M.Sc. ZOOLOGY PAPER CODE & PAPER TITLE

SEMESTER - I

Paper Code	Title of the Paper
Z/FS 101	Biosystematics, Biodiversity and Taxonomy
Z/FS 102	Biostatistics and Bioinformatics
Z/FS 103	Tools and Techniques for Biology
Z/FS 104	Molecular Cell Biology
Z/FS 101 - 104	Practicals for all theory papers

SEMESTER - II

Paper Code	Title of the Paper
Z/FS 105	Immunology
Z/FS 106	General and Comparative Physiology
Z/FS 107	Molecular Biology
Z/FS 108	Biomolecules
Z/FS 105 – 108	Practical's for all theory papers

SEMESTER - III

Paper Code	Title of the Paper
Z/ 109	Population Genetics and Evolution
Z/ 110	Developmental Biology
Z/ 111	Aquaculture
Z/ 112	Principles of Ecology and Conservation
Z/ 109 – 112	Practicals for all theory papers

SEMESTER - IV

Paper Code	Title of the Paper
Z/ 113	Endocrinology and Animal Behaviour
Z/ 114	Parasitology
Z/ 115	Genetics and Molecular Cytogenetics
Z/ 116	Biotechnology and Applied Biology
Z/ 113 – 116	Practicals for 113,114,115 theory papers and Project work in the place of 116 theory paper

Syllabus 2021-'22

M.Sc. Zoology Programme - I Semester

Theory Syllabus - Paper Code Z / 101

BIOSYSTEMATICS, BIODIVERSITY AND TAXONOMY

(With effect from 2021- '22 admitted batch)

Hours per week: 4 **Semester End Examination: 80Marks**

Credits: 4 **Internals: 20Marks**

UNIT – I

1.1 Definition & basic concepts of biosystematics & taxonomy.

1.2 History, Problems, aims and tasks in taxonomy.

1.3 Importance and applications of biosystematics in biology

1.4 Material basis of biosystematics – Taxonomic attributes.

UNIT – II

2.1 Theories of biological classification (Essentialism, Nominalism, Empirism, Cladism)

2.2 Evolutionary classification.

2.3Trends in biosystematics- Concepts of different conventional and newer aspects.

2.4 Chemotaxonomy; Cytotaxonomy; Molecular taxonomy; Eco - taxonomy and Behavioral taxonomy

UNIT – III

3.1 Species Concept - Different species concepts - Typological, Nominalistic, Biological& evolutionary species concept.

3.2 Sub-species and other infra specific categories, Polytypic species.

3.3 Dimensions of speciation- types of lineage changes, production of additional lineage

3.4 Speciation – Allopatric, Sympatric &Parapatric speciation, and factors affecting speciation.

UNIT – IV

4.1 Sustainable utilization of Biodiversity - Origin of biodiversity, Types of biodiversity & ecosystem, Threats of biodiversity.

4.2 Equitable sharing & conservation of Biodiversity (in-situ & ex-situ & gene banks).

4.3 Genetic Variations & Non genetic Variations - Molecular perspectives on conservation of Biodiversity, Hierarchy of categories.

4.4 Origin of reproductive Isolation (Prezygotic & Post zygotic mechanisms).

UNIT – V

5.1 Taxonomic procedures – taxonomic collections, preservation, curetting of animals and Process of identification. Preservation of specimens.

5.2 Taxonomic Keys - Procedure keys in taxonomy, Types, merits & demerits.

5.3 Systematic publications – different kinds of publications, Process of typication and different Zoological types.

5.4 International code of Zoological Nomenclature (ICZN) - Operative principles, Interpretation and application of important rules, Zoological nomenclature, formation of scientific names of various taxa. Interpretation of rules of nomenclature.

Suggested Readings

1. M. Kato. The Biology of Biodiversity, Springer.

2. J.C. Avise. Molecular Markers, Natural History and Evolution, Chapman & Hall, New York.

3. G.G. Simpson, Principle of Animal taxonomy, Oxford IBM Publishing Company.

4. E.O. Wilson. The diversity of Life (The College Edition), W.W. Northern & Co.

5. B.K. Tikkadhar, Threatened Animals of India, ZSI Publication Calcutta.

6. Mayr, E. 1969. Principles of Systematic Zoology. McGraw-Hill, N.Y.

7. Mayr, E. 1970. Populations, species and evolution, Cambridge Mass, Harvard Univ. Press.

8. Ferguson, A., 1976. Biochemical systematics and evolution, john biley and Sons, N.Y., Toronlo.

9. Gote, H.E. 1982. Animal Taxonomy.

10. Mayr, E. & E. Aschhok. 1991. Principles of systematic, McGraw Hill Book Co. London.

11. Minell, A. 1983. Priological systematics, The state of Art champan of Hill, London.

12. Quicke, D.L.J. 1996. Principles and Techniques of contemporary Taxonomy.Blacky Academic and Professional, London, New York.

13. Sebuh, R.T. 2000. Biological systematics: Principles & Application, Cornell University Press.

Syllabus 2021 – 2022

M.Sc. Zoology Programme - I Semester

Theory Syllabus - Paper Code Z / 102

BIOSTATISTICS AND BIOINFORMATICS (Effective from admitted Batch 2021 – 2022)

Hours per week: 4 End **Semester End Examination: 80Marks**

Credits: 4 **Internals: 20Marks**

Course Content:

UNIT – I

1.1 **Introduction to Biostatistics** – Importance of Statistics in biology, Application and Role of biostatistics in modern research. Samples and populations, variables in biology, Accuracy and Precision. Sampling – Characteristics, advantages and methods of sampling and sampling errors.

1.2 **Data Collection and Presentation**: Types of biological data. **Presentation of the data** - Frequency distribution tables Preparation of ordered, discrete, continuous and Cumulative frequency distribution tables.

1.3 **Diagrammatic and Graphical Presentation of data** - Data presentation by diagrams, graphs and curves, Skewness and Kurtosis.

UNIT – II:

2.1 **Measures of central tendency** - Mean, Median and Mode

2.2 **Measures of dispersion**: Standard deviation, variance and coefficient of variance.

2.3 **Probability and distributions** - Elements of Probability, definition, terminology and laws, independent events. Addition and multiplication rules, conditional probability, example – Bernoulli.

2.4 **Probability distributions**: Binomial and Poisson distribution Normal Distribution: frequency distributions of continuous variables, properties of normal distribution, applications of normal distribution.

UNIT – III

3.1 **Proportion data**- Examples of Proportion data- MPM- sterility testing of medicines- animal toxicity- infection and immunization studies e.g., LD50, ED50, PD50 statistical treatment to proportion data- Chi-square test- goodness of fit to normal distribution.

3.**2** **Count data**- Examples of count data (bacterial cell count, radioactivity count, colony and plaque count, etc.). Statistical treatment to count data- poission distribution- standard error- confidence limits of counts.

3.3 **Tests of Significance** - Concepts of Null hypothesis and alternative hypothesis, degrees of freedom Level of significance, errors of inference. Students t-test, Chi-square test.

UNIT – IV:

4.1 **Analysis of Variance –** One Way and Two-Way ANOVA - Applications in biology

4.2. **Correlation -** Concepts and applications of correlation and regression, Bivariate data, Scatter plot, correlation coefficient (r), properties, interpretation of r.

4.3. **Linear regression -** Fitting of lines of regression, regression coefficient, coefficient of Determination standard curves and interpolations of unknown y-values thereon.

UNIT – V: Bioinformatics

5.1. **Introduction to Bioinformatics**; Types of Biological data and its applications using computational tools; Omics studies; Major resources of Bioinformatics: Nucleic acid sequence databases NCBI, Genbank, EMBL, EMBL – EBI, Protein sequence databases: Swiss- prot, PDB, BLAST, PSI- BLAST (Steps involved in use and interpretation of results). Literature databases: PubMed, PubMed Central and Public Library of Sciences. File formats- FASTA, GCG and Clustal W.

5.2. **Databank search**- Data mining, data management and interpretation. Multiple sequence alignment of genes and primer designing. Phylogenetic analysis with the program PHYLIP, DISTANCES, and GROWTREE. Basics of designing a microarray, image analysis and normalization, annotations.

5.3 **Genomics & Proteomics:** Proteins,secondarystructureandfolding,RNAsecondarystructures, protein prediction tools- protein secondary structure, molecular modelling, identification and characterization of protein mass fingerprint, world- wide biological databases. Protein modelling, protein structure analysis, docking,

Suggested Readings

1. Statistics - Gupta and Kumar
2. Biostatistics – A foundation for analysis in the Health Sciences: W.W. Daniel
3. Biostatistics - J. Zar
4. Biometry - Sokal, R.R. & F.J. Rohlf , Freeman, San Francisco.
5. Statistical methods for environmental biologists - Snedecor, G.W. and W.G. Cochran, John Wiley & sons. New York.
6. Bioinformatics for Dummies, Claverie J. M., Notredame C., (2nd Ed., 2007), Wiley Publishing, Inc., New York, USA.
7. Bioinformatics: Sequence and Genome Analysis, Mount, D. W. (2nd Ed., 2001), Cold Spring Harbor Laboratory Press, New York, USA.

Syllabus 2021-22

M.Sc. Zoology Programme - I Semester

Hours per week: 4 **Semester End Examination: 80Marks**

Credits: 4 **Internals: 20Marks**

UNIT – I

1.1. Assays- Chemical and Biological assay, Centrifugation, Working Principle and applications of Centrifugation; differential and density gradient centrifugation, Ultrafiltration.

1.2. Electrophoresis – Electrophoresis, Agarose Gel electrophoresis, 2- D Electrophoresis workingPrinciple, structural components and applications of electrophoresis. Analysis of RNA, DNAand proteins by one and two-dimensional gel electrophoresis, Isoelectric focusing gels.

1.3. Chromatography-Working Principle and applications of chromatography, Chromatography Planar chromatography (paper & TLC), Gas Chromatography (GC-MS), High Performance Liquid Chromatography (HPLC), and LC-MS

1.4. Spectrophotometer - UV-visible, fluorescence, circular dichroism, absorption spectrophotometry principles and applications, NMR and ESR spectroscopy, Molecular structure determination using X-ray diffraction and NMR. Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

UNIT – II

2.1. Microscopy - Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells.

2.2.Principle and applications of different types of microscopes - Light, Phase Contrast, Fluorescence microscopy.

2.3. Electron microscopy: SEM, TEM and Atomic force microscopy (AFM).

2.4. Image processing methods in microscopy: Image acquisition- 2D image techniques- 3D image techniques- Analysis.

UNIT – III

3.1. Microtomy- Working principle and different types of Microtomes.Knives and Blades.

3.2. Tissue embedding (paraffin wax), Section cutting, Floatation (water bath), slide mounting, drying (oven or hot plate) and section adhesives.

3.3. Applications of microtomy in biological studies: Traditional Histology Technique-Frozen section procedure- Electron Microscopy Technique-Spectroscopy Technique.

3.4. Cryotechniques- History and applications of Cryotechniques for light and electron microscopy. Different fixation and staining techniques for EM, freeze-etch and freeze fracture methods for EM.

UNIT – IV

4.1. Media preparation & Sterilization, Inoculation and growth monitoring.

4.2. Biochemical Mutants and their use, Microbial assays.

4.3. Cell Culture System - History and scope of animal cell and tissue culture, Advantages and disadvantages of tissue culture, Substrates and Culture media, Treatment of substrate surfaces, Feeder layers, gas phase for tissue culture, Culture media for cells and tissues, Culture procedures.

4.4. Cell culture techniques - Primary culture and large scale cell cultures, Tissue and Organ Culture: Primary explantation techniques, Tissue culture (slide, flask and test tube cultures), Organ culture, whole embryo culture, and tissue engineering (artificial skin and artificial cartilage).

UNIT-V:

5.1. Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

5.2. GM (Geiger-Muller) Counter, Scintillation Counter – Principle, Types, Description and Applications.

5.3. Autoradiography – Principle and applications.

5.4. Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT.

Suggested Readings

1. Principles and Techniques of Biochemistry and Molecular Biology, Wilson K andWalker J.M. Cambridge University Press

2. Biophysical& Biochemical Techniques, Wilson K and Walker J.M.,

3.Laboratory Exercises and techniques in Cellular Biology, Anthony ContantoWiley Publ.2012

4. Histological &Histochemical methods: Theory and Practice, Kiernan J.A. Scion Publ.

5. Histochemistry: Pearse A.G.E, Garfield.

6. Animal cell culture - A practical approach, Ed. John R.W. Masters, IRI Press.

7. Introduction to Instrumental Analysis. Robert Braun. McGraw Hill International Edition.

8. A Biologist Guide to Principles and Techniques of Practical Biochemistry. KWilson & K.H. Goulding, ELBS Edition.

Syllabus 2021 – 2022

M.Sc. Zoology Programme - I Semester

Theory Syllabus - Paper Code Z / 104

MOLECULAR CELL BIOLOGY

Hours per week: 4 **Semester End Examination: 80Marks**

Credits: 4 **Internals: 20Marks**

Course Content

UNIT – I

1.1 **Cytoskeleton in eukaryotic cell architecture and function** - Recapitulation of the structure of the eukaryotic cell with emphasis on how it functions as a unit of life.

1.2 **Structure and dynamics of microfilaments**; Cytoskeletal elements in cell shape and motility; their structure and dynamics (Microtubules, Cilia and Flagella). Cell movements – intracellular transport, role of kinesin and dynein.

1.3 **Microtubules:** structure, organization and dynamics; Role of microtubules in cell shape and mitosis; Structure and function of intermediate filaments.

UNIT - II

2.1 **Membrane structure and function -** Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels.

2.2 **Transport across cell membranes -** Active transport with suitable examples, membrane pumps, mechanism of sorting and regulation of intracellular transport. Cotransport by symporters and antiporters, Membrane potential.

2.3 **Acidification of cell organelles and stomach**; transepithelial transport; Maintenance of cellular pH; Cell excitation; Bulk transport: Receptor mediated endocytosis. Intracellular trafficking.

UNIT – III

3.1 Protein sorting and targeting to organelles; Targeting of proteins to lysosomes for degradation; Molecular mechanism of the secretory pathway; Secretion of neurotransmitters.

3.1 **Cell signaling –** Types and stages of cell signaling. Cell-Cell interactions: Cellular gap junctions and adhesions; structure and functional significance of plasmodesmata; Mechanisms of cellular recognition and communication.

3.2 C**ellular communication:** Extracellular matrix, Signal transduction, Intracellular receptor and cell surface receptors; Signaling via G-protein linked receptors (PKA, PKC, CaM kinase); Overview of various cellular signaling cascades with examples such as Egfr, Notch, Wingless, JAKSTAT etc.; Enzyme linked receptor signaling pathways; Network and cross- talk between different signal mechanisms; regulation of signaling pathways, Programmed cell death.

UNIT – IV

4.1 **Cell division and Cell Cycle -** Overview of mitosis and meiosis; chromosome labeling and cell cycle analysis; cell cycle and control mechanisms; types and regulation of cyclins, sister chromatid cohesion remodeling; differential regulation of cohesion complex during mitosis and meiosis; mitotic spindle and arrangement of chromosomes on equator; regulation of exit from metaphase, chromosome movement at anaphase.

4.2 Genetic control of meiosis with examples from yeast.

4.3 **Steps in cell cycle** - Role of Cyclins' and Cyclin Dependent Kinases (CDKs) in the regulation and control of cell cycle.

4.4 **Cell cycle checkpoints –** Different types of check points, Checkpoint genes and significance of checkpoints in cell cycle.

UNIT – V

5.1 **Organization of Genes and Chromosomes -** Hierarchy in organization

5.2 Chromosomal organization of genes and non-coding DNA, Mobile DNA, unique and repetitive DNA, interrupted genes, gene families.

5.3 Morphological and functional elements of eukaryotic chromosomes, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons.

5.4 **Cancer -** Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

SEMESTER - I

Paper Code Z / FS 101 BIOSYSTEMATICS,

BIODIVERSITY AND TAXONOMY

LIST OF EXERCISES FOR LABORATORY COURSE

1. A practical approach towards Biosystematics and taxonomy - Examples representing differenttaxa in the order of evolution.
2. Techniques of collection and preservation with respect to insects and fishes
3. To prepare identification keys of various animal groups
4. To study external morphological features of various animal groups (Eg. beaks & claws of birds, scales of fishes, wing venation and external genitalia of insects).
5. Methods of collection, preservation and identification of fauna – zooplankton, insects, fishes,birds etc.
6. Representative forms of terrestrial and aquatic fauna.

SEMESTER - I

Paper Code Z / FS 102 BIOSTATISTICS

AND BIOINFORMATICS

LIST OF EXERCISES FOR LABORATORY COURSE

1. Sampling – Lottery method and Random digits
2. Preparation of frequency distribution tables using biological data.
3. Graphical presentation of the data.
4. Measures of Central Tendency – Mean, median and mode
5. Measures of Dispersion – Standard deviation and Coefficient of variation
6. Probability – Tossing the coin
7. Chi – Square analysis – Testing significance
8. Coefficient of Correlation
9. Nucleic acid and protein databases.
10. Retrieval and analysis of DNA or protein sequence from NCBI.

SEMESTER - I

Paper code Z/FS 103

TOOLS AND TECHNIQUES FOR BIOLOGY

LIST OF EXERCISES FOR LABORATORY COURSE

1. Separation of call organelles by Differential centrifugation.
2. Separation of protein by electrophoresis (Native & SDS page).
3. Separation of amino acids by paper and Thin Layer Chromatography - Demonstration ofcolumn Chromatography.
4. Validation of Beer-lamberts law of a colored compound (CuSO4).
5. Spectrophotometer – Estimation of Biomolecules
6. pH meter - Preparation of buffer.
7. Light microscopy - Observation of unstained and stained cells.
8. Demonstration of - Fixation, Dehydration, Sectioning and staining of animal tissue.
9. Preparation of chick fibroblast and viability testing.

I SEMESTER

Paper Code Z/ FS 104 MOLECULAR CELL BIOLOGY

LIST OF EXERCISES FOR LABORATORY COURSE

1. Sub-cellular fractionation – separation of macromolecules
2. Isolation of mitochondria from mouse liver by differential centrifugation.
3. Stages of Mitosis and Meiosis
4. Squash preparation – Acetoorcein staining
5. Preparation of Meiotic chromosomes using Haemotoxylin / Feulgen stain - *Poecilocera picta*
6. Isolation of Nuclei and determination of its purity
7. Isolation of mitochondria and plastids and Examination under microscope
8. Isolation of mitochondria and chloroplast DNA – Qualitative analysis of DNA

M.Sc. Zoology Programme - II Semester

Theory Syllabus - Paper Code Z / 105

IMMUNOLOGY

Hours per week: 4 **Semester End Examination: 80Marks**

Credits: 4 **Internals: 20Marks**

Course Content

UNIT – I

1.1 **Overview of the Immune system -** A Historical Perspective of Immunology, Important Concepts for understanding the Mammalian Immune Response, the Good, Bad, and Ugly of the Immune System. Clonal Selection Theory.

1.2 **Cells, Organs, and Microenvironments of the Immune System –** Haematopoiesis, Cells of the Immune System, Lymphoid Organs – their structure and Function.

1.3 **Antigens -** Immunogenecity, Antigenecity and factors effecting immunogenicity, Epitopes and Haptens. Superantigens and their properties and immune response.

UNIT – II

2.1 **Antibodies –** Gross and molecular structure of Immunoglobulin molecule, Antibody Classes and their effector functions. Polyclonal & Monoclonal antibodies and their application.

2.2 Ag. - Ab. Interactions and Diagnostic techniques – Diagnostic techniques: Immunoprecipitation based techniques, Agglutination reactions, Ab assays based on Ag binding to solid phase supports (RIA, ELISA, ELISPOT, Western Blotting), Immunofluorescence based imaging techniques. Vaccines

2.3 The Major Histocompatibility Complex and Antigen Presentation - Structure and function of MHC Molecules, General Organization and Inheritance of the MHC, Role of MHC and expression patterns.

2.4 **Antigen Presentation**: Endogenous and exogenous pathway of antigen processing and presentation, Cross presentation of exogenous antigens, Presentation of nonpeptide antigens.

UNIT - III

3.1 Innate Immunity – External defences (Anatomical, chemical, biological barriers), Internal defences – Cellular (Neutrophils, macrophages, NK cells & TKRs), Extra cellular (Cytokines, Complement Proteins, Coagulation proteins).

3.2 Inflammatory Responses. Molecular recognition and regulation and Evasion of Innate and Inflammatory Responses, Interactions between the innate and adaptive immune systems, Ubiquity of Innate Immunity. Adaptive immunity

3.3 Receptors and Signalling – B and T cell Receptors; Structure and their role in signal Transduction, Properties of Cytokines, Cytokines and associated Receptor Molecules.

3.4 The Complement System – Components and functions of Complement, complement activation, biological consequences of complement activation, Complement deficiencies.

UNIT – IV

4.1 T -Cell Development - Early thymocyte development, Positive and Negative Selection, Maturation, self-tolerance, Apoptosis. T-Cell Activation, Differentiation, Memory - T-Cell Activation and the Two-Signal Hypothesis. T-Cell Differentiation and T-Cell Memory.

4.2 B-Cell Development - B - Cell development, Development of B-1 and marginal - zone B cells, Comparison of B- and T-Cell development. B-Cell Activation, Differentiation and memory generation. T-dependent and T-Independent B-Cell responses, Negative regulation of B Cells.

4.3 Effector Responses- Cell Mediated Immunity, Humoral Immunity, Immune Response kinetics, Antibody mediated effector functions, Cell mediated effector responses.

UNIT V

5.1 Allergy, Hypersensitivities, and Chronic Inflammation Type I- Hypersensitivity reaction, Antibody mediated (Type II) Hypersensitivity reactions, Immune Complex-Mediated (Type III) Hypersensitivity, Delayed-Type (Type IV) Hypersensitivity (DTH), Chronic Inflammation.

5.2 Autoimmunity & Immunodeficiency Disorders: Establishment and maintenance of tolerance, Autoimmunity. Immunodeficiency Disorders **-** Primary and Secondary Immunodeficiency diseases.

5.3. Transplantation Immunology – Transplantation antigens, Transplantation immunology, Graft Versus Host Disease.

5.4 Cancer and the Immune System– Terminology, Malignant transformation of cells, Tumour antigens, Immune response to cancer, Cancer Immunotherapy.

Syllabus 2021-'22

M.Sc. Zoology Programme - II Semester

Theory Syllabus - Paper Code Z / 106

GENERAL AND COMPARATIVE PHYSIOLOGY

(With effect from 2021- '22 admitted batch)

Hours per week: 4 **Semester End Examination: 80Marks**

Credits: 4 **Internals: 20Marks**

Unit – I

1.1. Functional anatomy of digestive system.

1.2. Digestion and absorption. Neuroendocrine regulation of gastro – intestinal movements and secretions. Energy balance, BMR

1.3 Respiratory system - Comparison of respiration in different species, anatomical considerations. Breathing movements, transport and exchange of gases, waste elimination.Respiratory quotient.Respiratory Pigments.

1.4 Neural and hormonal control of breathing. Respiratory acidosis and alkalosis and regulation of blood PH.

Unit –II

2.1. Blood & Circulation - Blood corpuscles, hemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, hemoglobin, hemostasis.

2.2. Cascade of biochemical reactions (factors) involving in blood coagulation.

2.3. Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissue.

2.4. ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation.

Unit –III

3.1.Excretory system - Comparative physiology of excretion, kidney and its renal units.
3.2. Physiology of urine formation. The significance of Henley's loop.Role of hormones in renal physiology.
3.3. Waste elimination- Formation of nitrogenous excretory products NH3, Urea & Uric acid.
3.4. Micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.

Unit – IV

4.1 Nervous system - Structure of neuron, Fundamentals of nerve impulse- resting potential, Action potential, role of ion channels.

4.2 Types of synapses- electrical and chemical, gap junctions, ligand gated channels and the Mechanism of synaptic transmission, cholinergic and adrenergic, Neuromuscular junction.

4.3 Gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture.

4.4 Types of muscles: Striated, non-striated and cardiac muscles. Ultra-structure of striated muscle. Muscle contraction – Muscle proteins, sliding filament theory.

Unit – V

5.1 Homeostatic mechanisms of the body - Concepts of Homeostasis.

5.2 Thermoregulation - Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.

5.3 Stress Physiology - Basic concept of environmental stress and strain, concepts of elastic and plastic strain, stress resistance, stress avoidance and stress tolerance. Responses to biotic and abiotic factors.

5.4 Sense organs - Vision, hearing and tactile response.

Syllabus 2021 – 2022

M.Sc. Zoology Programme - II Semester

Theory Syllabus - Paper Code Z / 107

MOLECULAR BIOLOGY

Hours per week: 4 **Semester End Examination: 80Marks,**
Credits: 4 **Internals: 20Marks Content**

UNIT – I

1.1 **Chemical composition of DNA -** Discovery of DNA, Evidence for DNA as the genetic material. Chemical structure of DNA and Base composition, biologically important nucleotides, Watson-Crick model, Supercoiled DNA, Structure of different types of nucleic acids, hydrolysis of nucleic acids. Conformation of nucleic acids: A-, B-, Z-, DNA, t-RNA, micro-RNA. Stability of nucleic acid structure.

1.2 **DNA content and C - value paradox-** Genome size and content over members of different orders and of the same family (Genomes of bacteria, viruses, plasmids, mitochondria and chloroplast). Methods to measure DNA content variation - Various types of DNA sequences (simple sequences, repetitive sequences, nonsense sequences, tandem gene clusters, satellites)

1.3 Resolving the paradox by DNA-DNA and DNA-RNA hybridization kinetics, Kinetics of DNA-DNA hybridization, DNA-RNA hybridization, Cot curves, Rot curves.

UNIT - II

2.1 **DNA damage -** DNA damaging agents, Physical, chemical and biological mutagens; types of damage caused by endogenous and exogenous agents, Molecular mechanisms of mutagenesis – Transition, Transversion, Frame Shift, mis-sense and non-sense mutations

2.2 **DNA repair mechanisms**: Direct reversal, photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, double strand break repair, SOS repair; Recombination: Homologous, non-homologous and site-specific recombination.

2.3 **Enzymes involved**; Types of topoisomerases and their function in adding or removing super helical structures.

UNIT III

DNA replication

3.1 **Prokaryotic DNA replication -** Replication origin and site. Enzymes and accessory proteins and their mechanisms - DNA polymerases, composition and features, replication factors and mechanism of replication, leading strand and lagging strand synthesis, processivity and fidelity and regulation of replication. Extrachromosomal replicons, Replication of single stranded DNA, M13 viral DNA. Link with cell cycle.

3.2 **Eukaryotic replication -** Replication origin, replication fork, replication initiation complexes and their assembly, licensing factors, DNA polymerases and their composition telomerase and mode of action, replication factors, disassembly of chromatin components and reassembly during replication.

3.3 Prokaryotic gene regulation: Lac and Trp operons. Lytic and lysogenic phases of Bacteriophage λ life cycle. Sporulation in Bacillus subtilis. Eukaryotic gene regulation: Role of chromatin in eukaryotic gene regulation. Cis-trans elements, DNA methylation, chromatin remodeling. Environmental gene regulation. RNAi in gene regulation. Epigenetic gene regulation

UNIT IV **RNA Transcription**

4.1. Types of RNA, secondary and tertiary structure and function.

4.2. Prokaryotic and Eukaryotic transcription; Transcription factors and machinery, formation of initiation complex, transcription activator and repressor.

4.3. RNA polymerases, capping, elongation, and termination. RNA processing, RNA editing, splicing, and polyadenylation. Nuclear Export of m-RNA.

4.4. **Post transcriptional modifications -** RNA splicing and processing (5' capping, Poly A adenylation), mRNA editing, inhibitors of transcription, reverse transcription.

UNIT V **- Protein Translation**

5.1 Ribosome structure, Genetic code (codon anticodon recognition, wobble hypothesis, mutations).

5.2 **Prokaryotic and eukaryotic translation –** Polypeptide synthesis (initiation, elongation, termination), control of eukaryotic translation, Effect of antibiotics on protein synthesis

5.3 **post-translational modification** of proteins, protein folding, protein sorting; Mitochondrial translation, proteomics and proteomic analysis.

M.Sc. Zoology Programme - II Semester

Theory Syllabus - Paper Code Z / 108

BIOMOLECULES

(With effect from 2021- '22 admitted batch)

Hours per week: 4 **Semester End Examination: 80Marks**

Credits:4 **Internals: 20Marks**

UNIT- I

1.1 Biomolecules- chemical composition and bonding , chemical reactivity , ionization of water.

1.2 Weak acids and weak bases (pH) , buffers: buffering in biological systems, Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).

1.3 Principles of bioenergetics – Principles and Laws of thermodynamics, reaction kinetics, colligative properties and their applications in biological system : entropy and enthalpy.

1.4 Standard free energy changes standard reduction potentials, reaction.

UNIT- II

2.1 Carbohydrates- Definition and classification of carbohydrates, nomenclature.

2.2 Reaction of Mono-saccharides- Acid derivatives of Mono-saccharides, amino-sugars, Oligo - saccharides, structure and properties.

2.3 homo and hetero - polysaccharides, peptidoglycan, glycosaminoglycans, glycoproteins and other glycoconjugates.Biosynthesis and degradationof glucose and glycogen.

2.4 Bioenergetics - Glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.

UNIT- III

3.1 Amino acids – classification, Peptide bond,

3.2 Proteins – classification, structural organization of proteins, primary structure, secondary structure, tertiary structure, quaternary structure.

3.3 Conformation of proteins (Ramachandran plot) domains, motifs and folds. Denaturation &renaturation of proteins.Biosynthesis of urea.

3.4 Tissue proteinin health and diseases, collagen-structure and synthesis, abnormal collagens, elastin, keratins,muscle proteins, lens proteins and cataract.

UNIT- IV

4.1 Biological importance of lipids. Fatty acids: classification, nomenclature.

4.2 Simple fats:Triacylglycerol (Triglycerides) – Physical properties. Reactions – Hydrolysis, Saponification,Rancidity. Acid number, Saponification number, Iodine number oxidation, Ketosis, Reichert-Meissl-Wollnyvalue.

4.3 Compound lipids: Phospholipids- Lecithin, Phosphatidyl inositol, Cephalins,plasmologens,Glycolipids, Sphingolipids Steroids: Biologically important steroids-cholesterol,Vitamin D, Bile acids, Ergosterol, Terpenes. 4.4 Prostaglandins- Structure, types, synthesis andfunctions. Lipoproteins.

UNIT- V

5.1 Structural organization of DNA (Watson-Crick model)-Characteristic features of A,B,C and Z DNA. Structural organization of tRNA and micro RNA- stability of proteins and nucleic acids.

5.2 Protein-nucleic acid interactions- Electrostatic interaction,hydrogen bonding stacking interactions. DNA binding proteins-DNA regulatory proteins, foldingmotifs, finger motifs, Zipper motifs, conformation flexibilities- Biological roles of nucleotides andnucleic acids.

5.3 Enzymes: Classification- (I.U.B.system) co-enzymes, iso-enzymes, ribozyme. Enzyme specificity.Mechanismof action of enzymes.Formation of enzyme substrate complex.Various theories.

5.4 Enzyme kinetics:Michaelis-Menten equation. Km value and its significance.Enzyme velocity and factors influencingenzyme velocity.Enzyme inhibition- suicide inhibition and feedback inhibition. Enzyme regulation:Types of regulation, Allosteric regulations-Key enzymes, Covalent modification.

II - SEMESTER PAPER CODE - Z/FS 105

IMMUNOLOGY

LIST OF EXERCISES FOR LABORATORY COURSE

1. Lymphoid organs in Rat, Chick and Fish – Dissection & display.
2. Lymphoid organs – Histology slides
3. Cells of the Immune system - Staining with Giemsa.

   To determine Total Leukocytes Count (TLC) of the given sample.

   To determine Differential Leukocytes Count (DLC) of the given sample.
4. Isolation of lymphocytes from peripheral blood by ficoll method.
5. Viability of lymphocytes by Trypan blue staining.
6. Lysis of red blood cells (hypotonic lysis with H2O and ammonium chloride).
7. Antigen – Antibody reactions – Kits
   a) Hemagglutination assay for ABO blood group typing and determination of Rh factor.
   b) Agglutination test which detects the presence of serum agglutinins (H and O) -Diagnostic test for typhoid
8. To perform Radial Immunodiffusion (RID) by Mancini's technique.
9. To perform Double Immunodiffusion (DID) by using Ouchterlony method.
10. To perform the Quantitative precipitation assay-test.
11. To learn the technique of rocket Immuno-electrophoresis.
12. To perform Erythrocyte Rosette-forming Cell Test - ERFC.

II SEMESTER PAPER CODE - Z/FS 106
GENERAL AND COMPARATIVE PHYSIOLOGY

LIST OF EXERCISES FOR LABORATORY COURSE

1. Action of pepsin in digestion of proteins.
2. Estimation of salivary amylase activity.
3. Estimation of lipase activity.
4. Oxygen consumption and estimation in an aquatic or terrestrial animal.
5. Determination of cell fragility by osmotic hemolysis experiment.
6. Water and ionic regulation of freshwater animal in different osmotic media.
7. Observation of an earthworm's responses in the cases of repeated stimulation and dualstimulation.
8. Observation of the response of invertebrates to different lighting conditions.
9. Estimation of Urea, Ammonia.

II SEMESTER

PAPER CODE - Z/FS 107

MOLECULAR BIOLOGY

LIST OF EXERCISES FOR LABORATORY COURSE

1. Isolation of genomic DNA from animals and microorganisms.
2. Estimation of DNA (diphenyl method)
3. Estimation of RNA (Orcinol method)
4. UV absorption spectra of native and denatured DNA
5. Isolation of plasmid and determination of purity.
6. Determination of molecular weight and quantification of DNA.

II SEMESTER PAPER CODE - Z/FS 108

BIOMOLECULES

LIST OF EXERCISES FOR LABORATORY COURSE

1. Estimation of glycine by formal titration
2. Estimation of proteins by Lowry and Biuret methods
3. Analysis and identification of monosaccharides
4. Estimation of maltose by DNS method
5. Determination of Iodine value of oils
6. Estimation of Cholesterol
7. Extraction of biochemical constituents from various tissues.
8. Estimation of Enzyme activity (e.g.Urease)
9. Effect of pH and temperature on enzyme activity- Amylase.
10. Purification & Estimation of Casein in milk.

M.Sc. Zoology Programme - III Semester

Theory Syllabus - Paper Code Z / 109

POPULATION GENETICS AND EVOLUTION

Hours per week: 4 **Semester End Examination: 80Marks,**
Credits: 4 **Internals: 20Marks**

Course Content

UNIT – I

1.1 **Theories of organic evolution-** Lamarckism, Neo Lamarckism, Darwinism, Neo Darwinism.

Concepts of Variation - Genetic drift, Migration, Selection, Adaptation, Struggle, Fitness and Mutations.

1.2 Natural Selection, the Modern Synthesis, Evolution of populations.

1.3 Origin of unicellular and multicellular organisms, plants and animal - Origin of basic biological molecules, Abiotic synthesis of organic monomers and polymers, Concept of Oparin and Haldane; Experiment of Miller (1953).

1.4 **The first cell -** Evolution of Prokaryotes; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.

UNIT – II

2.1 **Gene Frequency and Genetic Equilibrium –** Gene pool, gene frequencies and genotype frequencies, Hardy Weinberg Law, conservation of gene frequency. Assumptions and Testing Hardy-Weinberg principle with population models.

2.2 **Gene evolution -** Multigene families, gene duplication and Divergence, Molecular drive.

2.3 **Speciation and Evolution –** Race formation, the species, modes of speciation (allopatric, parapatric, sympatric). Evolutionary processes causing speciation - natural selection, sexual selection, random genetic drift, Muller incompatibility.

2.4 **Evolutionary genetics of speciation -** Evolution of Proteins and nucleotide sequences. Mechanism of reproductive isolation.

UNIT III

3.1 **Genetic structure of populations -** Optimum phenotypes and Selection pressure, kinds of selection, Fisher's theorem, genetic variability, Canalization, Genetic homeostasis, genetic load, genetic death. Mutational and Segregational load.

3.2 Phenotypic Variation

3.3 Models explaining the genetic structure of populations

3.4 Factors effecting Human disease frequency

UNIT IV: Genetics of quantitative traits in populations

4.1 Analysis of quantitative traits, Quantitative traits and natural selection,

4.2 Heritability or Estimation of – Broad sense and narrow sense heritability,

4.3 Genotype: Environment interactions

4.4 Inbreeding and Heterosis.

UNIT V: Molecular Population Genetics

5.1 **Molecular phylogeny-** Immunological techniques, amino acid sequences, DNA – DNA hybridizations nucleic acid phylogeny.

5.2 **Patterns and modes of substitution -** Nucleotide substitutions, Evolutionary rate, Molecular clock.

5.3 Phylogenetic trees, construction method, phylogenetic gradualism, punctuated equilibrium, phylogenetic classification, phenetics, cladistics.

5.4 **Induced Changes in genetic material -** Ionizing and UV radiation, Chemical mutagens, Oxygen and environmental effects, DNA repair, induced mutations in humans.

M.Sc. Zoology Programme - III Semester

Theory Syllabus - Paper Code Z / 110

DEVELOPMENTAL BIOLOGY

(With effect from 2021- '22 admitted batch)

Hours per week: 4 **Semester End Examination: 80Marks**

Credits: 4 **Internals: 20Marks**

UNIT – I

1.1 Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

1.2 Heterogamy in eukaryotes.

1.3 Comparative account of differentiation of gonads in a mammal and an invertebrate (Snail).

UNIT - II

2.1 Production of gametes – Spermatogenesis, Spermiogenesis (Sperm structure, Semen composition and formation; assessment of sperm functions), Oogenesis and Vitellogenesis (Ovarian follicular growth and differentiation) cell surface molecules in sperm - egg recognition in mammals (Rodents), Acrosomal reaction, zygote formation.

2.2 Fertilization - Pre-fertilization, Biochemistry of fertilization, Post-fertilization

2.3 Cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals, embryogenesis

UNIT – III

3.1 Cell aggregation and differentiation in Dictyostelium, Axes and pattern formation in Drosophila, amphibia and chick.

3.2 Organogenesis – vulva formation in Caenorhabditiselegans, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons,

3.3 Post embryonic development - larval formation, metamorphosis; environmental regulation of normal development; sex determination.

UNIT – IV

4.1 Collection and cryopreservation of gametes and embryos.

4.2Multiple ovulation and embryotransfer technology (MOETT) (Superovulation,In vitro oocyte maturation, In vitrofertilization, embryo transfer).

4.3 Transgenic animals and knockouts: Production & Applications.

4.4 Embryonic stem cells.

UNIT – V5.1 Assisted reproduction technologies –Ovulation induction- In vitro fertilization- Pre-implantation genetic diagnosis- Mitochondrial replacement therapy- gamete intrafallopian transfer- Reproductive surgery, treating- cryopreservation.

5.2 Embryo sexing and cloning, Screening for geneticdisorders, ICSI, Cloning of animals by nuclear transfer

5.3 Teratological effects of Xenobiotics.

5.4 contraception: Barrier methods- hormonal birth control- intrauterine devices (IUDs) - Surgical sterilization - behavioral methods - Immunocontraception.

M.Sc. Zoology Programme - III Semester
Theory Syllabus - Paper Code Z / 111
AQUACULTURE

(With effect from 2021- '22 admitted batch)

Hours per week: 4 **Semester End Examination: 80Marks**

Credits: 4 **Internals: 20Marks**

UNIT – I

1.1 Basis of Aquaculture - General Principles, Scope, Definition, Cultural and Socio-economic basis, Biological and Technological basis. National resources and Aquaculture development.History and Present status of Aquaculture.

1.2 Types of culture systems - Traditional, extensive, semi-intensive and intensive culture, monoculture, polyculture/ composite culture, monosexculture; cage culture, `pen culture, raft culture,race way culture, culture in recirculatory systems, warm water and cold-water aquaculture, sewage fed fish culture.

1.3 Biological characteristics of aquaculture species - Fish seed resources and transportation. Fish seed technology - Natural collection, bundh breeding, induced breeding. Transport of finfish and shellfish-transport of eggs, fry, fingerlings and adults.Fish hatchery.Design and construction of Shellfish hatcheries and management.

1.4 Reproduction and Genetic selection - Reproductive cycles, control of reproduction, preservation of gametes (cryopreservation), use of sex steroids for sex reversal. Genetic selection and Hybridization.

UNIT - II

2.1 Selection of site for aquaculture– Survey and location of suitable site (topography; soil characteristics; acid sulphate soils. Land based and Open water farms. Construction of fresh water & brackish water fish farms.

2.2 Pond preparation and Management - Design and construction of pond layout, construction, water intake system, drainage system. Aeration and aerators, recent advances in aquaculture engineering, tips for better aquaculture practices.

2.3 Pre stocking Management- Sun drying, ploughing, tilling, desilting, liming, fertilization and eradication of weed fishes, Stocking, Acclimatization of seed and release, species combinations, stocking density and ratio, Maturation section, larval and post larval sections.

2.4 Post Stocking Management- Water and soil quality parameters required for optimum production, control of aquatic weeds and aquatic insects, algal blooms, Specific food consumption, food conversion ratio (FCR), protein efficiency ratio, true net protein utilization, apparent net protein utilization, biological value of protein.

UNIT – III

3.1 Freshwater culture – Indian Major Carps, Catfishes, Murrels and Prawn culture

3.2 Brackish water culture – Grey mullets and milk fish, Sea bass and sea breams, Crabs and Crayfish culture.

3.3 Mariculture - Molluscan culture; Lobster culture, Mussel culture, Pearl oyster culture, Edible oyster culture and Seaweed culture. Ornamental fish culture

3.4 Integrated farming - Paddy cum fish culture and Fish cum Livestock culture.

UNIT - IV

4.1 Hydrology of Ponds- Types of ponds; sources of water: precipitation, direct run off, stream inflow, ground water inflow, regulated inflow. Losses of water: evaporation, seepage, outflow, consumptive use, water budgets of embankment ponds, water budget of an excavated pond, water exchange.

4.2 Water quality management: Physico-chemical factors- Light - Temperature - Turbidity –dissolved oxygen –COD-BOD- pH-alkalinity-salinity- ammonia- hardness- turbidity.

4.3 Feed management: Principles of fish nutrition - Nutritional requirements of commercially important finfish and shellfish. Feed types, feeding techniques and schedules, protein requirements at different ages of finfish and shellfish, wet and dry feeds, Role of probiotics in nutrition.

4.4 Feed formulation and processing-Pulverizer,grinder, mixer, pelletizer, crumbler, drier, extruder/expander, vacuum coater and fat sprayer-Feed storage methods- feeding schedules and ration size- FCR.

UNIT - V

5.1 Post harvest technology: Handling- Storage- curing- battered and breaded products.

5.2 Methods to suppress bacterial growth: Salting- drying- smoking- fermentation- canning- cooling & freezing

5.3 Economics of different kinds of aquaculture and productivity of culture ponds.

5.4 Environmental impact of aquaculture - Aquaculture wastes and future development in waste minimization, environmental consequences of hyper-nutrification, Use of Antibiotics in aquaculture: beneficial and harmful effects.

M.Sc. Zoology Programme - III Semester

Theory Syllabus - Paper Code Z / 112

PRINCIPLES OF ECOLOGY & CONSERVATION

Hours per week: 4 **Semester End Examination: 80Marks,**
Credits: 4 **Internals: 20Marks**

Course Content

UNIT – I:

1.1 **Ecology:** Basic concepts, scope, multidisciplinary nature and relevance; Ecosystem concept, organization and significance; Biosphere concept, organization and significance; Cybernetic nature of ecosystems. Ecosystem structure; ecosystem function.

1.2 **Factors affecting ecosystem**: Major environmental factors (biotic and abiotic) influencing organisms in various ecosystems; Concept of limiting factors; Liebig's law of the minimum; Shelford law of tolerance.

1.3 **Habitat and Ecological Niche** – Concept of habitat and niche; niche width and overlap niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

UNIT – II

2.1 **Ecosystem -** Nature of ecosystem, bio- geochemical cycles, resilience of ecosystem, ecosystem management. The biosphere, biomes and impact of climate on biomes.

2.2 **Productivity**: Primary productivity; concept, methods of estimation, world patterns of primary productivity and Man's exploitation of primary productivity; Secondary productivity; concept, methods of estimation, world patterns of secondary productivity, and man's exploitation of secondary productivity.

2.3 **Energy flow and trophic dynamics**: Energy flow in ecosystems; Concept of trophic dynamics and trophic cascade; Food chains, food webs and trophic levels; Ecological pyramids; Energy transfer; Ecological efficiencies; Biogeochemical cycles (water, oxygen, carbon, nitrogen, phosphorus and Sulphur) and man's impact.

2.4 **Climate change** - Environmental Stresses and their management, global climatic pattern, global warming, atmospheric ozone, acid and nitrogen deposition, coping with climatic variations.

UNIT – III:

3.1 **Attributes of population**: Population growth, density; Density dependent and density independent factors; Natality, mortality, biotic potential, carrying capacity; Survivorship and age structure; Seasonal population fluctuation.

3.2 **Population energetics and interactions**: Population energetics; Patterns of population distribution, aggregation and Allee's principle; Isolation; Population interactions: competition (allelopathy), parasitism, predation, herbivory, protocooperation, commensalisms, mutualism.

3.3 **Population growth –** Growth of organisms with non-overlapping generations, exponential growth, Verhulst – Pearl logistic growth model, Stochastic and time lag models of population growth, stable age distribution, population growth projection using Leslie Matrix. Lotka-Volterra equations.

3.4 **Population Regulation-** Extrinsic and Intrinsic Mechanisms: Case studies in population dynamics (examples from fisheries). Ecological Modelling: Fundamentals of constructing models and testing them

UNIT IV

4.1 **Community ecology**: Community concept; Nature of communities; community structure and attributes; levels of species diversity and its measurement. Individualistic and organismic nature of communities; Qualitative and quantitative characters of community; Methods of studying vegetation; Species diversity and its measurement.

4.2 **Life history strategies-** Evolution of life history traits, longevity and theories of ageing, energy apportionment between somatic growth and reproduction, reproductive strategies, optimal body size, r and K selection. Demography construction of Life Tables and their demographic application.

4.3 **Succession and climax**: Types of succession, trends of succession; Models of succession; Mechanisms; Concept of climax community; theories on climax, ecotone and edge effect; Ecotypic differentiation; r and k strategies.

UNIT – V

5.1 **Terrestrial and aquatic communities**: Plant and animal communities in forest, grassland, desert and mangrove ecosystems; High altitude communities; Zonation and stratification of plant and animal communities.

5.2 **Biodiversity & Conservation Biology –** Overview of global environmental change, Biodiversity status monitoring and documentation, Major drivers of biodiversity change.

5.3 **Conservation Biology**: Principles of conservation, major approaches to management, Indian case studies on conservation, management strategy (Project Tiger, Biosphere reserves).

5.4 **Biogeography-** Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. Faunal diversity and biodiversity Hotspots in India.

M.Sc. Zoology Programme - IV Semester

Theory Syllabus - Paper Code Z / 113

ENDOCRINOLOGY AND ANIMAL BEHAVIOUR

(With effect from 2021- '22 admitted batch)

Hours per week: 4 **Semester End Examination: 80Marks**

Credits: 4 **Internals: 20Marks**

UNIT-I

1.1 Scope and significance of endocrinology- Concept of neurohormones and neurotransmitters.

1.2 Mechanism of hormone action: Protein Hormones- Membrane receptors- G-proteins and control of adenylatecyclase- Cyclic AMP cascade- Other signal Transduction systems (PLC and PLA pathways)- Steroid hormones

1.3 Hypothalamo-hypophysial System: General organization- Neurohypophysialoctapeptides (Oxytocin and Vasopressin)-Hypophysiotropic hormones: Chemistry- localization and actions.

1.4 Adenohypophysial hormones- Chemistry and physiological roles ofSomatotropin and Prolacin-Glycoprotein hormones (FSH, LH and TSH)- Pro-opiomelanocortin (ACTH, MSH, β-LPH & β-endorphin)-Neural control of adenohypophysis

UNIT – II

2.1 Thyroid Gland- biosynthesis of thyroid hormones- Control of secretion- Physiological roles- Steroid hormone biosynthesis and pathways.

2.2Testis- Organization- Physiological roles of androgens- Inhibin- Ovary- Organization- Physiological roles of Estrogen, Progesterone and Relaxin- Inhibin.

2.3Adrenal Cortex- Organization- Control of mineralocorticoid and glucocorticoid secretions- Physiological roles of glucocorticoid and mineralocorticoid- Adrenal Medulla: Catecholamine biosynthesis, release and its physiological roles.

2.4Role of parathormone: Calcitonin and vitamin D in calcium homeostasis- Endocrine Pancreas: Biosynthesis and physiological actions of Insulin and Glucagon

UNIT – III

2.1 Neuro-endocrine system in invertebrate groups - neuro-endocrine mechanisms of moulting, growth and reproduction in crustaceans & insects-hormonal control of reproduction in Mollusca and Echinodermata.
2.2 Neuroendocrine regulation of reproductive processes & gametogenesis
2.3 Physiological actions of hormones of Parathyroid and Thymus glands.
2.4 Role of endocrinology in health and diseases.

UNIT – IV

3.1 Physiological actions of adrenal medullary hormones - Importance of adrenocortical and adrenomedullary interaction. renin-angiotensin system, hormonal control of water and electrolyte balance, Catecholamine biosynthesis, its storage and release mechanism.

3.2 Evolution of discrete adrenal gland; Synthesis of corticosteroid, structural diversity of glucocorticoids among vertebrates, role of glucocorticoid in gluconeogenesis.

3.3 Comparative aspects of endocrine physiology in vertebrates – Structure and Function of Gastrointestinal hormones or gut hormones; Gastrin family hormones, Secretin glucagon family, GI regulatory peptides - Physiological actions of these hormones.

3.4 Hormones in IVF, pregnancy testing, and Amniocentesis.

Unit – V

4.1 Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks.

4.2 Approaches and methods in study of behaviour; Proximate and ultimate causation; Altruism and evolution-Group selection, Kin selection, Reciprocal altruism.

4.3 Development of behavior; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care;

4.4 Aggressive behaviour; Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioral changes.

M.Sc. Zoology Programme - IV Semester
Theory Syllabus - Paper Code Z / 114
PARASITIOLOGY

Hours per week: 4 End **Semester End Examination: 80Marks**

Credits: 4 **Internals: 20Marks**

Course content:

UNIT – I: Introduction to Parasites

1.1 **Introduction to Parasitology -** Scope of the subject, definition and concept of parasitism and parasites. Types of animal associations, parasite and types of parasitism (Commensalism, Symbiosis, Predaterism, Phoresis and Mutualism). Hyper-parasitism.

1.2 **Types of Hosts**: Final, intermediate, paratenic and reservoir hosts with examples, Vectors, natural and unnatural, host parasite relationship and types of parasites

1.3 **Host-parasite relationship-** Effects of parasitism to their host - Mechanical action. Hosts response to parasitic infection. Specificity of parasites in relation to species, breed, sex of host and location in the host (organ specificity).

1.4 **Factors influencing Pathogenesis –** Host factors and Parasite factors. Mechanisms by which parasites induce pathology. Modes of transmission of parasites and methods of dissemination of infective stages of parasites

UNIT – II: Protozoa and Cestoda

2.1 Salient morphological features of diagnostic importance, life cycle, transmission, pathogenesis, symptoms, epidemiology, diagnosis and general control measures including treatment of *Entamoeba histolytica, Giardia intestinalis, Trichomonas tenax. Trypanosoma gambiense, T. cruzi. Leishmania donovani, L. tropica, P. vivax, Plasmodium* sps. - their Differential diagnosis and *Toxoplasma gondai*

2.2 Free living amoebae: Hartmanella, Acanthamoeba and Naegleria

2.3 Cestodes: Diphyllobothrium latum, Taenia solium, T. saginata, Hymenolepis nana, Echinococcus granulosus

2.4 Classification of Parasitic Protozoans and Cestodes up to families

UNIT-III: Trematoda and Nematoda

3.1 General characters**,** Patterns of Life cycles and larval forms in Digenetic trematodes and Nematodes.

Salient morphological features of diagnostic importance, life cycle, transmission, pathogenesis, symptoms, epidemiology, diagnosis and general control measures including treatment of the following trematodes and nematode parasites.

3.2 **Trematodes-** *Chlonorchis sinensis*, *Paragonimus westermani, Schistosoma ansoni*. Schistosome species - differential diagnosis

3.3 **Nematodes-** *Ascaris lumbricoides, Enterobius vermicularis, Ancylostoma duodenale, Wuchereria bancrofti*, *Trichinella spiralis* and *Trichiuris trichiura*.

3.4 Classification of Parasitic Trematodes and Nematodes up to families.

Unit IV. Beyond humans: Parasites of veterinary importance.

4.1 **Parasitic insects, mites and ticks**; parasites of insects and their significance;

4.2 Nematode parasites of plants, morphology, biology, lifecycle and infection of crop plants by major plant parasitic nematodes, host parasite interactions.

4.3. Parasitic adaptations (morphological, anatomical, and larval), Mode of transmission Of Parasites. Zoonos is and its significance.

4.4 General principles of control of helmithic diseases by adapting physical, chemical, biological control (Integrated Parasite Control, IPC). International regulations for control of different helminthic diseases.

UNIT-V: Immune reactions to Parasitic infections & Pathology

5.1 Resistance of host to parasitic infections/infestation. Complete, incomplete age and reverse age resistance.

5.1 **Immunity to parasitic infections (natural and acquired)** Innate Immunity **–** Physical factors, Chemical and microbial factors, the acute inflammatory response and cell mediated immunity.

5.3 **Adaptive immunity –** Avoiding the host immune response, Depression of the immune System. immunity and immune evasion mechanisms, drug targets, mechanism of drug resistance, vaccine strategies.

5.4 **Immunity to Parasites –** Malarial parasites and Schistosome parasites.

M.Sc. Zoology Programme - IV Semester

Theory Syllabus - Paper Code Z / 115

GENETICS AND MOLECULAR CYTOGENETICS

Course Content:

UNIT – I Genetics & Concept of gene

1.1 **Concept of gene -** Evolution of gene concept: Mendel to Beadle and Tatum; Complementation test as an operational definition of gene, cistron concept. Fine structure of gene: exons, introns, UTRs; Split genes; pseudogenes; overlapping genes and multi-gene families

1.2 **Mendelian Principles and Extension studies -** Dominance, Segregation, Independent assortment. Allele, multiple alleles, pseudo-alleles. Extensions of Mendelian principles - Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited, and sex influenced characters.

1.3 **Extra chromosomal inheritance -** Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

UNIT – II DNA Structure and Chromosome Organisation

2.1 **Molecular Structure of DNA -** A, B, Z and triplex DNA structure, Central dogma, DNA as genetic material; Histones, DNA, nucleosome morphology and higher-level organization. DNA compaction, nucleosome, 10 nm "beads-on-a-string" fibre, nuclear matrix in chromosome organization and function. Repetitive and unique sequence, Satellite DNA, DNase hypersensitive regions, DNA methylation patterns & epigenetic effects.

2.2 **Chromosome organization -** Structure of eukaryotic chromosomes, Metaphase chromosome, centromere, kinetochore, telomere and its maintenance. Heterochromatin and euchromatin; position effect, variegation, functional states of chromatin and alterations in chromatin organization, chromatin remodelling.

2.3 Holocentric chromosomes and supernumerary chromosomes, Giant chromosomes polytene and lamp brush chromosomes, Chromosomal domains (matrix, loop domains) and their functional significance.

UNIT – III Chromosome segregation and Genome mapping

3.1 **Linkage, recombination and crossing over -** Crossing over as a measure of genetic distance, Recombination mapping with two-point and three-point test cross, recombination frequency and genetic map distance, Detection of linkage in experimental organisms: Tetrad analysis in fungi, balancer chromosome technique in Drosophila, centromere mapping in ordered tetrads in Neurospora, cytogenetic mapping in Drosophila, detection of linked loci by pedigree analysis in humans.

3.2 **Regulation of Gene Expression:** General introduction to gene regulation in eukaryotes at transcriptional and posttranscriptional levels; Regulation of gene activity in *lac* and *trp* operons of *E. coli*.; Chromatin organization and gene expression, transcription factors, enhancers and silencers, non-coding genes.

3.3 Mechanisms of sex determination and Dosage Compensation: Human, *Drosophila* and *C. elegans*.

UNIT – IV

4.1 **Genome mapping strategies:** Overview of genome mapping **- Genetic analysis** with biochemical markers (*Saccharomyces cerevisiae*), DNA markers for genetic mapping - Restriction fragment length polymorphisms (RFLPs), Simple sequence length polymorphisms (SSLPs), Single nucleotide polymorphisms (SNPs), Linkage analysis is the basis of genetic mapping, Gene mapping by human pedigree analysis, Genetic mapping in bacteria.

4.2 Physical Mapping **-** Restriction mapping, Fluorescent in situ hybridization (FISH), Sequence tagged site (STS) mapping4.3 Human Genome Project (HGP): Strategies involved, outcome and applications. Ethical, legal and social issues involved (ELSI).

UNIT –V Human Cytogenetics

5.1 **Human genetics -** Human karyotype - Karyotyping, Chromosomal banding and staining Techniques, Chromosomal nomenclature.

5.2 **Chromosomal abnormalities –** Cytogenetic implications (chromosomal non-disjunction), **structural abnormalities**: Deletions, Duplications, Inversion and Translocations. **Numerical abnormalities**: Autosomal and Sex chromosomal syndromes, Sex determination in *Caenorhabditis elegans*, *Drosophila melanogaster* and mammals. Dosage compensation in *Drosophila melanogaster* and mammals.

5.3 Molecular cytogenetic techniques in human chromosome analysis - Spectral karyotyping (SKY); Chromosome Painting; Comparative genomic hybridization (CGH), GISH, FISH, DNA Finger Printing and Flow Cytometry.

M.Sc. Zoology Programme - IV Semester7

Theory Syllabus - Paper Code Z / 116

BIOTECHNOLOGY AND APPLIED BIOLOGY

Hours per week: 4 **Semester End Examination: 80Marks,**
Credits: 4 **Internals: 20Marks**

Course content:

UNIT – I Recombinant DNA technology & Genetic engineering

1.1 **Outlines of recombinant DNA technology**. Restriction endonucleases, Isolation of gene fragments using restriction endonucleases, cDNA, PCR, RACE PCR.

1.2 **Cloning vectors** – plasmids, bacteriophages, cosmids, Ti - plasmid. Expression vectors, CRISPR- Cas 9 technology. Construction of gene libraries – cDNA library, genomic library, YAC, BAC library. Cloning strategies – shot gun experiments, cDNA cloning in bacteria. Screening of libraries

1.3 **Chemical synthesis of genes**. Ligation of fragments. RFLP, restriction maps. Mapping genes – chromosomal walking, chromosomal jumping

UNIT –II: Gene Amplification & Sequencing

2.1. Gene Amplification - Basic PCR and its modifications (inverse PCR, anchored PCR, PCR for mutagenesis, asymmetric PCR); Application of PCR in biotechnology and genetic engineering.

2.2 **DNA sequencing methods** - Major landmarks in DNA sequencing - Maxam-Gilbert sequencing, Chain-termination methods, Advanced methods and de novo sequencing, Shotgun sequencing, Next-generation sequencing, Massively Parallel Signature Sequencing (MPSS), Polony sequencing, pyrosequencing, Illumina (Solexa) sequencing, SOLiD sequencing, Ion semiconductor sequencing, DNA nanoball sequencing, Heliscope single molecule sequencing, Single molecule real time (SMRT) sequencing.

2.3 Genomics and its application to health and agriculture, including gene therapy.

UNIT – III:

2.1 **Animal Breeding** - Principles, Structure of livestock breeding – poultry, sheep and cattle. Marker -assisted selection. Artificial insemination (AI) techniques, in vitro fertilization. Preservation of endangered species. Germplasm bank.

2.2 **Production of transgenic animals and their applications**: Mice, sheep and fish. Molecular farming and animal cloning.

2.3 **Somatic cell nuclear transfer in humans** – Legal and ethical aspects. Potential applications of transgenic animals – Animal models for diseases and disorders.

UNIT – IV: Microbial fermentations

3.1 **Types of fermentation and fermenters** – Solid state and liquid-state (stationary and submerged) fermentations, Microbial growth kinetics in batch, continuous and fed-batch (eg. baker's yeast) fermentation process.

3.2 **Microbial production of industrial products** - Microbial preparation of Tempeh, Miso, Yogurt, Probiotics, Single cell protein. Microbiology and production of alcoholic beverages (wine & beer), organic acids (acetic and gluconic acids), amino acids (glutamic acid, lysine and tryptophan), vitamins (riboflavin and vitamin A) & Enzymes (Protease, Lipase).

UNIT – V: Bioremediation

4.1 **Bioremediation** - Bioremediation using naturally occurring microorganism - removal of spilled oil and grease deposits. Bioremediation using Genetically Engineered Microbes (GEM) – detection of PAHs in the soil, treating oil spills, and for sequestering heavy metals. Bioleaching – Microbial recovery of metals and acid mine drainage.

4.2 **Biosensors** - Biosensor to detect environmental pollutants (In situ bioremediation of both soil and ground water contamination, Bioremediation of contaminated soil and contaminated surface waters (pits, ponds and lagoons). Treatment of toxic wastes before they reach environment, Conservation of soil city wastes, SPCI's strategy on biotreatment.

4.3 **Biofertilizers** – Blue green algal fertilizers – Azolla, Anabaena, symbiotic association. Sea weed fertilizers. Mycorrhizal biofertilizers, bacterial fertilizers. Biopesticides in agricultural production.

IV SEMESTER

Paper Code Z 113 ENDOCRINOLOGY & ANIMAL

BEHAVIOUR

LIST OF PRACTICAL EXERCISES FOR LABORATORY COURSE

1. Dissection of endocrine glands in a suitable host – Fish, Cockroach, Prawn, Crab, Sepia
2. Determination of insulin level using spectrophotometer
3. Study of slides of endocrine material from different animals - Histological slides pertaining to endocrine glands.
4. Histology of ovary and testes.
5. Study of male and female reproductive systems in some reproductive animals.
6. Identification of chemical structures of peptides and steroid hormones
7. Estimation of hormones in blood
8. Study of Comparative structure of endocrine glands of selected vertebrates and invertebrates.
9. Diagnosis of pregnancy by the presence of HCG in urine (Acheim Zondek test).

IV SEMESTER

Paper Code Z 114 PARASITIOLOGY

LIST OF PRACTICAL EXERCISES FOR LABORATORY COURSE

1. Smear preparation for protozoa
2. Host examination for collection and preservation, of parasites (trematodes, cestodes andnematodes).
3. Staining, mounting and identification of helminth parasites - Preparation of whole mount.
4. Study of permanent slides: Microscopic examination and taxonomic studies of allrepresentative groups of parasites.
5. Microscopical Examination of blood smears for microfilariae.
6. Examination of fecal samples for parasite eggs.

IV SEMESTER
Paper Code Z 115
GENETICS AND MOLECULAR CYTOGENETICS

LIST OF PRACTICAL EXERCISES FOR LABORATORY COURSE

1. Numerical problems on basic Genetics.
2. Study the mitotic complement of chromosomes in *Allium cepa*
3. Preparation of polytene chromosome slides from salivary glands of *Drosophila melanogaster*
4. Study of Barr body using buccal smear.
5. Karyotyping of mitotic metaphase chromosomes for cytological characterization ofchromosomes in the genome - Human chromosomes – karyotyping
6. Ideogram preparation of Human chromosome set
7. Numerical and structural abnormalities of human chromosomes- syndromes – Preparation ofkaryotypes.
8. Development of physical linkage maps.

IV SEMESTER
Paper Code Z 116 BIOTECHNOLOGY AND APPLIED BIOLOGY

Project work in the place of practical