



**Rabindranath Tagore University**  
**Department of Zoology**  
**B.Sc. Syllabus (NEP)**

Semester	Paper code	Paper name
<b>1st sem</b>	ZOO-MAJ- 1.1	Diversity of non-chordate
	ZOO-MIN- 1.1	Principle of Ecology
	ZOO- SEC- 1.1	Bee keeping
<b>2<sup>nd</sup> sem</b>	ZOO-MAJ- 2.1	Diversity of Chordates
	ZOO-MIN- 2.1	Introduction to non-chordates
	ZOO-SEC- 2.1	Sericulture
<b>3<sup>rd</sup> sem</b>	ZOO-MAJ- 3.1	Principle of genetics
	ZOO-MAJ- 3.2	Cell biology
	ZOO-MIN- 3.1	Diversity of chordates
	ZOO- SEC- 3.1	Ornamental fish and fisheries
<b>4<sup>th</sup> sem</b>	ZOO-MAJ- 4.1	Animal taxonomy Systematics & Biostatistics
	ZOO-MAJ-4.2	Principle of Ecology & Evolution
	ZOO-MAJ- 4.3	Comparative anatomy of vertebrates
	ZOO-MIN-4.1	Cell biology and genetics
<b>5<sup>th</sup> sem</b>	ZOO-MAJ-5.1	Animal physiology and Histology
	ZOO-MAJ-5.2	Fundamental of biochemistry and metabolic processes
	ZOO-MAJ-5.3	Economic and Applied Zoology
	ZOO-MAJ-5.4	Immunology and Endocrinology
	ZOO-MIN- 5.1	Molecular biology and Evolution
<b>6<sup>th</sup> sem</b>	ZOO-MAJ-6.1	Molecular biology
	ZOO-MAJ-6.2	Wildlife conservation
	ZOO-MAJ-6.3	Developmental biology and Reproductive Biology
	ZOO-MAJ-6.4	Animal biotechnology and instrumentation
	ZOO-MIN- 6.1	Fundamental of Biochemistry and instrumentation
<b>7<sup>th</sup> sem</b>	ZOO-MAJ-7.1	Applied immunology
	ZOO-MAJ-7.2	Computational biology and Bioinformatics
	ZOO-MAJ-7.3	Animal behavior
	ZOO-MAJ-7.4 (Optional)	Environmental Science and Climate change
	ZOO-MIN-7.1	Research methodology
<b>8<sup>th</sup> sem</b>	ZOO-MAJ-8.1	General Ichthyology
	ZOO-MAJ-8.2	Research methodology
	ZOO-MAJ-8.3 (Optional-I)	Animal cell culture and genetic engineering
	ZOO-MAJ-8.4	Evolution and chronobiology
	ZOO.MIN-8.1 (optional-II)	Computational biology

**B.Sc. 1<sup>st</sup> SEM**  
**MAJOR**  
**PAPER 1.1**  
**DIVERSITY OF NON-CHORDATES**

**Course Outcome:**

1. Explain the evolutionary and taxonomic diversity among non-chordates and understand their ecological roles.
2. Illustrate the anatomical and physiological features of representative invertebrates.
3. Compare developmental stages and parasitic life cycles relevant to human health.
4. Employ scientific tools and techniques for morphological and anatomical study of invertebrate specimens.
5. Integrate knowledge of coelom evolution and metamerism in the context of invertebrate evolution.

**THEORY**

**(Credit 3)**

**Unit 1: Protista and Parazoa**

**4**

General characteristics and Classification upto classes of Protista.

Locomotion and nutrition in Protozoa.

**Unit 2: Porifera**

**4**

General characteristics and Classification upto classes Canal system and spicules in sponges

**Unit 3: Cnidaria**

**4**

General characteristics and Classification upto class. Polymorphism in Cnidaria. Corals and coral reef formation.

**Unit 4: Platyhelminthes**

**6**

General characteristics and Classification up to classes. Life cycle and pathogenicity of *Fasciola hepatica*. Public health significance and control measures of helminth infections.

**Unit 5: Nematelminthes**

**6**

General characteristics and Classification up to classes. Lifecycle, and pathogenicity of *Ascaris lumbricoides*.

**Unit 6: Introduction to Coelomates**

**3**

Evolution of coelom and metamerism

**Unit 7: Annelida**

**4**

General characteristics and Classification upto classes Excretion in Annelida

**Unit 8: Arthropoda**

**6**

General characteristics and Classification upto classes. Respiration in Arthropoda  
Metamorphosis in Insect. Hormonal control of metamorphosis and its ecological implications.

**Unit 9: Mollusca**

**5**

General characteristics and Classification upto classes. Torsion and detorsion in Gastropoda.  
Evolutionary significance of trochophore larva

**Unit 10: Echinodermata**

**4**

General characteristics and Classification upto classes Water-vascular system in Echinodermata.

**SUGGESTED READINGS:**

1. Invertebrate Zoology – Ruppert, Fox, and Barnes
2. A Textbook of Invertebrates – R.C. Rastogi
3. Invertebrates – Richard C. Brusca, Wendy Moore, Stephen M. Shuster
4. Invertebrate Zoology – E.L. Jordan and P.S. Verma
5. Invertebrate Zoology – D.P. Singh and S.S. Grewal
6. Invertebrate Zoology (Pradeep's Series) – R.L. Kotpal
7. The Invertebrates: A New Synthesis – R.S.K. Barnes

**PRACTICALS**

**(Credit 1)**

1. Study of whole mount of Euglena, Amoeba and Paramecium.
2. Examination of pond water collected from different places for diversity in protista
3. Study of Sycon (T.S. and L.S.), Hyalonema, Euplectella, Spongilla
4. Study of Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora
5. Study of adult Fasciola hepatica, Taenia solium.
6. Study of adult Ascaris lumbricoides.
7. Study of following specimens: Annelids-Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria Arthropods - Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta, termites and honey bees Onychophora - Peripatus Molluscs - Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus Echinodermates - Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria and Antedon
8. Dissection of digestive system and nervous system of periplaneta.
9. To submit a Project Report on any related topic to larval forms (crustacean, mollusc and echinoderm)

**B.Sc. 1<sup>st</sup> SEM**  
**MINOR**  
**Paper – 1.1**  
**PRINCIPLE OF ECOLOGY**

**Course Outcome:**

1. Define foundational ecological principles and differentiate between autecology and synecology.
2. Analyze population attributes and apply models to interpret growth patterns and population interactions.
3. CO3: Characterize community structure, succession patterns, and ecological equilibrium.
4. CO4: Describe ecosystem components, nutrient cycling, and energy flow using real-world examples.
5. Apply ecological knowledge in wildlife conservation and management contexts.

**Theory**

**(Credit 3)**

Unit 1: Introduction to Ecology

4

History of ecology. Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors

Unit 2: Population

18

Unitary and Modular populations, Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion Exponential and logistic growth, equation and patterns, r and K strategies Population regulation - density-dependent and independent factors Population interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and Predation, functional and numerical responses

Unit3: Community

10

Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological succession with one example Theories pertaining to climax community

Unit 4: Ecosystem

10

Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies Nutrient and biogeochemical cycle with one example of Nitrogen cycle, Human modified ecosystem

Unit 5: Applied Ecology

4

**SUGGESTED READINGS:**

1. Fundamentals of Ecology – Eugene P. Odum & Gary W. Barrett
2. Ecology: Principles and Applications – J.L. Chapman & M.J. Reiss
3. Elements of Ecology – Robert L. Smith & Thomas M. Smith
4. Ecology and Environment – P.D. Sharma
5. Ecology: The Economy of Nature – Robert E. Ricklefs
6. Principles of Ecology – R.L. Kotpal
7. Essentials of Ecology – Colin R. Townsend, Michael Begon & John L. Harper
8. A Textbook of Ecology – S.C. Santra

**PRACTICALS**

**(Credit 1)**

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method).
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary

**B.Sc. 1<sup>st</sup> SEM**  
**SEC**  
**PAPER- ZOO-SEC-1.1**  
**BEE KEEPING**

**Course Outcome:**

1. Describe the biological features and social organization of honey bees.
2. Demonstrate the principles and methods of bee rearing and hive management.
3. Identify common pests and diseases affecting bee colonies and suggest control strategies.
4. Evaluate the economic and ecological importance of apiculture products.
5. Apply entrepreneurial skills in apiculture, including marketing and sustainable practices.

**THEORY**

**(Credit 2)**

**Unit 1: Biology of Bees**

**5**

History, Classification and Biology of Honey Bees, Social Organization of Bee Colony

**Unit 2: Rearing of Bees**

**10**

Artificial Bee rearing (Apiary), Beehives–Newton and Langstroth, Bee Pasturage, Selection of Bee Species for Apiculture, Bee Keeping Equipment, Value-added products: royal jelly, bee venom, propolis in pharma, Methods of Extraction of Honey (Indigenous and Modern), Pollinator decline and its impact on agriculture

**Unit 3: Diseases and Enemies**

**5**

Bee Diseases and Enemies, Control and Preventive Measures

**Unit 4: Bee Economy**

**5**

Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc.

**Unit 5: Entrepreneurship in Apiculture**

**5**

Bee Keeping Industry–Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens.

**SUGGESTED READINGS:**

1. The Hive and the Honey Bee – Roy A. Grout
2. The ABC and XYZ of Bee Culture – A.I. Root & E.R. Root
3. Beekeeping in India – G.K. Ghosh
4. Beekeeping for Beginners – Deborah Malone
5. PRACTICALS Manual of Apiculture – R.C. Mishra

**PRACTICALS****(Credit 1)**

1. Study of life cycle of honey bee
2. Identification of different species of honey bee
3. Identification of different castes of honey bee
4. Study of different equipment associated with apiculture
5. Visit to an apiculture farm and submission of report.



**B.Sc. 2<sup>nd</sup> SEM**  
**MAJOR**  
**ZOOLOGY**  
**PAPER-2.1**  
**DIVERSITY OF CHORDATE**

**Course Outcome:**

- 1 . Classify chordates based on key morphological and embryological features.
- 2 . Interpret evolutionary relationships using comparative anatomy and larval characters.
- 3 . Explain the physiological and behavioral adaptations in fishes, amphibians, reptiles, birds, and mammals.
- 4 . Apply knowledge of zoogeography to analyze distribution patterns of vertebrates.
- 5 . Appreciate conservation importance of key vertebrate taxa in different biogeographic realms.

**THEORY**

**(Credit 3)**

**Unit 1: Introduction to Chordates**

**2**

General characteristics and outline classification

**Unit 2: Protochordata**

**6**

General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata

**Unit 3: Origin of Chordata**

**3**

Dipleurula concept and the Echinoderm theory of origin of chordates Advanced features of vertebrates over Protochordata

**Unit 4: Agnatha**

**2**

General characteristics and classification of cyclostomes up to class

**Unit 5: Pisces**

**6**

General characteristics of Chondrichthyes and Osteichthyes, classification up to order Migration, Osmoregulation and Parental care in fishes

**Unit 6: Amphibia**

**5**

Origin of *Tetrapoda* (Evolution of terrestrial ectotherms); General characteristics and classification up to order; Parental care in Amphibians

**Unit 7: Reptilia**

**5**

General characteristics and classification up to order; Affinities of *Sphenodon*; Poison apparatus and Biting mechanism in snakes

### **Unit 8: Aves**

**5**

General characteristics and classification up to order *Archaeopteryx*- a connecting link; Principles and aerodynamics of flight, Flight adaptations and Migration in birds

### **Unit 9: Mammals**

**6**

General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages

### **Unit 10: Zoogeography**

**7**

Zoo geographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms

### **SUGGESTED READINGS:**

1. Chordate Zoology – P.S. Verma & V.K. Agarwal
2. Animal Diversity – Cleveland P. Hickman, David J. K. & N. G. W.
3. Textbook of Chordate Zoology – R.L. Kotpal
4. Vertebrate Life – F. Harvey Pough, Christine M. Janis, and John B. Heiser
5. Comparative Anatomy of Vertebrates – George C. Kent & Robert K. Carr
6. Chordates and Evolution – Donald E. Berrill
7. Biology of the Vertebrates – L. R. Taylor
8. Introduction to the Study of Vertebrates – R.W. H. Tillyard
9. Anatomy of Vertebrates – J.P. Green

### **PRACTICALS**

**(Credit 1)**

1. **Protochordata** Balanoglossus, Herdmania, Branchiostoma, Colonial Urochordata Sections of Balanoglossus through proboscis and branchio genital regions, Sections of Amphioxus through pharyngeal, intestinal and caudal regions. Permanent slide of Herdmania spicules
2. **Agnatha** Petromyzon, Myxine
3. **Fishes** Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetraodon/ Diodon, Anabas, Flat fish
4. **Amphibia** Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandra
5. **Reptilia** Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus Key for Identification of poisonous and non-poisonous snakes
6. **Aves** Study of six common birds from different orders. Types of beaks and claws
7. **Mammalia** Sorex, Bat (Insectivorous and Frugivorous), Funambulus, Loris, Herpestes, Erinaceus. Mount of weberian ossicles of fish Power point presentation on study of any two animals from two different classes by students (may be included if dissections not given permission)

**B.Sc. 2<sup>nd</sup> SEM**  
**MINOR**  
**ZOOLOGY**  
**PAPER 2.1**  
**INTRODUCTION TO NON-CHORDATES**

**Course Outcome:**

1. Describe diagnostic features of non-chordate phyla with an emphasis on representative types.
2. Explain anatomical, physiological, and reproductive adaptations of major invertebrate groups.
3. Analyze evolution of body cavities, segmentation, and larval strategies.
4. Identify medically important parasites and assess their impact on public health.
5. Demonstrate the role of invertebrates in ecosystems and applied zoology.

**THEORY**

**(Credit 3)**

**Unit 1: Protista and Protozoa**

**5**

General characteristics and Classification upto classes of protista.

Locomotion in protozoa.

**Unit 2: Porifera**

**5**

General characteristics and Classification upto classes Canal system in sponges

**Unit 3: Cnidaria**

**5**

General characteristics and Classification upto class. Polymorphism in Cnidaria.

**Unit 4: Platyhelminthes**

**5**

General characteristics and Classification up to classes. Life cycle and pathogenicity of *Fasciola hepatica*.

**Unit 5: Nematelminthes**

**5**

General characteristics and Classification up to classes. Lifecycle, and pathogenicity of *Ascaris lumbricoides*.

**Unit 6: Introduction to Coelomates**

**2**

Evolution of coelom.

**Unit 7: Annelida**

**4**

General characteristics and Classification upto classes. Locomotion in leech.

**Unit 8: Arthropoda** **6**

General characteristics and Classification upto classes. Metamorphosis in Insect.

**Unit 9: Mollusca** **5**

General characteristics and Classification upto classes. Torsion and detorsion in Gastropoda.

**Unit 10: Echinodermata** **5**

General characteristics and Classification upto classes Water-vascular system in echinodermata.

**SUGGESTED READINGS:**

1. Invertebrate Zoology – Ruppert, Fox, and Barnes
2. A Textbook of Invertebrates – R.C. Rastogi
3. Invertebrates – Richard C. Brusca, Wendy Moore, Stephen M. Shuster
4. Invertebrate Zoology – E.L. Jordan and P.S. Verma
5. Invertebrate Zoology – D.P. Singh and S.S. Grewal
6. Invertebrate Zoology (Pradeep's Series) – R.L. Kotpal
7. The Invertebrates: A New Synthesis – R.S.K. Barnes

**PRACTICALS**

**(Credit 1)**

1. Study of whole mount of Euglena, Amoeba and Paramecium.
2. Examination of pond water collected from different places for diversity in protista
3. Study of Sycon(T.S. and L.S.), Hyalonema, Euplectella, Spongilla
4. Study of Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora
5. Study of adult Fasciola hepatica, Taenia solium.
6. Study of adult Ascaris lumbricoides.
7. Study of following specimens: Annelids-Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria Arthropods - Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta, termites and honey bees Onychophora - Peripatus Molluscs - Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus Echinodermates - Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria and Antedon
8. Dissection of digestive system of periplaneta.
9. To submit a Project Report on any related topic to larval forms (crustacean, mollusc and echinoderm)

**B.Sc. 2<sup>ND</sup> SEM (NEP)**  
**SEC**  
**ZOOLOGY**  
**PAPER- 2.1**  
**SERICULTURE (NON- MULBERRY)**

**Course Outcome:**

- 1 . CO1: Describe biology and lifecycle of non-mulberry silkworms (Eri and Muga).
- 2 . Demonstrate rearing methods, mountage design, and cocoon harvesting techniques.
- 3 . CO3: Identify pests and diseases in silkworm culture and recommend control strategies.
- 4 . CO4: Analyze value chain and product development in non-mulberry sericulture.
- 5 . CO5: Design sustainable models for sericulture-based entrepreneurship.

**THEORY**

**(Credit 2)**

**Unit 1: Introduction**

**5**

Sericulture: Definition, history and present status of Mulberry and Non-Mulberry Sericulture; Varieties of Silk; Types and distribution of non-mulberry or wild sericigenous insects in N-E India

**Unit 2: Biology of Non-mulberry Silkworm:**

**5**

Life cycle of silkworm- Eri and Muga, Structure of silk gland and Nature of Silk

**Unit 3: Rearing of Silkworms**

**8**

(Eri and Muga Silkworm): Food plants of Eri and Muga Silkworm

Rearing Operation: Rearing house/Site and rearing appliances

Disinfectants: Formalin, bleaching powder

Rearing technology: Early age and Late age rearing

Environmental conditions in rearing-Temperature, Humidity, Light and Air Types of mountages

Harvesting and storage of cocoons, Spinning and Reeling of silk

**Unit 4: Pests and Diseases:**

**8**

Pests of eri and muga silkworm, Pathogenes of eri and muga silkworm diseases: Protozoan, viral, fungal and bacterial. Prevention and control measures of pests and diseases

**Unit 5: Entrepreneurship in Non-Mulberry Sericulture:**

**6**

Varieties of Non-Mulberry Silk products and economics in India

Prospectus of Non-Mulberry Sericulture in India: Non-Mulberry Sericulture industry in different states, employment generation and potential

**SUGGESTED READINGS:**

1. Sericulture – C.G. Bansal
2. An Introduction to Sericulture – B.K. Gupta
3. Sericulture and Silk Production – S. Sharma
4. Sericulture and Silk Farming – P. Venkateswarlu
5. The Biology of the Silkworm – M. G. Pandya
6. Textbook of Sericulture – G.V. Reddy
7. Sericulture: Technology and Practice – N. Srivastava

**PRACTICALS****(Credit 1)**

1. Identification of various non mulberry silkworms of different stages.
2. Identification of different pests of silkworm.
3. Study of rearing techniques of non-mulberry silk worm.
4. Reeling and weaving techniques.
5. Identification of silk products.
6. Visit to a sericulture farm and submission of report.

**B.Sc. 3<sup>rd</sup> Semester**  
**Major**  
**Paper: ZOO-MAJ-3.1**  
**PRINCIPLE OF GENETICS**

**Course Outcome:**

1. Apply Mendelian principles and extensions to classical and modern inheritance patterns.
2. Construct linkage and recombination maps from genetic crosses.
3. Explain the molecular basis and types of mutations, and their phenotypic consequences.
4. Evaluate non-Mendelian inheritance, sex determination, and bacterial/viral genetic mechanisms.
5. Analyze the roles of transposable elements in genome evolution and gene regulation.

**THEORY**

**(Credits 3)**

**Unit 1: Mendelian Genetics and its Extension**

**6**

Principles of inheritance, Incomplete dominance and codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex- influenced and sex-limited characters inheritance.

**Unit 2: Linkage, Crossing Over and Chromosomal Mapping**

**10**

Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, Interference and coincidence, Somatic cell hybridization.

**Unit 3: Mutations**

**8**

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

**Unit 4: Sex Determination**

**3**

Chromosomal mechanisms of sex determination in *Drosophila* and Man

**Unit 5: Extra-chromosomal Inheritance**

**5**

Criteria for extra-chromosomal inheritance, Antibiotic resistance in *Chlamydomonas*, Mitochondrial mutations in *Saccharomyces*, Infective heredity in *Paramecium* and Maternal effects

**Unit 6: Polygenic Inheritance**

**2**

Polygenic inheritance with suitable examples; simple numericals based on it.

**Unit 7: Recombination in Bacteria and Viruses****6**

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage

**Unit 8: Transposable Genetic Elements****6**

Transposons in bacteria, Ac-Ds elements in maize and P elements in *Drosophila*, Transposons in humans

**SUGGESTED READINGS:**

1. Principles of Genetics – D. Peter Snustad & Michael J. Simmons
2. Genetics: A Conceptual Approach – Benjamin A. Pierce
3. Genetics – Leland Hartwell, Leslie Hood, Michael Goldberg & Ann Reynolds
4. Genetics: From Genes to Genomes – Leland Hartwell, Leroy Hood, Michael Goldberg, & Ann Reynolds
5. Principles of Genetics – Gardner, Simmons, & Snustad
6. Introduction to Genetics: A Molecular Approach – T.A. Brown
7. Genetics: Analysis and Principles – Robert J. Brooker
8. Genetics: A Molecular Approach – D. Peter Snustad & Michael J. Simmons
9. Genetics: The Continuity of Life – R. J. Brooker
10. Molecular Genetics – Peter J. Russell

**PRACTICALS****(Credit 1)**

1. To study the Mendelian laws and gene interactions.
2. Chi-square analyses using seeds/beads/*Drosophila*.
3. Linkage maps based on data from conjugation, transformation, and transduction.
4. Linkage maps based on data from *Drosophila* crosses.
5. Study of human karyotype (normal and abnormal).
6. Pedigree analysis of some human inherited traits.



**B.Sc. 3<sup>rd</sup> Semester**  
**Major**  
**PAPER: ZOO-MAJ-3.2**  
**CELL BIOLOGY**

**Course Outcome:**

1. Distinguish between cell types and structural components of prokaryotes and eukaryotes.
2. Explain the organization and functions of subcellular organelles.
3. Describe the cytoskeleton's role in intracellular transport and cell division.
4. Analyze cell cycle regulation, checkpoints, and cancer relevance.
5. Interpret cell signaling pathways using molecular examples (e.g., GPCR, cAMP).

**THEORY**

**(Credits 3)**

**Unit 1: Overview of Cells**

**3**

Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions

**Unit 2: Plasma Membrane**

**6**

Various models of plasma membrane structure Transport across membranes: Active and Passive transport, Facilitated transport Cell junctions: Tight junctions, Desmosomes, Gap junctions

**Unit 3: Endomembrane System**

**6**

Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes

**Unit 4: Mitochondria and Peroxisomes**

**6**

Mitochondria: Structure, Semi autonomous nature, Endosymbiotic hypothesis Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis Peroxisomes

**Unit 5: Cytoskeleton**

**6**

Structure and Functions: Microtubules, Microfilaments and Intermediate filaments

**Unit 6: Nucleus**

**8**

Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome)

**Unit 7: Cell Division**

**6**

Mitosis, Meiosis, Cell cycle and its regulation

**Unit 8: Cell Signaling**

**4**

GPCR and Role of secondary messengers

**SUGGESTED READINGS:**

1. Molecular Cell Biology – Harvey Lodish, Arnold Berk, Chris A. Kaiser
2. Cell Biology – Thomas D. Pollard, William C. Earnshaw
3. Essential Cell Biology – Alberts, Bray, Lewis, Raff, Roberts, and Watson
4. Molecular Biology of the Cell – Bruce Alberts
5. Cell and Molecular Biology – Gerald Karp
6. Cell Biology: A Laboratory Handbook – Jack L. Maddox
7. Cell Biology and Genetics – Karp
8. Molecular Cell Biology and Genetics – W. Alberts
9. Principles of Cell Biology – George M. Cooper
10. Cell Biology: A Textbook – Martin W. Howley

**PRACTICALSS****(Credit 1)**

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis
2. Study of various stages of meiosis.
3. Preparation of permanent slide to show the presence of Barrbody in human female blood cells/cheek cells.
4. Preparation of permanent slide to demonstrate:
  - i. DNA by Feulgen reaction
  - ii Mucopolysaccharides by PAS reaction
  - iii Proteins by Mercurio bromophenol blue/Fast Green

**B.Sc. 3<sup>rd</sup> Semester**  
**Major**  
**Paper: ZOO-MIN-3.1**  
**DIVERSITY OF CHORDATES**

**Course Outcome:**

- 1 . Identify distinguishing characteristics of major chordate groups.
- 2 . Discuss adaptations in vertebrate taxa for locomotion, respiration, and reproduction.
- 3 . Explain evolutionary transitions using representative types.
- 4 . Interpret zoogeographical patterns and distribution of vertebrate diversity.
- 5 . Compare vertebrate morphology for ecological and taxonomic classification.

**THEORY** **(Credit 3)**

**Unit 1: Introduction to Chordates** **2**

General characteristics and outline classification

**Unit 2: Protochordata** **6**

General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates.

**Unit 3: Origin of Chordata** **3**

Dipleurula concept and the Echinoderm theory of origin of chordates Advanced features of vertebrates over Protochordata

**Unit 4: Agnatha** **2**

General characteristics and classification of cyclostomes up to class

**Unit 5: Pisces** **6**

General characteristics of Chondrichthyes and Osteichthyes, classification up to order Migration, Osmoregulation.

**Unit 6: Amphibia** **4**

General characteristics and classification up to order; Parental care in Amphibians

**Unit 7: Reptilia** **5**

General characteristics and classification up to order; Poison apparatus and Biting mechanism in snakes

**Unit 8: Aves** **6**

General characteristics and classification up to order. Principles and aerodynamics of flight, Flight adaptations and Migration in birds

### **Unit 9: Mammals**

**6**

General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages

### **Unit 10: Zoogeography**

**6**

Zoo geographical realms, Theories pertaining to distribution of animals, distribution of vertebrates in different realms

### **SUGGESTED READINGS:**

1. Chordate Zoology – P.S. Verma & V.K. Agarwal
2. Vertebrate Zoology – J.Z. Young
3. Animal Diversity – Cleveland P. Hickman, David J. K. & N. G. W.
4. Textbook of Chordate Zoology – R.L. Kotpal
5. Vertebrate Life – F. Harvey Pough, Christine M. Janis, and John B. Heiser
6. Comparative Anatomy of Vertebrates – George C. Kent & Robert K. Carr
7. Chordates and Evolution – Donald E. Berrill
8. Biology of the Vertebrates – L. R. Taylor

### **PRACTICALS**

**(Credit 1)**

**1. Protochordata** Balanoglossus, Herdmania, Branchiostoma, Colonial Urochordata Sections of Balanoglossus through proboscis and branchio genital regions, Sections of Amphioxus through pharyngeal, intestinal and caudal regions. Permanent slide of Herdmania spicules

**2. Agnatha** Petromyzon, Myxine

**3. Fishes** Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon, Anabas, Flat fish

**4. Amphibia** Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandra

**5. Reptilia** Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus Key for Identification of poisonous and non-poisonous snakes

**6. Aves** Study of six common birds from different orders. Types of beaks and claws

**7. Mammalia** Sorex, Bat (Insectivorous and Frugivorous), Funambulus, Loris, Herpestes, Erinaceus. Mount of weberian ossicles of fish Power point presentation on study of any two animals from two different classes by students (may be included if dissections not given permission)

**B.Sc. 3<sup>rd</sup> Semester**  
**SEC**  
**Paper: ZOO-SEC-3.1**  
**ORNAMENTAL FISH AND FISHERIES**

**Course Outcome:**

1. Identify native and exotic ornamental fish species of North East India.
2. Establish and maintain a functional home or commercial aquarium.
3. Formulate diets and breeding strategies for ornamental fish.
4. Evaluate water quality and biological filtration systems.
5. Design micro-entrepreneurial plans for ornamental fish culture.

**THEORY**

**(Credit 2)**

**UNIT 1: Ornamental Fish Diversity**

15

Ornamental Fish Diversity of North East India, Aquarium plant diversity, Natural feed of Ornamental Fish, Feed formulation of Ornamental Fish, Natural Breeding of Tricogaster species

**Unit 2: Ornamental Fish Management**

15

Strategies for maintenance of natural colour of Ornamental Fish Construction and management of Home Aquarium, Health management of Ornamental Fish Development of Biological filtration in Aquarium, Pure culture of planktons

**SUGGESTED READINGS: -**

1. Fish and fisheries of India --Jhingran
2. Ornamental fish culture and Aquarium management -- Dholakia
3. Ornamental fish of India – Archana Sinha

**PRACTICALS**

**(Credit 1)**

1. Identification of Ornamental Fish.
2. Culture of Indigenous ornamental fish in Aquarium.
3. Estimation of Physico-chemical characteristics of Aquarium water.
4. Biological filter for removal of Ammonia from Aquarium.
5. Culture of Planktons.
6. Field visit to fish farm/fishery college/fishery department and report submission.

**B.Sc. 4<sup>th</sup> Semester**  
**MAJOR**  
**Paper: ZOO-MAJ-4.1**  
**ANIMAL TAXONOMY, SYSTEMATICS AND BIOSTATISTICS**

**Course Outcome:**

- 1 . Explain fundamental principles and philosophies of taxonomy and systematics.
- 2 . Apply modern classification techniques including molecular taxonomy and species concepts.
- 3 . Perform scientific preservation and identification using taxonomic keys.
- 4 . Use biostatistics to analyze biological data and draw inferences.
- 5 . Integrate field and lab-based methods for biological data collection and analysis.

**Theory** **(Credit 3)**

**Unit 1- Taxonomy and systematics** **5**

Taxonomy: Introduction, traditional and cladistic taxonomy, stages of taxonomy.

Systematic: Introduction, derivation of term, relationship between taxonomy and systematic.

Newer aspects of Taxonomy: Cytotaxonomy, Chemotaxonomy, molecular taxonomy.

**Unit 2: Zoological classification** **10**

Biological classification, need of classification, advantage of classification, systems of classification: classical taxonomy, artificial taxonomy, natural system of classification. evolutionary classification. Species concept: Nominalistic species concept, typological species concept, phenetic species concept, biological species concept, evolutionary species concept.

**Unit 3: Taxonomic collection** **5**

Importance of collection, method for collecting invertebrates: method for terrestrial habitats, methods for aquatic habitats, Methods for collecting chordates: lower chordates, pisces, amphibian and reptiles, aves, mammalian.

**Unit 4: Preservation techniques and identification** **8**

Fixation and preservation. Preservation for invertebrates: invertebrates killing methods, dry methods of preservation, wet methods of preservation, Preservation of chordates: lower chordates, fish preservation, amphibian, reptiles, bird and mammalian preservation techniques. Identification methods, taxonomic key.

**Unit 5: Zoological nomenclature** **4**

ICZN: Basic concepts, important rule, Historical background of the code. Binomial nomenclature: history, rule of the system, trinomial nomenclature.

### **Unit 6- Concept, importance and application of biostatistics**

**12**

Collection and classification of statistical data. Measures of central tendency. Measures of dispersion- range, quartile deviation, mean deviation, standard deviation, standard error, Coefficient of Variance. Testing of hypothesis. ANOVA, Chi-square test, Student's t- test, Z test

#### **Suggested Readings:**

1. Principles of Animal Taxonomy – Ernst Mayr
2. Systematics and Evolution: Principles and Practice – R. L. F. DeSalle & B. S. L. Seibert
3. Animal Classification and Phylogeny – Richard L. Gregory
4. An Introduction to Animal Systematics – G.G. Simpson
5. Biostatistics- Veerbala Rastogi

#### **PRACTICALS**

**(Credit 1)**

1. Morphometry and meristic study of insect and fish.
2. Identification of distinguish species of insects/ fishes/ amphibian/ reptiles/ birds/ mammals using appropriate taxonomic keys.
3. Preparation, mounting and stuffing of fishes.
4. Collection and preservation of insects using appropriate methods.
5. Calculation of F value for a given set of data.
6. Graphical representation of statistical data using statistical software.
7. Calculation of t- test for given set of data.
8. Field visit to any natural history museum/ Zoo/ National park and preparation of scientific report and submission.

**B.Sc. 4<sup>th</sup> Semester**  
**MAJOR**  
**Paper: ZOO-MAJ-4.2**  
**PRINCIPLE OF ECOLOGY AND EVOLUTION**

**Course Outcome:**

1. Explain ecological principles governing population, community, and ecosystem dynamics.
2. Analyze classical and molecular evidence for evolution and speciation.
3. Apply population genetics to real-world evolutionary scenarios.
4. Describe macroevolutionary events and their significance in vertebrate history.
5. Interpret phylogenetic trees and evolutionary relationships using data tools.

**Theory**

**(Credit 3)**

**Unit 1: Introduction to Ecology**

**3**

History of ecology. Autecology and synecology

**Unit 2: Population**

**10**

Unitary and Modular populations, Unique and group attributes of population: Density, natality, mortality, life tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion Exponential and logistic growth, Population regulation - density-dependent and independent factors Population interactions, Gause's Principle with laboratory and field examples, Community characteristics: species richness, dominance, diversity, abundance, Ecological succession with one example.

**Unit 3: Ecosystem**

**6**

Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids, biogeochemical cycle with one example of Nitrogen cycle,

**Unit 4: Life's Beginnings**

**3**

Origin of photosynthesis, Evolution of eukaryotes. Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism

**Unit 5: Evidences of Evolution**

**8**

Fossil record (types of fossils, transitional forms, geological time scale, Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium; Natural selection, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive



resemblances, sexual selection. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon).

**Unit 6: Product of evolution**

**7**

Micro evolutionary changes (inter-population variations, clines, races, Species concept. Modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches). Extinctions, Background and mass extinctions (causes and effects), detailed example of K-T extinction

**Unit 7: Origin and evolution of man**

**4**

Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from *Dryopithecus* leading to *Homo sapiens*, molecular analysis of human origin

**Unit 8: Phylogeny**

**4**

Phylogenetic trees, multiple sequence alignment, construction of phylogenetic trees, interpretation of trees

**SUGGESTED READINGS:**

1. Futuyma, D. – *Evolutionary Biology*
2. Ridley, M. – *Evolution*
3. Organic Evolution- Veer Bala Rastogi
4. Evolution- Brian K.Hall & Benedict Hallgrimsson
5. Principles of Ecology – Eugene P. Odum & Gary W. Barrett
6. Fundamentals of Ecology – Eugene P. Odum
7. Ecology and Environment- P.D Sharma

**PRACTICALS**

**(Credit 1)**

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon- Weiner diversity index for the same community
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary
5. Study of fossils from models/pictures
6. Study of homology and analogy from suitable specimens
7. Study and verification of Hardy-Weinberg Law by chi square analysis
8. Graphical representation and interpretation of data of height/weight of a sample of 100 humans in relation to their age and sex.
9. Construction of phylogenetic trees.

**B.Sc. 4<sup>th</sup> Semester**  
**MAJOR**  
**PAPER: ZOO-MAJ-4.3**  
**COMPARATIVE ANATOMY OF VERTEBRATES**

**Course Outcome:**

1. Compare vertebrate organ systems with an evolutionary perspective.
2. Interpret functional morphology across representative chordates.
3. Analyze adaptations in vertebrate respiratory, circulatory, and excretory systems.
4. Relate anatomical structures to ecological roles and behavior.
5. Understand vertebrate evolution using anatomical transitions.

**THEORY**

**(Credit 3)**

**Unit 1: Integumentary System:**

**6**

Structure, functions and derivatives of integument

**Unit 2: Skeletal System:**

**8**

Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches

**Unit 3: Digestive System:**

**8**

Alimentary canal and associated glands, dentition

**Unit 4: Respiratory System:**

**8**

Skin, gills, lungs and air sacs; Accessory respiratory organs

**Unit 5: Circulatory System:**

**6**

General plan of circulation, evolution of heart and aortic arches

**Unit 6: Urinogenital System:**

**6**

Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri

**Unit 7: Nervous System:**

Comparative account of brain Autonomic nervous system, Spinal cord, Cranial nerves in mammals

**Unit 8: Sense Organs:**

**6**

Classification of receptors Brief account of visual and auditory receptors in man

**SUGGESTED READINGS:**

1. Kent, G. C., & Carr, R. K. – Comparative Anatomy of the Vertebrates
2. Kardong, K. V. – Vertebrates: Comparative Anatomy, Function, Evolution
3. Modern Text Book of Zoology Vertebrates. - Kotpal,

**PRACTICALS**

**(Credit 1)**

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Disarticulated skeleton of Frog, Fowl, Rabbit
3. Carapace and plastron of turtle/tortoise
4. Mammalian skulls: One herbivorous and one carnivorous animal
5. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted)

**B.Sc. 4<sup>th</sup> Semester**  
**MINOR**  
**Paper: ZOO-MIN-4.1**  
**CELL BIOLOGY AND GENETICS**

**Course Outcome:**

- 1.Distinguish between cell types and structural components of prokaryotes and eukaryotes.
- 2.Explain the organization and functions of subcellular organelles.
- 3.Describe the cytoskeleton's role in intracellular transport and cell division.
- 4.Analyze cell cycle regulation, checkpoints, and cancer relevance.
- 5.Interpret cell signaling pathways using molecular examples (e.g., GPCR, cAMP).
- 6.Laws of inheritances.

**THEORY**

**(Credit 3)**

**Unit 1: Over view of Cells**

**3**

Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions.

**Unit 2: Plasma Membrane**

**5**

Various models of plasma membrane structure Transport across membranes: Active and Passive transport, Facilitated transport

**Unit 3: Endomembrane System**

**4**

Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes

**Unit 4: Mitochondria and Peroxisomes**

**5**

Mitochondria: Structure, Semi-autonomous nature, ETS, Chemi-osmotichypothesis. Peroxisomes

**Unit 6: Nucleus**

**5**

Structure of Nucleus: Nuclear envelope, Nucleolus Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome)

**Unit 7: Cell Division**

**3**

Cell cycle, mitosis and meiosis

**Unit 8: Mendelian Genetics and its Extension**

**7**

Mendelian Principles of inheritance, Incomplete dominance and codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked inheritance.

**Unit 9: Linkage, Crossing Over, Mutations****8**

Linkage and crossing over, Molecular mechanisms of crossing over including models of recombination, Types of gene mutations (Classification), Types of chromosomal aberrations (Classification, figures and with one suitable example of each), genetic disease: causes and types.

**Unit 10: Sex Determination:****4**

Sex determination in various organisms including human.

**SUGGESTED READINGS:**

1. **Molecular Biology of the Cell** – Bruce Alberts
2. **Cell and Molecular Biology** – Gerald Karp
3. **Principles of Genetics** – Gardner, Simmons, & Snustad
4. **Principles of Genetics** – D. Peter Snustad & Michael J. Simmons

**PRACTICALS****(Credit 1)**

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis
2. Study of various stages of meiosis.
3. Preparation of permanent slide to show the presence of Barrbody in human female blood cells/cheek cells.
4. To study the Mendelian laws and gene interactions.
4. Linkage maps based on data from *Drosophila* crosses.
5. Study of human karyotype (normal and abnormal).
6. Pedigree analysis of some human inherited traits.

**B.Sc. 5<sup>th</sup> Semester**  
**MAJOR**  
**Paper: ZOO-MAJ-5.1**  
**ANIMAL PHYSIOLOGY AND HISTOLOGY**

**Course Outcome:**

1. Explain the physiological principles underlying digestion, respiration, circulation, and excretion in vertebrates.
2. Analyze neural transmission, reflexes, and muscle physiology.
3. Interpret the histological structure of tissues and organs in correlation with function.
4. Perform basic physiological measurements and histological staining techniques.
5. Evaluate homeostatic mechanisms and the interdependence of physiological systems.

**THEORY**

**(Credit 3)**

**Unit 1: Physiology of Digestion**

**5**

Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Hormonal control of secretion of enzymes in Gastrointestinal tract.

**Unit 2: Physiology of Respiration**

**5**

Mechanism of respiration, pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Dissociation curves and the factors influencing it

**Unit 3: Renal Physiology**

**5**

Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; counter current mechanism.

**Unit 4: Circulatory system**

**8**

Body fluid and internal transport: Composition of blood, lymph, blood coagulation, Structure of mammalian heart; Origin and conduction of cardiac impulses. Cardiac cycle; Cardiac output and its regulation, nervous and chemical regulation of heart rate. Electrocardiogram, Blood pressure and its regulation

**Unit5: Nervous System**

**5**

Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and non-myelinated nerve fibers; Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc.

**Unit 6: Muscle physiology****5**

Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; summation and tetanus

**Unit 7: Histology****10**

Basic principles of fixation and staining: classification, composition and properties of dye, Use of mordants. Microtomy technique, Structure and function of epithelial, connective, muscular, nervous, cardiac tissues; Histology of liver, pancreas, spleen, lung, kidney of mammal.

**SUGGESTED READINGS:**

1. Guyton & Hall –Textbook of Medical Physiology
2. Sherwood, L. –Human Physiology: From Cells to Systems
3. Bloom & Fawcett –A Textbook of Histology
4. Essentials of Medical Physiology - K. Sembulingam

**PRACTICALS****(Credit 1)**

1. Determination of ABO Blood group
2. Enumeration of red blood cells and white blood cells using haemocytometer
3. Estimation of haemoglobin using Sahli's haemoglobinometer
4. Preparation of haemin crystals
5. Recording of blood pressure using a sphygmomanometer
6. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells.
7. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, nerve cells, intestines, stomach, kidney, liver, testes and ovary.
8. Histological preparation of mammalian tissues: liver, kidney, intestine, spleen and lung

**B.Sc. 5<sup>th</sup> Semester**

**MAJOR**

**Paper: ZOO-MAJ-5.2**

**FUNDAMENTAL OF BIOCHEMISTRY AND METABOLIC PROCESSES**

**Course Outcome:**

1. Describe the structural properties and biochemical functions of macromolecules.
2. Explain the catalytic mechanisms and kinetics of enzymes.
3. Map metabolic pathways, their regulation and energy transduction mechanisms.
4. Correlate metabolic disorders with defects in pathways.
5. Apply biochemical assays and enzyme kinetics methods in laboratory settings.

**THEORY**

**(Credit 3)**

**Unit 1: Carbohydrates**

**5**

Structure and Biological importance: Monosaccharides, Disaccharides. Polysaccharides and Glycoconjugates

**Unit 2: Lipids**

**5**

Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Triacylglycerols, Phospholipids, Glycolipids.

**Unit 3: Protein**

**7**

Amino acids: Structure, Classification and General properties of amino acids; Physiological importance of essential and non-essential amino acids. Proteins: Bonds stabilizing protein structure; Levels of organization in proteins; Denaturation; Introduction to simple and conjugate proteins

**Unit 4: Enzymes**

**7**

Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of  $K_m$  and  $V_{max}$ , Lineweaver- Burk plot;; Regulation of enzyme action.

**Unit 5: Overview of Metabolism**

**4**

Catabolism vs Anabolism, Stages of catabolism, Compartmentalization of metabolic pathways, ATP as "Energy Currency of cell"; coupled reactions; Use of reducing equivalents and cofactors.

**Unit 6: Carbohydrate Metabolism**

**8**

Sequence of reactions and regulation of glycolysis, Citric acid cycle, Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis



**Unit 7: Lipid Metabolism****5**

$\beta$ -oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis

**Unit 8: Protein Metabolism****6**

Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids

**Unit 9: Electron Transport System****5**

Redox systems; Review of mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System, Oxidative phosphorylation

**SUGGESTED READINGS:**

1. Lehninger, A. L. – Principles of Biochemistry
2. Voet & Voet – Biochemistry
3. Satyanarayana & Chakrapani – Biochemistry
4. Molecular Cell Biology – Bruce Alberts

**PRACTICALS****(Credit 1)**

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Detection of amino acids using Ninhydrin test through paper chromatography.
4. Effect of pH, temperature on the action of salivary amylase.
5. Demonstration of protein separation by SDS-PAGE.
6. Estimation of total protein in given solutions by Lowry's method.
7. Quantitative estimation of carbohydrate by Anthrone method.
8. To study the enzymatic activity of pepsin, Trypsin and Lipase
9. Quantitative estimation of cholesterol in animal tissue.

**PAPER: ZOO-MAJ-5.3**  
**ECONOMIC AND APPLIED ZOOLOGY**

**Course Outcome:**

1. Take up various entrepreneurship project for self-sustenance.
2. Culture, rear and propagate economically important fauna for business as well as for conservation.
3. Connect theoretical knowledge with the PRACTICALS application.
4. Expose themselves into the world of various academia-industry interface.

**THEORY**

**(Credit 3)**

**Unit 1: Economic importance of non-chordates**

**5**

Soil protozoa and their role in agriculture, Earthworm and soil improvement, Prawn culture, Pearl culture.

**Unit 2: Applied Entomology**

**20**

**2.1 Apiculture:** Life history of honey bee, colony, nest, caste distinction, 2. Economics of bee keeping.

**2.2 Lac culture:** Enemies of lac, uses of lac; 2. Insect control: Mechanical, Physical, Cultural and Biological control of Pests; 3. Integrated Pest management.

**2.2 Sericulture:** Types of silkworms; Life cycle of Bombyx mori; Structure of silk gland and secretion of silk; Silkworm rearing technology: Early age and Late age rearing, Spinning, harvesting and storage of cocoons; Pests of silkworm: Uzi fly, dermestid beetles and vertebrates; Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial.

**Unit 3: Fish industry & Economic significance of Amphibia and Reptilia**

**20**

**3.1 Fish industry and economy:** Inland Fisheries; Marine Fisheries, Pen and cage culture; Polyculture; Composite fish culture, Integrated fish farming, Induced breeding of fish; Fish diseases: Bacterial, viral, and parasitic, Preservation and processing of harvested fish, Fishery by-products, Indigenous ornamental fishes.

**3.2. Economic importance of Amphibia and Reptilia**

Amphibia as a biological control agent, Snake venom and its uses, Antivenin production.

**Suggested Reading:**

1. **Ganga, G., & Sulochana, C.** – Introduction to Sericulture
2. **Sharma, P. D.** – Applied Entomology
3. **Pillay, T. V. R.** – Aquaculture: Principles and Practices
4. Introduction to Economic Zoology- **Sarkar Kundu Chaki**

**PRACTICALS****(Credit 1)**

1. Study of some important pests of Paddy, Jute, Tea, Cane sugar, vegetables and stored grain pest.
2. Study of the lifecycle of silk worms (Eri, Muga and Mulberry), life history of honey bee
3. Dissection of mouth parts of Honey bee, Sting apparatus of honey bee.
4. Identification of commercially important (10 spp.) and ornamental fishes (5spp.).
5. Identification of Exotic fishes.
6. In vivo demonstration of pituitary gland from commonly found fishes.
7. Maintenance of fresh water aquarium.
8. Field visit to a site of economic importance and report submission.

**B.Sc. 5<sup>th</sup> Semester**  
**MAJOR**  
**Paper: ZOO-MAJ-5.4**  
**IMMUNOLOGY AND ENDOCRINOLOGY**

**Course Outcome:**

1. Explain structural and functional components of innate and adaptive immunity.
2. Describe antigen-antibody interactions and hypersensitivity reactions.
3. Analyze hormone biosynthesis, regulation, and endocrine feedback.
4. Identify immune and endocrine disorders and their mechanisms.
5. Perform immunological assays and hormone tissue identifications.

**Theory**

**(Credits 3)**

**A: IMMUNOLOGY**

**Unit-1: Introduction and Historical Background**

**12**

Cells and Organs of Immune System: Definition, Overview of Immune System- Acquired and innate immunity, Anatomical, Physiological and Inflammatory Barriers. Hematopoiesis - Formation of B-Lymphocytes and T-Lymphocytes. Cells of the Immune System- NK Cells, B-Lymphocytes, T-Lymphocytes, Granulocytic Cells, Dendritic Cells Primary Lymphoid Organs and their Functional Role- Bone Marrow and Thymus. Secondary Lymphoid Organs and Its Functional Role- Lymph Nodes. Spleen. Mucosal-Associated Lymphoid Tissue (MALT), Intraepithelial Lymphocytes [IEL]. Cutaneous-Associated Lymphoid Tissue [CALT]

**Unit-II**

**12**

Antigen and Immunogen, Structure and Function of Immunoglobulins, Structure and Function of MHC: Antigen- Definition and Its Properties; Immunogen- Definition and Its Properties. Antigenicity Vs. Immunogenicity and Factors Affecting It. Haptens and Adjuvants. Basic Structure of Immunoglobulin. Classes of Immunoglobulin and Its Biological Activities. Major Histocompatibility Complex [MHC] Structure.

**Unit-III**

**8**

Interaction of Antigen-Antibody, Immune Effector Mechanism, Allergy and Hypersensitivity and their types.

**B: ENDOCRINOLOGY:**

**Unit IV: Mechanism of Hormone Action**

**6**

Classification, Characteristic and Transport of Hormones, Neuro secretions and Neuro hormones. Hormone action at Cellular level: Hormone receptors, transduction and regulation of Hormone action

#### **Unit V: Hypothalamo-hypophysial Axis**

**6**

Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction. Structure of hypothalamus, Structure of pituitary gland, Hormones and their functions. Hypothalamo- hypophysial portal system, Disorders of pituitary gland.

#### **Unit VI: Peripheral Endocrine Glands**

**6**

Structure, Hormones, Functions and Regulation of Thyroid gland, Parathyroid, Adrenal, Pancreas, Ovary and Testis, Hormones in homeostasis, Disorders of endocrine glands

#### **SUGGESTED READINGS:**

1. Abbas, A. K., & Lichtman, A. H. – Basic Immunology
2. Guyton & Hall – Textbook of Medical Physiology (for Endocrinology)
3. Norris, D. O. – Vertebrate Endocrinology
4. Kuby Immunology – Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Janis Kuby

#### **PRACTICALS**

**(Credit 1)**

1. Study of antigen- antibody reaction through ABO blood grouping.
2. Demonstration of ELISA
3. Study of agglutination reaction.
4. Identification of Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid through permanent slides.
5. Dissect and display of Endocrine glands in laboratory bred rat

**B.Sc. 5<sup>th</sup> Semester**  
**MINOR**  
**Paper: ZOO-MIN-5.1**  
**MOLECULAR BIOLOGY AND EVOLUTION**

**Course Outcome:**

1. Describe structure, replication, and regulation of nucleic acids.
2. Interpret transcription, translation and gene expression in prokaryotes and eukaryotes.
3. Explain post-transcriptional modifications and gene regulatory mechanisms.
4. Analyze population genetics and mechanisms of evolution.
5. Connect molecular processes to evolutionary theory and speciation.

**THEORY**

**Credit 3**

**Unit I: Nucleic Acids**

**5**

Salient features of DNA and RNA, Watson and Crick model of DNA

**Unit II: DNA Replication**

**6**

DNA Replication in prokaryotes and eukaryotes, Semi-conservative model

**Unit III: Transcription**

**6**

RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors

**Unit IV: Translation**

**8**

Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes and eukaryotes: Ribosome structure and assembly in prokaryotes, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis

**Unit V:**

**5**

**Life's Beginnings:** Origin of photosynthesis, Evolution of eukaryotes.

Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism

**Unit VI:**

**8**

**Evidences of Evolution:** Fossil record: types of fossils, transitional forms, geological time scale, Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium

**Unit VII:****6**

**Product of evolution:** Micro evolutionary changes (inter-population variations, clines, races, Species concept. Modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches), Human evolution.

**SUGGESTED READINGS:**

1. Molecular Biology of the Cell – Bruce Alberts
2. Lehninger Principles of Biochemistry – David L. Nelson, Michael M. Cox
3. The Origin of Species – Charles Darwin
4. Organic Evolution- - Veerbala Rastogi
5. Biochemistry- U Satyanarayan
6. Cell and Molecular Biology- Concepts and Experiments by Gerald Karp

**PRACTICALS****(Credit 1)**

1. Study of Polytene chromosomes from Chironomous / Drosophila larvae
2. Quantitative estimation DNA using colorimeter (Diphenylamine reagent)
3. Study and interpretation of electron micrographs/ photograph showing
  - (a) DNA replication
  - (b) Transcription
  - (c) Split genes
4. Study of fossils from models/pictures
5. Study of homology and analogy from suitable specimens
6. Study and verification of Hardy-Weinberg Law by chi square analysis

**B.Sc. 6<sup>th</sup> Semester**  
**MAJOR**  
**Paper: ZOO-MAJ-6.1**  
**MOLECULAR BIOLOGY**

**Course Outcome:**

1. Describe mechanisms of DNA replication, transcription, and translation in prokaryotes and eukaryotes.
2. Analyze post-transcriptional regulation and gene expression control.
3. Explain mechanisms of gene regulation and DNA repair pathways.
4. Evaluate the role of regulatory RNAs in gene silencing.
5. Perform basic molecular biology techniques and interpret gene expression results.

**THERORY**

**Credit 3**

**Unit I: Nucleic Acids:**

**4**

Salient features of DNA and RNA, Watson and Crick model of DNA

**Unit II: DNA Replication**

**8**

DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, Replication of circular and linear *ds*-DNA, Types of DNA repair mechanisms

**Unit III: Transcription**

**8**

RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors

**Unit IV: Translation**

**10**

Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation

**Unit V: Post Transcriptional Modifications and Processing of Eukaryotic RNA**

**6**

Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA, RNA interference, miRNA, siRNA.



## Unit VI: Gene Regulation

8

Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from *lac* operon and *trp* operon; Transcription: regulation in eukaryotes.

### SUGGESTED READINGS:

1. Molecular Biology of the Gene – James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann
2. Molecular Biology of the Cell – Bruce Alberts
3. Molecular Biology: Principles and Practice – Michael M. Cox, Jennifer Doudna, Michael O'Donnell
4. Lehninger Principles of Biochemistry – David L. Nelson, Michael M. Cox

### PRACTICALS

(Credit 1)

1. Study of Polytene chromosomes from Chironomous / *Drosophila* larvae
2. Quantitative estimation DNA using colorimeter (Diphenylamine reagent)
3. Quantitative estimation of RNA using Orcinol reaction
4. Study and interpretation of electron micrographs/ photograph showing
  - (a) DNA replication
  - (b) Transcription
  - (c) Split genes

**B.Sc. 6<sup>th</sup> Semester**  
**MAJOR**  
**Paper: ZOO-MAJ-6.2**  
**WILDLIFE CONSERVATION**

**Course Outcome:**

1. Explain ecological, economic, and ethical bases of wildlife conservation.
2. Conduct habitat and population assessments using field and analytical methods.
3. Interpret conservation laws and frameworks (IUCN, WPA, CBD).
4. Evaluate protected area management, restoration ecology, and biotelemetry.
5. Demonstrate PRACTICALS wildlife monitoring and field documentation techniques.

**THEORY**

**(Credit 3)**

**Unit 1: Introduction to Wild Life**

**4**

Definition, Values of wildlife-positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies.

**Unit 2: Evaluation and management of wild life**

**8**

Habitat analysis, Physical parameters: Topography, Geology, Soil and water; Biological Parameters: food cover, forage, browse and cover estimation; Standard evaluation procedure: remote sensing and GIS.

**Unit 3: Management of habitats**

**8**

Setting back succession; Grazing logging; Mechanical treatment; Advancing the successional process; Cover construction; Preservation of general genetic diversity; Restoration of degraded habitats

**Unit 4: Population estimation**

**8**

Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation; Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, Hair identification, Pug marks and census method.

**Unit 5: Conservation Strategies**

**8**

Strategies for wildlife conservation and management; in-situ and ex-situ conservation; IUCN Red list; wildlife protection act of 1972 and 1991 amendment; Protected areas: Wildlife sanctuaries, National parks, community reserves, biosphere reserves of India with special emphasis to NER; community reserves, Rare and endangered mammalian species of NE India.

## **Unit 6: Management of excess population and Protected areas**

**8**

Bio-telemetry; Care of injured and diseased animal; Quarantine; Common diseases of wild animal

### **SUGGESTED READINGS:**

1. Primack, R. B. – Essentials of Conservation Biology
2. Hunter, M. L. – Fundamentals of Conservation Biology
3. Wildlife Management- S.K. Singh
4. Booklets and reports by Wildlife Institute of India, IUCN publications
- 5.

### **PRACTICALSS**

**(Credit 1)**

1. Identification of mammalian fauna, avian fauna, herpeto-fauna
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses)
3. Familiarization and study of animal evidences in the field; Identification of animals through pugmarks, hoofmarks, scats, pellet groups, nest, antlers etc.
4. Visit to a wildlife sanctuaries/ National parks/ zoological park/ captive breeding center to study behavioral activities of animals and submission of report.

**B.Sc. 6<sup>th</sup> Semester**  
**MAJOR**  
**Paper: ZOO-MAJ-6.3**  
**DEVELOPMENTAL BIOLOGY AND REPRODUCTIVE BIOLOGY**

**Course Outcome:**

- 1 . Describe gametogenesis, fertilization, and early embryonic development in vertebrates.
- 2 . Explain pattern formation, axis specification, and morphogenesis.
- 3 . Discuss hormonal regulation of reproduction and reproductive cycles.
- 4 . Evaluate developmental defects, ARTs, and prenatal diagnostic techniques.
- 5 . Perform comparative analysis of embryonic stages across vertebrate taxa.

**THEORY**

**(Credit 3)**

**Unit1: Historical perspective and basic concepts**

**4**

Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division, concepts of potency, commitment, specification, induction, competence, determination and differentiation, stem cells.

**Unit 2: Gamete biology and fertilisation**

**7**

Gametogenesis: Spermatogenesis, Oogenesis, hormonal control of gametogenesis. Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy

**Unit 3: Early Embryonic Development**

**10**

Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizers

**Unit 4: Late Embryonic Development**

**7**

Formation of Germ Layers in amphibia, chick and mammals; Extra-embryonic membranes; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta).

**Unit 5: Post Embryonic Development**

**10**

Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Aging: Concepts and Theories.

**Unit 6: Implications of Developmental Biology****4**

Teratogenesis: Teratogenic agents and their effects on embryonic development; *In vitro* fertilization, Stem cell (ESC), Amniocentesis

**Unit 7: Reproductive biology****8**

Histology of testis and ovary; Physiology of male and female reproductive system; reproductive ageing, reproductive cycles: estrus and menstrual cycle, pregnancy and fetal development, parturition, lactation. Infertility – causes and management, Assisted Reproductive Technologies

**SUGGESTED READINGS:**

1. Gilbert, S. F. – Developmental Biology
2. Carlson, B. M. – Human Embryology and Developmental Biology
3. Knobil & Neill – Physiology of Reproduction

**PRACTICALS****(Credit 1)**

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: 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: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
3. Study of the developmental stages and life cycle of *Drosophila* from stock culture
4. Study of different sections of placenta (photomicrograph/slides)
5. Project report on *Drosophila* culture/chick embryo development
6. Preparation of histological slides from testis and ovary of insect.
7. Preparation of whole mount of chick embryo of different stages.

**B.Sc. 6<sup>th</sup> Semester**  
**MAJOR**  
**Paper: ZOO-MAJ-6.4**  
**ANIMAL BIOTECHNOLOGY AND INSTRUMENTATION**

**Course Outcome:**

1. : Explain principles of rDNA technology and gene manipulation.
2. Describe transgenic animal models and their applications.
3. Perform and interpret fundamental molecular diagnostics.
4. Operate and understand instrumentation used in biological sciences.
5. Apply biotechnology to animal health, reproduction, and pharmaceuticals.

**THEORY**

**(Credit 3)**

**Unit 1. Introduction**

**4**

Concept and scope of biotechnology

**Unit 2. Molecular Techniques in Gene manipulation**

**12**

Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics). Restriction enzymes: Nomenclature, detailed study of Type II . Transformation techniques: Calcium chloride method and electroporation. Construction of genomic and cDNA libraries and screening by colony and plaque hybridization Southern, Northern and Western blotting DNA sequencing: Sanger method. Polymerase Chain Reaction, DNA Fingerprinting

**Unit 3. Genetically Modified Organisms**

**10**

Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection. Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knock out mice. Production of transgenic plants: *Agrobacterium* mediated transformation. Applications of transgenic plants: insect and herbicide resistant plants.

**Unit 4. Culture Techniques and Applications**

**7**

Animal cell culture, expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia) Recombinant DNA in medicines: Recombinant insulin and human growth hormone, Gene therapy

**Unit 5: Microscopy**

**5**

Principles and applications of bright field, dark field, phase contrast, Fluorescence, confocal and electron microscopes

**Unit 6: Tracer techniques** **4**

Principles and application of tracer techniques- autoradiography and radio immunoassay.

**Unit 7: Immunological techniques** **4**

Immunodiffusion, Immunoelectrophoresis, Enzyme linked Immuno-absorbant assay (ELISA).

**Unit 8: Centrifugation** **4**

Density gradient and unit gravity centrifugation, tissue processing and Separation of various sub-cellular organelles by centrifugation

**Unit 9: Chromatography Techniques** **4**

Thin layer chromatography, Ion-Exchange, Absorption, partition, gel filtration and affinity chromatography, and HPLC.

**SUGGESTED READINGS:**

1. Brown, T. A. – Gene Cloning and DNA Analysis
2. Sambrook & Russell – Molecular Cloning: A Laboratory Manual
3. Wilson & Walker – Principles and Techniques of Biochemistry and Molecular Biology

**PRACTICALS**

**(Credit 1)**

1. DNA isolation from animal tissue
2. Demonstration of Restriction digestion of plasmid DNA.
4. Construction of circular and linear restriction map from the data provided.
5. Calculation of transformation efficiency from the data provided.
6. To study following techniques through photographs
  - a. Southern Blotting
  - b. Northern Blotting
  - c. Western Blotting
  - d. DNA Sequencing (Sanger's Method)
  - e. PCR
7. Separation of biomolecules by centrifugation.
8. Separation of amino acids by paper and thin layer chromatography.

**B.Sc. 6<sup>th</sup> Semester**  
**MINOR**  
**Paper: ZOO-MIN-6.1**  
**FUNDAMENTAL OF BIOCHEMISTRY AND INSTRUMENTATION**

**Course Outcome:**

1. Explain the biochemical structure and role of macromolecules.
2. Interpret enzyme catalysis and metabolic pathways.
3. Describe principles of optical, electrical, and chromatographic instrumentation.
4. Apply biochemical and instrumental methods for molecular analysis.
5. Use immunological and chromatographic techniques in PRACTICALS contexts.

**THEORY**

**Credit 3**

**Unit1: Carbohydrates**

**6**

Structure and Biological importance: Monosaccharides, Disaccharides. Polysaccharides and Glycoconjugates

**Unit2: Lipids**

**6**

Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Triacylglycerols, Phospholipids,

**Unit3: Protein**

**8**

Amino acids: Structure, Classification and General properties of amino acids; Physiological importance of essential and non-essential amino acids. Proteins: Bonds stabilizing protein structure; Levels of organization in proteins;

**Unit4: Enzymes**

**8**

Nomenclature and classification; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of  $K_m$  and  $V_{max}$ ,

**Unit 5: Microscopy**

**6**

Principles and applications of bright field, dark field, phase contrast, and electron Microscopy.

**Unit 6: Immunological techniques**

**6**

Immunodiffusion, Immunoelectrophoresis, Enzyme linked Immuno-absorbant assay (ELISA).



**Unit 7: Centrifugation****6**

Density gradient and unit gravity centrifugation, tissue processing and Separation of various sub-cellular organelles by centrifugation

**Unit 8: Molecular separation Techniques****6**

Ion-Exchange, Absorption, gel filtration and affinity chromatography, and HPLC.

**SUGGESTED READINGS:**

1. Lehninger Principles of Biochemistry – David L. Nelson, Michael M. Cox
2. Molecular Biology of the Cell – Bruce Alberts
3. Textbook of Biochemistry for Medical Students – D.M. Vasudevan, S. S. Sreekumari
4. Principles of Instrumental Analysis – Douglas A. Skoog, F. J. Holler, Timothy A. Nieman

**PRACTICALS****Credit 1**

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Paper chromatography of amino acids.
3. Action of salivary amylase under optimum conditions.
4. Separation of biomolecules by centrifugation.
5. Quantitative estimation of carbohydrate and protein.

**B.Sc. 7<sup>th</sup> SEM**  
**MAJOR**  
**PAPER 7.1**  
**APPLIED IMMUNOLOGY**

**Course Outcome:**

1. Describe immune responses in infectious diseases.
2. Explain autoimmune diseases, immune cancer biology, and vaccine technology.
3. Operate core immunoassays and clinical diagnostics.
4. Analyze principles of transplantation immunology.
5. Design immunotechniques in diagnostics and biotechnology.

**THEORY**

**Credit 3**

**Unit –I**

**12**

**Immune Response to Infectious Diseases**

Mechanism of Immune Response During: Viral Infections [Influenza, HIV]. Bacterial Infections [Corynebacteria and Mycobacterium] Protozoan Infection [Plasmodium, Trypanosoma and Leishmania]. Helminthes Infections [Ascaris and Schistosoma].

**Unit- II**

**12**

**Disease of Immune System and Vaccines**

Mechanism of Autoimmune Diseases- Systematic Lupus Erythromatous (SLE). Myasthenia Gravis, Rheumatoid Arthritis. Cancer of Blood Cells Lymphoma and Leukemia (Hodgkin and Non-Hodgkin), Apoptotic pathways and necrosis, Vaccines, Historical Background and its types Production of Monoclonal Antibodies

**Unit – III**

**12**

**Immunotechnology**

Separation of Immune Cells by Flow cytometry [FACS]: Its Principle and Application Principle and Application of Immunoprecipitation. Application of in-Situ Hybridization Technology-FISH [Fluorescence In-Situ Hybridization) and GISH [Genome in-Situ Hybridization]. Principle, Methodology and Application of Following Techniques- ELISA (Enzyme Linked Immunosorbent Assay]. RIA [Radio Immuno Assay]. Western Blotting. Allergy Evaluation: Principle and Methodology of Skin Prick Test for Allergy

**Unit – IV**

**12**

**Transplantation Immunology**

Transplantation- History, Graft Vs. Host Rejection Studies for Specific Transplantation L.E Skin Graft, Kidney, Liver and Heart With Reference to Hyperacute, Acute and Chronic Rejection and Its Mechanism. Immunosuppression- Definition. Drugs Used for Immunosuppression and Its Mechanism of Action. Xenotransplantation- Definition and Its Application. HLA Phenotyping. Lymphoproliferation Assay, Its Working Principle and Applications. Blood Groups- MN, ABO Blood Group and Blood Transfusion.

### **SUGGESTED READINGS:**

1. Abbas, A. K., & Lichtman, A. H. – Basic Immunology
2. Kuby Immunology – Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Janis Kuby

### **PRACTICALS**

**Credit 1**

1. RBC count and Total WBC count.
2. WBC Differential count.
3. Erythrocyte Sedimentation Rate (ESR).
4. Packed Cell Volume (PCV).
5. Estimation of Haemoglobin (Hb).
6. Immunodiffusion.
7. Single Radial Immunodiffusion.
8. Immunoelectrophoresis.
9. Detection of HCG by latex agglutination inhibition test.
10. Haemagglutination tests for identification of human blood groups.
11. Demonstration of RIA and ELISA

**B.Sc. 7<sup>th</sup> SEM**  
**MAJOR**  
**PAPER 7.2**  
**COMPUTATIONAL BIOLOGY AND BIOINFORMATICS**

**Course Outcome:**

1. Access and interpret biological databases.
2. Perform sequence alignment and gene annotation.
3. Use tools like BLAST, Clustal, and MEGA for phylogenetics.
4. Apply computational tools to genomics and proteomics.

**THEORY**

**Credit 3**

**Unit 1: Introduction to Bioinformatics**

**5**

Importance, Goal, Scope; Genomics, Transcriptomics, Systems Biology, Functional Genomics, Metabolomics, Molecular Phylogeny; Applications and Limitations of Bioinformatics

**Unit 2: Biological Databases:**

**10**

Introduction to biological databases; Primary, secondary and composite databases; Nucleic acid databases (GenBank, DDBJ, EMBL and NDB); Protein databases (PIR, SWISS-PROT, TrEMBL, PDB); Metabolic pathway database (KEGG, EcoCyc, and MetaCyc); Small molecule databases (PubChem, Drug Bank, ZINC, CSD)

**Unit 3: Data Generation and Data Retrieval:**

**13**

Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)

**Unit 4: Basic Concepts of Sequence Alignment:**

**13**

Scoring Matrices (PAM, BLOSUM), Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Local and global alignment, pair wise and multiple sequence alignments; Similarity, identity and homology of sequences.

**Unit 5: Applications of Bioinformatics**

**7**

Structural Bioinformatics (3-D protein, PDB), Functional genomics (genome- wide and high throughput approaches to gene and protein function), Receptor-Ligand interaction and protein-protein interaction , Drug discovery method (Basic concepts),

**SUGGESTED READINGS:**

1. Xiong J. Essential Bioinformatics. Cambridge University Press; 2006 Mar 13.
2. Lesk, Arthur M. Introduction to Bioinformatics. Oxford University Press, 2018.
3. Claverie JM, Notredame C. Bioinformatics for dummies. John Wiley & Sons; 2006 Dec 18.
4. Sinha PK, Sinha P. Computer fundamentals. BPB publications; 2010.
5. Brookshear JG. Computer science: An overview. Benjamin-Cummings Publishing Co., Inc.; 1991 Jan 3.

**PRACTICALS****(Credit 1)**

1. Accessing biological databases
2. Retrieval of nucleotide and protein sequences from the databases.
3. Demonstration of Receptor-ligand interaction
4. To perform pair-wise alignment of sequences (BLAST) and interpret the output
5. Predict the structure of protein from its amino acid sequence.
6. Construction of Phylogenetic tree using PHYLIP/MEGA, etc

**B.Sc. 7<sup>th</sup> SEM**  
**MAJOR**  
**PAPER 7.3**  
**ANIMAL BEHAVIOR**

**Course Outcome:**

1. Explain mechanisms behind instinctive and learned behaviours.
2. Discuss neuroethology, communication, and motivational systems.
3. Examine social structures, altruism, and reproductive strategies.
4. Evaluate evolutionary context of behaviour.
5. Design behavioural experiments and interpret outcomes.

**THEORY**

**Credit 3**

**Unit-I**

**25**

1. Patterns of animal behavior, Objectives and mechanism of behaviours. b. Types of reflexes, characteristics of reflexes and complex behaviour. c. Orientation: Primary and Secondary Orientation, Sun-Compass Orientation. d. Kinesis: Orthokinesis and Klinokinesis. e. Taxis: Different kind of taxis.
2. Development of behaviour: Genetic basis of behaviour, Hormone brain relationship
3. Neural basis of behaviour: Key stimuli, Stimulus filtering, Supernormal stimuli, Open and closed IRM, Biological rhythms.
4. Learning Definition, Types of learning, Neural mechanism of learning
5. Communication: Types of communications-Auditory communication; Infrasound communication among Elephants and Whales; Sonar, Navigation, and communications; Vocalization in nonhuman primates; Echolocation in Bats; Visual communication; Chemical signals; Functions of scent in vertebrates; Tactile communications.

**Unit-II**

**20**

1. Motivational system: Physiological basis of motivation, control of hunger drive and thirst drive in animals. Motivational conflict and decision making, displacement activity, models of motivation, measuring motivation, hormones and pheromones influencing behaviour of animals.
2. Sociobiology: Units of Sociobiology; major social behaviours; Altruism: Reciprocal altruism, group selection, kin selection and concept of inclusive fitness, cooperation, /reciprocation; Selfishness; Eusociality.
3. Reproductive strategies: Sexual selection, intrasexual selection (male rivalry), intersexual selection (female choice), infanticide, mate guarding.
4. Parental Behaviour: Care before birth; Care after birth; Early parental care; Types of parental care; Factors affecting parental care; Care and attachment; Parent offspring

**SUGGESTED READINGS:**

1. Alcock. Animal Behaviour- An Evolutionary Approach (7thed.) Sinaur Associates, Inc.2001
2. Drickamer & Vessey. Animal Behaviour Concepts, Processes and Methods (2nd ed.), Wadsworth, 1986.
3. Jonathan Ross. The Princeton Guide to Evolution. 2014. Princeton University Press
4. Bergstrom, CT and Dugatkin, LA. Evolution (1ed). 2012.
5. McFarland, D. Animal Behaviour. 1999. Addison Wesley Longman Limited
6. Circadian Physiology 3rd Edition by Roberto Refinetti, PhD. Copyright 2016, Taylor and Francis.

**PRACTICALS****Credit 1**

1. Activity budgeting of bird/mammal
2. Effect of toxicant on opercular movement and surfacing in fish.
3. Effect of toxicant on movement of fish.
4. Habituation experiment using earthworms or insects
5. Recording the activity pattern of mice/insects under controlled light-dark cycles
6. Ant trail following experiment
7. To study geotaxis behavior of earthworms

**B.Sc. 7<sup>th</sup> SEM**  
**MAJOR**  
**PAPER 7.4**  
**ENVIRONMENTAL SCIENCE and CLIMATE CHANGE**

**Course Outcome:**

- 1 . Understanding Environmental Issues and Biodiversity Management
- 2 . Explaining Global Environmental Concerns and Biogeochemical Cycles
- 3 . Evaluating Human Impact and Environmental Assessment Tools
- 4 . Understanding Environmental Policies and Legislations
- 5 . Promoting Sustainable Development and Community Participation

**THEORY**

**CREDITS 3**

- UNIT 1.** Environmental issues and biodiversity management approaches. **6**
- UNIT 2.** Environmental concerns: Climate change, global warming, greenhouse effect, and environmental pollution, Ozone layer depletion, and Acid rain. **6**
- UNIT 3.** Biogeochemical cycles: carbon, nitrogen, and Sulphur cycles; impact of human activity on nutrient cycles. **6**
- UNIT 4.** Human and Environment: Anthropogenic Impact on Environment, Environmental Impact assessment, biodiversity, global economy, and agriculture. **6**
- UNIT 5.** Environmental monitoring and Policies: International agreements and programs: Earth Summit, UNFCCC, Montreal and Kyoto protocols, Convention on Biological Diversity (CBD), Ramsar convention, The Chemical Weapons Convention (CWC), UNEP, CITES, etc. **6**
- UNIT 6:** Environment legislation in India: Wildlife Protection Act, 1972; Water (Prevention and Control of Pollution) Act, 1974; Forest (Conservation) Act 1980; Air (Prevention & Control of Pollution) Act, 1981; Environment Protection Act, 1986; Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 **6**
- UNIT 7.** Major drivers of biodiversity changes in environment and principles of biodiversity **6**
- UNIT 8:** Urbanization and environment: Impact of industry and technology on environment; urban sprawl, traffic congestion and social-economic problems; conflict between economic and environmental interests. **6**



**UNIT 9:** Community participation: State, corporate, civil society, community, and individual-level initiatives to ensure sustainable development; case studies of environmental movements (Appiko Movement, Chipko Movement, Narmada Bachao Andolan), environmental education and awareness.) **6**

### **SUGGESTED READINGS:**

1. Suraj Mal, R.B. Singh, Christian Huggel, Editors. Climate Change, Extreme Events and Disaster Risk Reduction, Towards Sustainable Development Goals. Book · Springer International Publishing AG 2018.
2. Joachim Monkelbaan. Governance for the Sustainable Development Goals, Book · Springer International Publishing, Nature Singapore Pte Ltd, 2019.
3. Climate and Global Environmental Change by L.D. Danny Harvey, Prentice Hall publication
4. Climate Change- An Indian Perspective by S.K. Das, Foundation books
5. Global Warming- A very short introduction by Mark Maslin, Oxford publication.

### **PRACTICALS**

**(Credits 1)**

1. Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
2. Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.
3. Collect climate data (temperature, precipitation, etc.) for your region analyze trends, seasonal variations, and anomalies.
4. Youth participation and engagement activities for awareness towards sustainable development and Climate change

**B.Sc. 7<sup>th</sup> SEM MINOR**  
**PAPER- 7.1**  
**RESEARCH METHODOLOGY**

**Course Outcome:**

1. Understand research paradigms and design methodologies.
2. Formulate hypotheses and identify appropriate statistical tools.
3. Perform sampling and data analysis.
4. Interpret scientific data and publish ethically.
5. Apply project planning, literature review, and citation tools.

**THEORY**

**Credit 3**

**1. Foundations of Research**

**4**

Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method Understanding the language of Research Concept, Construct. Definition, Variable. Research Process.

**2. Problem Identification & Formulation**

**4**

Question Measurement Issues - Hypothesis - Qualities of a good Hypothesis- Research Question – Investigation. Null Hypothesis & Alternative Hypothesis. Hypothesis Testing Logic & Importance.

**3. Research Design**

**5**

Concept and Importance in Research - Features of a good research design - Exploratory Research Design - concept, types and uses. Descriptive Research Designs - concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

**4. Qualitative and Quantitative Research**

**5**

Qualitative research – Quantitative research - Concept of measurement, causality, generalization, replication. Merging the two approaches.

**5. Measurement**

**5**

Concept of measurement- what is measurement? Problems in measurement in research- Validity and Reliability. Levels of measurement- Nominal, Ordinal, Interval, Ratio.

**6. Statistical Analysis**

**5**

Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error. Sample Size. Non-Response. Characteristics of a good sample. Probability Sample- Simple Random

Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling.  
Determining size of the sample- PRACTICALS considerations in sampling and sample size.

**7. Data Analysis 5**

Data Preparation Univariate analysis (frequency tables, bar charts, pie charts, percentages),  
Bivariate analysis- Cross tabulations and Chi-square test including testing hypothesis of  
association.

**8. Interpretation of Data and Paper Writing- 5**

Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals. When  
and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

**9. Use of Encyclopedias, Research Guides, Handbook etc. Academic Databases Computer  
Science Discipline. 3**

**10. Use of tools and techniques for research 5**

Method to search required information effectively, reference management software like  
Zotero/ Mendeley, software for paper formatting like LaTeX/ MS office, software for  
detection of plagiarism.

**SUGGESTED READINGS:**

1. Kothari, C. R. – Research Methodology: Methods and Techniques
2. Creswell, J. W. – Research Design: Qualitative, Quantitative, and Mixed Methods Approaches
3. Kumar, R. – Research Methodology: A Step-by-Step Guide for Beginners
4. Day, R. A. & Gastel, B. – How to Write and Publish a Scientific Paper

**RESEARCH METHODOLOGY PRACTICALS**

**(Credit 1)**

1. Assignment
2. Preparation of a research paper.

**BSC 8<sup>TH</sup> SEM**  
**MAJOR**  
**PAPER 8.1**  
**GENERAL ICHTHYOLOGY**

**Course Outcome:**

1. Classify fish based on taxonomy and morphological criteria.
2. Explain physiology of respiration, osmoregulation, and locomotion.
3. Assess conservation strategies for freshwater and marine fish.
4. Describe fish adaptations in different habitats.
5. Evaluate fish biodiversity of NE India.

**THEORY**

**Credit 3**

**Unit I**

**10**

Classification of Fishes, Systematic Position. Habit and Habitat, Morphology. Distribution, Significance and Affinities of Holocephali and Dipnoi. Fins, Their Origin and Evolution, Locomotion in Fishes. Histomorphology and Elementary Physiology (A) Digestive System (With Particular Reference to Food and Feeding Habits of Freshwater Fishes) (B) Excretory System (With Particular Reference to Acid Base Balance and Osmoregulation) (C) Accessory Respiratory Organs in Fishes.

**Unit II**

**10**

General Survey of the Marine, Estuarine and Inland Capture Fisheries of India with Particular Reference to Fishery Resources of NE India. Methods of Fishing: Fishing Gears and Crafts. Cold Water Fishery Sewage-Fed Fishery and Shell-Fish Fishery. Nutrition and Growth Including Age and Growth Relationship, Chemical Composition of Fish Flesh, Length-Weight Relationship, Natural Food and Artificial Feed and Their Role in Fish Culture. Plankton and Benthos in Relation to Fish Production

**Unit III**

**14**

Electric Organs in Fishes. Brief Knowledge of Sexual Dimorphism, Courtship and Parental Care. Migratory Instincts, Hill Stream Adaptations Reproduction in a Major Carps- Structure of Gonad, Spawning. Early Development and Metamorphosis. Microscopic Structure and Hormonal Functions of The Following Endocrine Glands: Pituitary. Thyroid, Pancreas, Adrenal. Corpuscles Of Stannins, Ultimobranchial Glands, Caudal Neurosecretory System and Sex Hormones. Current Trends in Induced Breeding in Fishes.

**Unit IV**

**8**

Brief Knowledge of Sense Organs: Organs of Smell, Eyes, Hearing. Ampolla of

Lorenzen, Bio-Luminescence, Sound Production and Lateral Line System.  
Parental Care in Fishes. Venomous and Non-Venomous Fishes. Fish Pheromones. Coloration in Fishes.

### **SUGGESTED READINGS:**

1. Fishes: an introduction to ichthyology: Moyle, Peter B
2. Fish Physiology. W. S. Hoar and D. J. Randall, Eds. Vol. 1
3. The Ecology of Fishes - by G. V. Nikolsky

### **PRACTICALS**

**(Credit 1)**

1. Classification, identification and description of
  - a. Ornamental freshwater fish
  - b. Ornamental marine fishes
  - c. Ornamental organism used in the aquarium
2. Construction and maintenance of home aquarium.
3. Water quality management through testing kits. Disease diagnostic and management.
4. Dissection and display of cranial, arterial system, pituitary gland and internal ear of fishes.

**BSC 8<sup>TH</sup> SEM  
MAJOR  
PAPER 8.2  
RESEARCH METHODOLOGY**

**Course Outcome:**

1. Conduct independent scientific investigations.
2. Apply appropriate quantitative and qualitative methods.
3. Interpret peer-reviewed data and synthesize literature.
4. Write research proposals and plan thesis work.
5. Present research through posters, seminars, or publication.

**THEORY**

**(Credit 3)**

**1. Foundations of Research**

**4**

Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method Understanding the language of Research Concept, Construct. Definition, Variable. Research Process.

**2. Problem Identification & Formulation**

**4**

Question Measurement Issues - Hypothesis - Qualities of a good Hypothesis- Research Question – Investigation. Null Hypothesis & Alternative Hypothesis. Hypothesis Testing Logic & Importance.

**3. Research Design**

**5**

Concept and Importance in Research - Features of a good research design - Exploratory Research Design - concept, types and uses. Descriptive Research Designs - concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

**4. Qualitative and Quantitative Research**

**5**

Qualitative research – Quantitative research - Concept of measurement, causality, generalization, replication. Merging the two approaches.

**5. Measurement**

**5**

Concept of measurement- what is measurement? Problems in measurement in research- Validity and Reliability. Levels of measurement- Nominal, Ordinal, Interval, Ratio.

**6. Statistical Analysis**

**5**

Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error. Sample Size. Non-Response. Characteristics of a good sample. Probability Sample- Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample- PRACTICALS considerations in sampling and sample size.

**7. Data Analysis 5**

Data Preparation Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis- Cross tabulations and Chi-square test including testing hypothesis of association.

**8. Interpretation of Data and Paper Writing 5**

Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals. When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

**9. Use of Encyclopedias, Research Guides, Handbook etc.. Academic Databases Computer Science Discipline. 3**

**10. Use of tools and techniques for research 5**

Method to search required information effectively, reference management software like Zotero/ Mendeley, software for paper formatting like LaTeX/ MS office, software for detection of plagiarism.

**SUGGESTED READINGS:**

5. Kothari, C. R. – Research Methodology: Methods and Techniques
6. Creswell, J. W. – Research Design: Qualitative, Quantitative, and Mixed Methods Approaches
7. Kumar, R. – Research Methodology: A Step-by-Step Guide for Beginners
8. Day, R. A. & Gastel, B. – How to Write and Publish a Scientific Paper

**RESEARCH METHODOLOGY PRACTICALS**

**(Credit 1)**

3. Assignment
4. Preparation of a research paper.

**B.Sc. 8<sup>th</sup> SEM**  
**MAJOR**  
**PAPER 8.3**  
**ANIMAL CELL CULTURE AND GENETIC ENGINEERING**  
**(Optional)**

**Course Outcome:**

1. Explain principles and protocols in mammalian cell culture.
2. Operate and maintain aseptic techniques.
3. Design vectors for gene manipulation and expression.
4. Understand gene therapy and recombinant technology.
5. Perform diagnostics using genetically engineered products.

**THEORY**

**(Credit 3)**

**UNIT 1**

**25**

1. Cell culture: Basic techniques of cell culture. Development of primary cell cultures; cell separation, harvesting and maintenance of cell lines; Transformation and differentiation of cell cultures, types of cell culture: monolayer, suspension, clonal and stem cell culture, cryopreservation cell lines.
2. Cell culture Media: Primary and established cell line cultures; Media supplements- their metabolic functions; Serum and protein-free defined media and their applications.
3. Measurement of viability and parameters of growth. Cell cycle analysis and synchronization of cultures; Assessment of cell culture contaminants, safety parameters.
4. Cell culture Bioassays: Cell proliferation assays

**UNIT 2:**

**20**

5. Automated sequencing methods; Sanger's dideoxynucleotide method; Shotgun DNA DNA sequencing method; Polymerase chain reaction and its advantages.



6. DNA polymorphism: Basis of DNA typing/fingerprinting; Expressed sequence tags and their use for developing STSs, SSRs and SNPs
7. Basic biology of cloning vectors: plasmids, phages, single stranded DNA vectors, high capacity vectors, retroviral vectors, expression vectors, and other advanced vectors in use; genomic library and cDNA library
8. RNA interference: History, molecular mechanisms and applications of antisense RNA, microRNA, siRNA, and ribozymes.
9. Gene and somatic cloning techniques
10. Transgenic technology-animals as bioreactors

### **SUGGESTED READINGS:**

1. Freshney, R. I. – Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications
2. Brown, T. A. – Gene Cloning and DNA Analysis: An Introduction
3. Glick, B. R., & Patten, C. L. – Molecular Biotechnology: Principles and Applications of Recombinant DNA
4. Watson, J. D. et al. – Recombinant DNA: Genes and Genomes – A Short Course

### **PRACTICALS**

**(Credit 1)**

1. Isolation of genomic DNA from mammalian tissue.
2. Restriction-digestion of DNA sample and separation of fragments by performing agarose gel electrophoresis. Interpretation of the results by comparing with the standard digests.
3. MTT cell proliferation assay, cell viability assay.
4. Separation of biomolecules by centrifugation.
5. Separation of amino acids by paper and thin layer chromatography.
6. To study following techniques through photographs
  - a. Southern Blotting
  - b. Northern Blotting
  - c. Western Blotting
  - d. DNA Sequencing (Sanger's Method)
7. Visit to an animal cell culture lab and report submission.

**BSC 8 SEM  
MAJOR  
PAPER 8.4  
EVOLUTION AND CHRONOBIOLOGY  
(Optional)**

**Course Outcome:**

1. Describe evolutionary mechanisms including molecular evolution.
2. Analyze phylogenetic relationships and evolutionary clocks.
3. Explain biological rhythms and their genetic basis.
4. Discuss chronobiology in health, ecology, and development.
5. Link evolution with genomics and speciation.

**THEORY**

**(Credit 3)**

**UNIT 1:**

**24**

1. Theories of organic evolution, Prebiotic molecules (Amino acid and Nucleic acid bases).
2. Evolution of Prokaryotes and Eukaryotes.
3. Origin of life: Modern theories, Changes in hereditary instructions in relation to evolution.
4. Notion of selectively neutral mutations, evolutionary gene duplication, the founder principle, bottleneck effect of genetic drift.
5. Evolutionary history of natural integration, evolution of man.
6. Factors and forces of evolution: Mutation, Genetic variation, Isolation mechanisms and their role in speciation.
7. Emergence of the theory of Neo-Darwinism.
8. Molecular evolution: Concept of neutral evolution (Kimura), molecular divergence and molecular clock, molecular tools in phylogeny, classification and identification, Origin of new genes and proteins, gene duplication and divergence

**UNIT 2:**

**24**

1. Biological clocks
2. Significance of Biological time keeping

3. Biological rhythms: Types of rhythms- Circadian, Circatidal, Circalunar, Circannual; Centres of biological rhythms- Suprachiasmatic nuclei, Pineal gland, Optic lobes; Factors influencing biological rhythms- Environmental, Photoperiod, Temperature, Other Zeitgebers.
4. Methods of measurement: Entrainment, Re-entrainment, Phase angle difference, Free run, Phase shift, Phase response curve, Arrhythmia.
5. Molecular bases of circadian rhythms: Clock genes: Drosophila and Mouse.
6. Applied Chronobiology: Human circadian rhythms, Application of circadian rhythms and principles; Jet-lag/shift work; Depression and sleep disorders; Chronopharmacology and Chronotherapy.

## **PRACTICALS**

**(Credit 1)**

1. Study of Hardy-Weinberg equilibrium in human population by taking the example of blood group system (ABO).
2. Use of search engines like Scopus, Science Direct for reference material collection management.
3. Data mining for sequence analysis
4. Web based tools for sequence searches and homology screening
5. Construction for phylogenetic trees for proteins using UPGMA or Neighbor joining method.
6. Reproduction of the same phylogeny using MEGA software for the given set of sequences
7. Observing Daily Locomotor Activity of fish/ insect
8. Food-Entrainment and Anticipatory Activity in fish.

**B.SC. 8<sup>TH</sup> SEM**  
**MINOR**  
**PAPER-8.1**  
**COMPUTATIONAL BIOLOGY**

**Course Outcome:**

1. Retrieve, manage, and analyze biological data computationally.
2. Perform protein structure prediction and domain analysis.
3. Construct and interpret phylogenetic trees.
4. Conduct statistical tests on biological datasets.
5. Employ bioinformatics tools in genomics/proteomics.

**THEORY**

**(Credit 3)**

**Unit 1: Introduction to Bioinformatics**

**5**

Importance, Goal, Scope; Genomics, Transcriptomics, Systems Biology, Functional Genomics, Metabolomics, Molecular Phylogeny; Applications and Limitations of Bioinformatics

**Unit 2: Biological Databases**

**10**

Introduction to biological databases; Primary, secondary and composite databases; Nucleic acid databases (GenBank, DDBJ, EMBL and NDB); Protein databases (PIR, SWISS-PROT, TrEMBL, PDB); Metabolic pathway database (KEGG, EcoCyc, and MetaCyc); Small molecule databases (PubChem, Drug Bank, ZINC, CSD)

**Unit 3: Data Generation and Data Retrieval**

**12**

Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)

**Unit 4: Basic Concepts of Sequence Alignment**

**12**

Scoring Matrices (PAM, BLOSUM), Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Local and global alignment, pair wise and multiple sequence alignments; Similarity, identity and homology of sequences.

**Unit 5: Applications of Bioinformatics**

**6**

Structural Bioinformatics (3-D protein, PDB), Functional genomics (genome- wide and high throughput approaches to gene and protein function), Drug discovery method (Basic concepts)

**PRACTICALS****(Credit 1)**

1. Accessing biological databases
2. Retrieval of nucleotide and protein sequences from the databases.
3. To perform pair-wise alignment of sequences (BLAST) and interpret the output
4. Predict the structure of protein from its amino acid sequence.
5. Construction of phylogenetic tree.