microbes in agriculture, bioenergy, and food production.
- To develop laboratory skills of DNA isolation and basic microbiological techniques of bacterial culture.
- To gain basic mathematical skills for restriction mapping and bacterial genetic mapping

Course Outcomes

Upon completion of the course, students will be able to explain the principles of recombinant DNA technology and cloning strategies. They will demonstrate knowledge of vector systems, library construction, and transformation techniques. Students will understand the fundamentals of animal cell culture and molecular biotechnology techniques. They will be able to interpret the applications of DNA sequencing, DNA fingerprinting, and molecular diagnostics. Students will also evaluate the roles of cloning, gene therapy, and recombinant proteins in modern biotechnology. They will be able to explain bacterial nutrition, growth patterns, and reproductive processes and to evaluate the significance of microbiological applications in agriculture, food production, health, and biotechnology.

[Difficulty Level 400

Modes of Instruction: Lecture, Practical and Tutorial]

Theory (Credits 4)

Group-A: ANIMAL BIOTECHNOLOGY

Unit 1: Techniques in Gene manipulation:

Recombinant DNA technology; Restriction endonucleases: properties and types (I, II & III); Cloning Vectors & their features: Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC, and HAC. Shuttle and Expression Vectors; Construction of Genomic libraries and cDNA libraries; Transformation techniques: Cloning in bacteria and detection technique of clone (CaCl₂ & Electroporation Methods).

Unit 2: Animal Cell Culture:

Basic techniques in animal cell culture and organ culture; Primary Culture and Cell lines; Culture media – Natural and Synthetic, Cryopreservation of cultures.

Unit 3: Molecular Techniques used in Biotechnology:

Agarose and Polyacrylamide Gel Electrophoresis; Southern, Northern and Western blotting; Polymerase chain reaction, RAPD & RT PCR.

Unit 4: Biotechnological Applications:

DNA sequencing: Sanger's method; DNA Microarray; DNA Fingerprinting; Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia, Thalassemia); Dolly & Polly cloning; Genetically modified economically important animal; Gene Therapy; Production of recombinant Proteins: Insulin.

Group- B: MICROBIOLOGY

Unit 1: Introduction to Microbiology

General characteristics of different groups: Acellular microorganisms (Viruses, Viroid's, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa).

Unit 2: Growth and Nutrition

Nutritional requirements in bacteria and nutritional categories (photoautotrophs, photoheterotrophs, chemoautotrophs, chemoheterotrophs); Culture media: components of media, natural and synthetic media, complex media, selective media.

Unit 3: Antibiotics

Mechanisms of action of antibiotics: Cell wall inhibitors (beta-lactams), Protein synthesis inhibitors (tetracyclines), DNA synthesis inhibitors (quinolones), RNA synthesis inhibitors (rifamycin's); Overview of antibiotic resistance mechanisms in the present context.

Unit 4: Applications of Microbiology

Probiotics: Health benefits, types of microorganisms used; production of Curd and Cheese; Concept of Biofertilizers, Mycorrhizae, Bio-ethanol and bio-diesel; GM crops: Benefits and environmental and health safety issues of Bt cotton and brinjal.

PRACTICAL (Credits 2)

Animal Biotechnology

1. Genomic DNA isolation from *E. coli*/animals/ human and Plasmid DNA isolation (pBR322) from *E. Coli*.
2. Techniques- DNA fingerprinting, DNA Microarrays (By Photographs).
3. Construction of circular and linear restriction map from the data provided.

Microbiology

1. Preparation of bacterial culture medium.-
2. Logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.
3. Inoculation techniques: streak, spread, pour plate methods.
4. To study the principles and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, pH meter) used in the microbiology laboratory.
5. Gram's staining from the Curd sample.
6. Mapping (Problems to be solved): Interrupted mating technique and time of entry mapping, Mapping co-transduction of markers.

Suggested Readings:

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA — Bernard R. Glick, Cheryl L. Patten & Jack J. Pasternak.
2. Principles of Gene Manipulation and Genomics — S.B. Primrose & R.M. Twyman.
3. Animal Biotechnology — M.M. Ranga.
4. Biotechnology: Expanding Horizons — B.D. Singh.
5. Prescott's Microbiology — Joanne Willey, Linda Sherwood & Christopher Woolverton.
6. Microbiology — Pelczar, Chan & Krieg.
7. Microbiology: An Introduction — Tortora, Funke & Case.
8. Microbial Biotechnology: Fundamentals of Applied Microbiology — Alexander N. Glazer & Hiroshi Nikaido.
9. Microbiology: Principles and Explorations. 8th ed. - Black, J. G. (2011) John Wiley and Sons.
10. Brock Biology of Microorganisms 12th edn. Int. Microbiol, 11(1) - Madigan, M. T., Martinko, J. M., Dunlap, P. V., & Clark, D. P. (2008).
11. Nester's Microbiology: A Human Perspective - Anderson, D., Salm, S., Beins, M., Auman, A., Walker, J., & Nester, E. W. (2016).

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

MAJOR – 16

DISSERTATION

(For B.Sc. Honours with research only)

MODALITIES TO BE DECIDED

8th Semester

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

MAJOR – 17

BIOPHYSICS AND BIOINFORMATICS

Course Description

This course provides an interdisciplinary introduction to the foundational principles and quantitative tools of biophysics and bioinformatics. Students will explore the physics behind advanced analytical instrumentation, including high-resolution microscopy, centrifugation, spectrophotometry, and various chromatographic techniques. Concurrently, the curriculum covers the architectural framework of major biological databases, sequence alignment algorithms like BLAST, and the computational methodologies used to reconstruct molecular phylogenetic trees. Through integrated practical sessions, learners will gain hands-on experience executing laboratory techniques like paper chromatography alongside computational workflows involving NGS data retrieval, AlphaFold 3D protein structure prediction, and molecular visualization.

Course Objectives

The objective of this course on Biophysics and Bioinformatics is to provide students with a foundational understanding of the key laboratory techniques used in biological research along with basics of computational biology.

Course outcomes

- Students will gain knowledge of laboratory techniques such as microscopy, centrifugation, spectrophotometry, various chromatography techniques. Overall, this course will equip students with the necessary statistical and laboratory skills to conduct and analyze biological research effectively.
- Students will understand of the concepts of Bioinformatics. They will be able to utilize appropriate terminology, methods to analyze and interpret biological data.

[Difficulty Level 400

Modes of Instruction: Lecture, Practical and Tutorial]

**Theory
(Credits 4)**

Group-A (BIOPHYSICS)

Unit-1: Microscopy

Magnification and resolution; basic principle, working and applications of: Light Microscope, Phase Contrast, Fluorescence, Electron and Confocal Microscopy.

Unit-2: Centrifugation

Basic principles of sedimentation; differential and density gradient centrifugation.

Unit-3: Spectrophotometry

Basic principle, working and applications of visible, UV spectrophotometer and FTIR (Fourier Transform Infrared) spectroscopy.

Unit-5: Chromatography

Basic principle, techniques, and applications of: Paper Chromatography, Thin Layer Chromatography, Gas Chromatography and HPLC.

Unit 6: Analytical and Optical Instrumentation

Basic principle, techniques, and applications of: Flow cytometry, X-ray crystallography.

Group-B (BIOINFORMATICS)

Unit 1: Introduction to Bioinformatics

Introduction, Goal, Scope, Applications and Limitations of Bioinformatics.

Unit 2: Biological Sequence Databases

Introduction to biological databases; Primary, secondary and composite databases with examples; Salient features of Databases: Nucleic acid databases (GenBank, DDBJ and EMBL); Protein databases (PIR, SWISS-PROT, TrEMBL, PDB); Metabolic pathway database (KEGG Pathway, EcoCyc, and MetaCyc); Small molecule databases (PubChem, ZINC, CSD)

Unit 3: Data Submission and Data Retrieval

Sequence submission tools (BankIt and Sequin); Sequence file format (GenBank FASTA); Sequence annotation; Data retrieval systems (SRS, Entrez, DBGET)

UNIT 4: Sequence Alignments & Molecular Phylogeny

Introduction, Concept of Alignment, Global and Local Alignments, Pairwise Sequence Alignment (PSA) and Multiple Sequence Alignment (MSA), Scoring Matrices: PAM and BLOSUM; Basic Local Alignment Search Tool (BLAST): Types, Similarity, Identity, and homology of sequences; Phylogenetic trees: Distance-based and character-based methods of construction

Practical (Credits 2)

1. Demonstration of functioning spectrophotometry/centrifuge/ thermal cycler
2. Paper chromatography of amino acids using ninhydrin.
3. Retrieval of nucleotide and protein sequences from the databases and their utilization in NGS
4. To perform pair-wise alignment of sequences (BLAST) and its interpretation
5. Construction of phylogenetic tree (using software like MEGA or PHYLIP etc)
6. Prediction of 3D structure of protein using AlphaFold.
7. Visualization of protein structure using RasMol: Basic analysis

Suggested Readings:

1. Attwood, T. K., & Parry-Smith, D. J. (2002). Introduction to bioinformatics.
2. Cotterill R, 2012. Biophysics-An Introduction. John Wiley & Sons Ltd. Pub.
3. Ghosh Z and Mallick B. (2008). Bioinformatics: Principles and Applications, Oxford University Press.
4. Lesk, A. M. (2019). *Introduction to bioinformatics*. Oxford university press.
5. Mukherjee K L, 1998. Medical Laboratory Techniques -Vol. I, II & III. Tata McGraw Hill

6. Pevsner J. (2009). Bioinformatics and Functional Genomics, II Edition, Wiley Blackwell
7. Roy R N.2001. A Text Book of Biophysics. New Central Book Agency Pub
8. Sharma V K, 1991. Techniques in Microscopy & Cell Biology. Tata Mc Graw Hill. Pub.
9. Wilson and Walker's (2018). Principles and Techniques of Biochemistry and Molecular Biology.8th ed.Cambridge University Press.
10. Zvelebil, Marketa and Baum O. Jeremy (2008). Understanding Bioinformatics, Garland Science, Taylor and Francis Group, USA.

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

MAJOR – 18

WILDLIFE BIOLOGY AND BIOSTATISTICS

Course Description:

This course explores the ecological dynamics of wildlife biology alongside the quantitative tools of biostatistics to monitor, manage, and analyze natural populations. Students will study wildlife conservation, biogeographic zones, population estimation techniques, wildlife diseases, and human-wildlife conflict mitigation strategies. Concurrently, the curriculum covers descriptive and inferential statistics, detailing data visualization, probability distributions, hypothesis testing through t-tests and ANOVA, and linear regression models. Through integrated practical sessions, learners will master species identification, field transect monitoring, and computational data analysis using Microsoft Excel to solve real-world ecological problems.

Course Objectives:

- To introduce students to the principles of wildlife biology, conservation, and management, while emphasizing zoonotic health concerns and human-wildlife interactions.
- To gain practical skills in biostatistics and Excel, enabling students to classify data, apply descriptive and inferential tests, and create professional visualizations to analyse and communicate wildlife research effectively.

Course Outcomes:

After completion of the course, students should be able to:

- Evaluate the principles of wildlife conservation, population monitoring, and habitat management while identifying key regional fauna and their associated health and conflict challenges.
- Apply descriptive and inferential biostatistical methods to model biological data, test ecological hypotheses, and determine statistical significance.
- Master hands-on practical skills in field transect monitoring, taxonomic identification of threatened fauna, and computer-assisted statistical computations in Excel.

[Difficulty Level 400

Modes of Instruction: Lecture, Practical and Tutorial]

Theory
(Credits 4)

GROUP-A
(WILDLIFE BIOLOGY)

Unit 1: Introduction to Wild Life

Values of wild life - positive and negative; Importance of wildlife conservation; Causes of depletion of Indian wildlife; basic idea of IUCN Red List categories.

Unit 2: Habitats and management

Major fauna of biogeographic four (4) zones (hotspots) of India; Concept of cover and its construction, forage and browse; Setting back succession: Grazing, logging, Mechanical treatment, Advancing the successional process.

Unit 3: Population Estimation

Details of pugmark census, wildlife telemetry, faecal samples and hair identification of ungulates.

Unit 4: Wildlife Health

Common diseases of wild animal: Bacterial: Tuberculosis, Anthrax, Brucellosis; Viral: Rabies, Canine distemper virus, Foot-and-mouth disease; Parasitic: Toxoplasmosis, Trichinosis; Care of injured and diseased animals; Quarantine.

Unit 5: Man and Wildlife

Human-Wildlife conflict-causes, consequences and mitigation; Eco tourism in forests; Ecology of perturbation, Concept of Zoonosis, Zoonotic Diseases – Avian Influenza (H5N1), Rabies, Anthrax (*Bacillus anthracis*), and Plague (*Yersinia pestis*).

GROUP-B
(BIOSTATISTICS)

Unit 1: Introduction to Biostatistics

Concept of Sample and Population; Concept of Data (Primary & Secondary); Distinguishing between nominal, ordinal, discrete, and continuous variables.

Unit 2: Descriptive Statistics and Data Visualisation

Frequency Distribution & Graphical Representation (Constructing and interpreting histograms, frequency polygon, and ogive).

Measures of Central Tendency: Calculation of the arithmetic mean, median, and mode, their merits and demerits.

Measures of Dispersion: Calculation of range, variance, standard deviation, and coefficient of variation.

Unit 3: Probability and Sampling Distributions

The Normal Distribution: Properties of the Gaussian curve and the Z-score transformation.

Unit 4: Inferential Statistics and Hypothesis Testing

Hypothesis Testing: Defining Null & Alternative Hypotheses, Type I and Type II errors.

T-tests: One-sample, two-sample (unpaired and paired t-tests).

ANOVA: One-way Analysis of Variance for comparing three groups.

Unit 5: Correlation and Regression:

Types of Correlation, Methods of Studying Correlation: Karl Pearson's r, Spemann's rank Correlation and scatter diagram. Calculation of Correlation coefficient (r), Linear regression.

Practical (Credits 2)

1. IUCN Status, Distribution & Identification (up to Genus label having scientific name) of: Insects: Rock bee, Termite, Common Jezebel; Fish: Boroli Fish, Mohashol; Herpeto Fauna: Gharial, Bengal Monitor, Small Tree Frog, Himalayan Salamander (Himalayan Newt), Northern River Terrapin; Mammalian Fauna: Ganges river dolphin, Indian wild dog or Dhole, Red panda, Fishing cat, Hispid hare, Lion tailed macaque; Avian Fauna: White-rumped Vulture, Rufous-necked hornbill, Forest owl, Green bee-eater, Greater Adjutant.
2. PCQ estimation.
3. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences).
4. Construction of graphical representation of data in Excel (Bar, Pie, Histogram).
5. Calculation of SD value of mean and include SD values (as error bar) in Excel graph.
6. Paired and unpaired t test and calculation of t value and P - value significance. (In data analysis tool in excel).
7. Basic understanding of Single factor ANOVA for analysis of Variance. (In data analysis tool in Excel).

Suggested readings:

1. Mathur, R. (2018) Wildlife conservation and management, 1st Ed, Rastogi Pub.
2. Saha, G.K. and Mazumdar, S.; (2017) Wildlife Biology: An Indian Perspective, PHI Learning.
3. Caughley, G., and Sinclair, A.R.E. (1994). *Wildlife Ecology and Management*. Blackwell Science.
4. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). *People and Wildlife, Conflict or Co-existence?* Cambridge University.
5. Bookhout, T.A. (1996). *Research and Management Techniques for Wildlife and Habitats*, 5 th edition. The Wildlife Society, Allen Press.

6. Sutherland, W.J. (2000). *The Conservation Handbook: Research, Management and Policy*. Blackwell Sciences
7. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). *Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory*. Blackwell Publishing.
8. Banerjee, P.K.; (2014) Introduction to Biostatistics, S. Chand Publishing.
9. Mahajan, B.K.; (2010) Methods in Biostatistics for Medical Students and Research Workers, Jaypee Brothers Medical Publishers.
10. Zar, J.H.; (2010) Biostatistical Analysis, Pearson Education India.
11. Forthofer, R.N., Lee, E.S. and Hernandez, M.; (2007) Biostatistics: A Guide to Design, Analysis, and Discovery, Academic Press.
12. Rastogi, V.B.; (2015) Biostatistics, Medtech Publishers.
13. Daniel, W.W. and Cross, C.L.; (2018) Biostatistics: A Foundation for Analysis in the Health Sciences, Wiley India.

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

MAJOR – 19

COMPARATIVE ANATOMY OF VERTEBRATES (For B.Sc. Honours without research only)

Course Description:

This course offers a comprehensive comparative study of the structural and functional anatomy of vertebrates, tracking evolutionary transitions across diverse taxonomic groups. Students will analyze the phylogeny and modifications of major organ systems, including the integumentary, skeletal, digestive, respiratory, circulatory, urinogenital, and nervous systems, across fishes, amphibians, reptiles, birds, and mammals. Special emphasis is placed on physiological adaptations—such as the avian respiratory complex, the ruminant stomach, and the evolution of the cerebral hemisphere—alongside the mechanics of specialized sensory receptors.

Course Objective

This course aims to provide a comprehensive understanding of the structural and functional organization of major organ systems in vertebrates, emphasizing evolutionary trends and comparative anatomy. Through detailed exploration of the integumentary, skeletal, digestive, respiratory, circulatory, urinogenital, nervous, and sensory systems, students will gain insights into the phylogenetic adaptations that underpin vertebrate diversity.

Course Outcomes

By the conclusion of this course, students will be able to analyze and compare the structural evolution of major vertebrate organ systems—ranging from the integumentary and skeletal frameworks to complex circulatory and urinogenital pathways—across fishes, amphibians, reptiles, birds, and mammals. Learners will evaluate how specific anatomical modifications represent evolutionary adaptations to diverse environmental pressures.

[Difficulty Level 400 Modes of Instruction: Lecture]

THEORY (CREDITS: 6)

Unit 1: Integumentary System

Phylogeny of integument in vertebrates: Fishes, Amphibians, Reptiles, Birds and Mammals; Types of integumental glands in mammals with modifications and examples: sebaceous, eccrine, and apocrine; Modifications of integument in vertebrates: Scales, Nails, Claws, Hooves, Horns, Antlers, Hair, Feathers, Baleen, Carapace & Plastron.

Unit 2: Skeletal System

Comparative account of Skull, Vertebrae, Pectoral-Pelvic Girdles and Limb Bones of: Toad, Pigeon and Guinea Pig. Jaw suspension in vertebrates.

Unit 3: Digestive System

Alimentary canal and associated glands; Ruminant stomach; Dentition in vertebrates: types and modifications.

Unit 4: Respiratory System

Structural and functional modification of skin, gills, and lungs in vertebrates; air sacs and double respiration in birds. Respiratory mechanism in diving mammals.

Unit 5: Circulatory System

Comparative anatomy and functions of Aortic arches and Hearts in vertebrates.

Unit 6: Urinogenital System

Succession of kidney, Comparative account of urinogenital ducts.

Unit 7: Nervous System

Comparative account of brain in vertebrates, Evolution of vertebrate cerebral hemisphere.

Unit 8: Sense Organs

Brief idea of the following specialised sensory organs/receptors: Chemoreceptors – Vomeronasal (Jacobson's) organ in Snakes; Electoreceptor – Ampullae of Lorenzini in Sharks; Photoreceptor – Pineal complex (parietal eye in reptiles); Mechanoreceptors – Lateral line sense organ in fishes, Electromagnetic receptors- Cryptochrome and Magnetite in birds. Concept of monocular, binocular and stereoscopic vision.

Suggested Readings:

1. Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education
2. Kent, G. C., & Carr, R. K. (2001). *Comparative anatomy of the vertebrates* (9th ed.). McGraw Hill Education.
3. Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons.
4. Romer, A.S. and Parsons, T.S.; (1986) *The Vertebrate Body*. VI Edition. Saunders College Publishing.

SUBJECT ZOOLOGY

4 YEAR UG SYLLABUS_CBPBU

MAJOR – 19

DISSERTATION

(For B.Sc. Honours with research only)

MODALITIES TO BE DECIDED