CENTRAL UNIVERSITY OF TAMIL NADU

(Established by an Act of Parliment, 2009)

DEPARTMENT OF LIFE SCIENCES

Hand Book

Semester 1: Subject Code: LIF011 Credits: 3

Title: Biology I

Unit I: Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism. Evolution of the cell, from molecules to first cell, From Prokaryotes to eukaryotes, from single cells to multicellular organisms, Functional differentiation of cells/cell types.

Unit II: **Principles & methods of taxonomy:** Evolutionary concepts: Lamarckism, Darwinism and Speciation Concepts of species and hierarchical taxa, biological nomenclature, classical &quantitative methods of taxonomy of plants, animals and microorganisms.

Unit III: Levels of structural organization: Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs & systems. Comparative anatomy, adaptive radiation, adaptive modifications.

Unit IV: Outline classification of plants, animals & microorganisms: Important criteria used for classification in each taxon. Classification of plants, animals and microorganisms. Evolutionary relationships among taxa.

Unit V: Natural history of Indian subcontinent: Major habitat types of the subcontinent, geographic origins and migrations of species. Common Indian mammals, birds. Seasonality and phenology of the subcontinent. Rare, endangered species. Conservation strategies.
(3 lectures)

Reference Books:

Campbell, NA, and Reece, JB, Biology, Pearson Benjamin Cummings, San Franscisco. Raven, PH *et al.,* Biology, Tata McGraw Hill publications, New Delhi.

Semester 1: Subject Code: LIF012 Credits: 2

Title: Biology I Practical

1. Use of micropipettes, preparation of normal, molar and standard solutions, preparation of buffers, serial dilutions, pH measurements.
2. To learn use of microscope, principles of fixation and staining.
3. To perform gram staining of bacteria.
4. To separate chlorophyll pigment from plant by TLC.
5. To study structure of different animal tissues through temporary mounts
6. Osmosis and Tonicity experiments

Semester 2: Subject Code: LIF021 Credits: 3

Title: ECOLOGY

UNIT I: Aquatic and terrestrial ecology: concept of population and community, succession process, competition and coexistence, types of interactions, predations, parasitism, antibiosis, commensalism, cooperation and mutualism, population growth. Abiotic and biotic environment, limiting factors, adaptation, habitat and niche, nature of environment. Biosphere, biomes, population parameters, structure, growth regulation, interactions between populations.

UNIT II: Ecosystem: types, characteristics, structure and function of ecosystems, population dynamics, carrying capacity, sustainable field, components of ecosystem, food web, producer, consumer, decomposer, biotic and abiotic components, ecological pyramids, bioaccumulation and bio-magnifications- mass and energy transfer successive tropical level.

UNIT III: Energy flow and fixation: ecological pyramids. Biogeochemical cycles, hydrological cycle, carbon, oxygen, nitrogen, sulphur and phosphorus cycles – their importance and applications. Ecological succession, primary and secondary successions, ecological climax, impacts of development on ecosystem.

UNIT IV

Ecology: Introduction to ecology, plant ecology, (ecophysiology, ecosystem Ecology), animal ecology (food chains, food cycle, size of food, niches and pyramid of numbers).

UNIT V

Biodiversity: Definition and types of biodiversity, (plants, animals, soils, forests, aquatic organisms, microbes, invertebrates and pollinators), loss of biological diversity in recent times, conservation biology and future of biosphere.

Text books:

1. Fundamentals of Ecology - by Eugene P. Odum
2. Biological Diversity: Frontiers in Measurement and Assessment – by A.E. Magurran, B.J. McGill
3. Cell Biology: Cooper

Semester 2: Subject Code: LIF022 Credits: 2

Title: Ecology practical

1. Using random sampling to measure the abundance of various different species on an area of grassland
2. The distribution of species across a footpath
3. A qualitative study of a community
4. The effects of different water regimes on plant growth
5. The relationship between nettle distribution and soil phosphate
6. A quantitative study of an ecosystem
7. The energetics of the stick insect (Cavausius morosus)
8. A study of decomposer organisms in the soil
9. A comparison of the growth of tolerant and non-tolerant seedlings when exposed to metal ions

Semester 3 **Subject Code: LIF031** **Credits: 3**

Title: Basic Biochemistry

***Specific objectives**:*

- *To understand the structure and functions of biomolecules*
- *To learn the basics of Biochemistry*

***Learning outcome**:*

- *Fundamentals of Biochemistry*

Pre-requisite:

- *Compulsory for the 2nd year I. M.Sc., Life Sciences students*

Syllabus contents:

UNIT I

Carbohydrates: Overview of macromolecules, definition, physical and chemical properties, structure and importance; Classifications - monosaccharides- aldoses and ketoses, disaccharides and polysaccharides; different types of polysaccharides (Homo, Hetero and Muco polysaccharides). Derivatives of sugars. Glycoproteins-Structure and function (12 Lectures)

UNIT II

Amino acids and Proteins: Overview, definition, classification and properties of amino acids; Proteins: Non-protein amino acids, Peptide bond, Structure, classification based on the function, solubility and nutritional value; proteoglycans, protein glycosylations and its significance-Blood grouping, Structure and functions of Hemoglobin (14 Lectures)

UNIT III

Lipids: Classification and properties of Lipids; Lipoproteins-Chylomicrons, HDL, LDL and VLDL. Sphingophospholipids, Cholesterol, Steroids, Bile acids and bile salts; lipid bilayers. Glycolipids, lipopolysaccharides. (10 Lectures)

UNIT IV

Enzymes: Nomenclature, Classifications, Factors affecting enzymes, Enzyme kinetics, Michalies-Menton equation, Types of enzyme inhibitions, Electron Transport Chain and Oxidative phosphorylation. Vitamins- classification, general sources, functions, deficiency symptoms and structural aspects of vitamins. (12 Lectures)

UNIT V

Nucleic Acids: Nucleosides and Nucleotides- Composition and Structure, DNA-Types, primary and secondary structure, denaturation and renaturation; RNA- Types, structure and functions of tRNA, rRNA and mRNA. Nucleoproteins, Chromatin. Direction of DNA synthesis, Overview of DNA and RNA synthesis. (10 Lectures)

Reference Books:

1. Nelson and Cox. Lehninger **Principles of Biochemistry**. Freeman, 6th ed. 2012.
2. Stryer L., **Biochemistry, (Recent Edition)**, WH Freeman and Company, New York.
3. Voet D, Voet G, **Biochemistry,** John Wiley and Sons
4. Zubay G, **Biochemistry,** Maxwell Macmillan International Editors
5. Conn E and PK Stump, **Outlines of Biochemistry,** Willey Eastern Ltd, New Delhi

Evaluation Policy:

Components	Weightage (%)
Internal I, II & III	30
Assignment/Seminars/Quiz	10
End Semester Exams	60

Semester 4: Subject Code: LIF041, Credits: 3

Title: Cell Biology

UNIT I: Membrane transport: Membrane transport of small molecules, Membrane transport of macromolecules and particles, exocytosis and endocytosis, Structure and function of Cell wall, Structure of ATP-powered pumps and their role in Intracellular Ionic environment, non-gated ion channels, structure and function of symporters and antiporters, movement of water (structure and function of Aquaporines), transepithelial transport, structure and function of voltage-gated Ion channels macromolecular transport across the nuclear envelop.

UNIT II: Structural organization and functions of cell organelles: Translocation of secretary proteins across the ER membrane, Insertion of proteins into the ER membrane, protein modifications, folding, and quality control in the ER, export of bacterial proteins, sorting of proteins to mitochondria and chloroplasts, sorting of peroxisomal proteins. Mitochondria and chloroplast, Ribosome, and vacuoles.

UNIT III: The cytoskeleton: the nature of cytoskeleton, Intermediate filaments, Microtubules, Action filaments, Cilia and centrioles, Organization of the cytoskeleton. Cell growth and division, cell division - mitosis and meiosis, cell cycle - phases of cell cycle, and regulation of cell growth and cell cycle, Checkpoints in cell cycle regulation. Cell junctions and extracellular matrix, cell motility, microtubules, structure and composition, microtubular associated proteins - role in intracellular motility, Cell-cell adhesion and communication, Cell matrix adhesion, Collagen, fibrous protein of the matrix, Non-collagen component of the extracellular matrix. Differentiation of cell membrane - microvilli, epithelia, Bell and spot desmosomes, cell-cell interaction, cell junctions.

UNIT IV: Cell to cell signalling: Cell aging and death - necrosis and apoptosis - mitochondrial and death receptor pathway.Autophagy, Cell signalling - signalling molecules and their receptors, functions of cell surface receptors, pathways of intracellular signal transduction, G protein coupled receptors, receptors tyrosine kinases, Role of Ras and Raf in Oncogenesis, MAP kinase pathways, introduction to gene therapy.

UNIT V : Methods in Cell Biology: Methods for disrupting tissues and cells, organ and tissue slice techniques, isolation of clones, tissue culture techniques (animal and plant), cell fixation - fluid fixatives, freezing and section drying, fixation for electron microscopy - buffered osmium solutions, fixation of organic and inorganic substances, staining techniques acid and basic, fluorescent and radioactive dyes, staining of lipids, steroids, nucleic acids, proteins and enzymatic reaction products. Histopathological studies - organ specific morphohistological examination, identification of morphological changes related to pathology.

Reference Books:

1. Molecular Biology of the Cell - by Alberts et al.
2. The Cell: A molecular approach - by Cooper and Hausman
3. Molecular Cell Biology - by Lodish et al.
4. Gerald Carp and Nancy L Puritt, Cell and Molecular Biology-Concepts and Experiment, John Wiley and Sons, Inc,

Tutorial: 2 credits

Semester 5: Subject Code: LIF051 , Credits: 3

Title: Genetics

Unit I: Mendelian principles & Extensions of Mendelian principles : Principles of Mendelian inheritance, Dominance & Recessive, segregation, independent assortment, epistasis, Allele, multiple alleles, pseudo allele, complementation tests, Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy,

Unit II : **Linkage and Sex Determination**: Linkage and crossing over, sex linkage, sex limited and sex influenced characters. Autosomal inheritance, Sex-determination and Sex-linked inheritance, Chromosomal basis of Sex- determination in animals and plants, Dosage compensation of X-linked genes, Lampbrush chromosome and their function, Polytene chromosome and gene expression.

Unit III: Gene mapping methods & extra chromosomal inheritance: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. Inheritance of Mitochondrial and chloroplast genes, maternal inheritance

Unit IV: Structural and numerical alterations of chromosomes & Mutation: Chromosome structure: Centromeres, Telomeres, Chromosomal aberrations: Deletion, duplication, inversion, translocation, ploidy and their genetic implications, Change in chromosome number. Somatic vs germinal mutation. Spontaneous and induced mutations, Types, causes and detection of Mutation, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.Molecular mechanism of DNA repair, mitochondrial mutations, Homologous and non-homologous recombination including transposition.

Unit V: Human genetics: mitochondrial genome organization, nuclear genome organization; size and banding of human chromosomes; Distribution of tandems and interspersed repetitive DNA,CpG islands, RNA-encoding genes, gene distribution and density in human nuclear genome;Functionally identical/similar genes, Diversity in size and organization of genes, Annotation Gene families: Multigene families – Classical gene families, families with large conserved domains, families with small conserved domains, Gene superfamilies, Gene families in clusters, Pseudogenes, Repetitive DNA and transposable elements, Origin of gene families organization of genes coding for rRNA, mRNA, small nuclear RNA

Unit VI:Population and Evolutionary Genetics: Pedigree analysis; Calculation of allele frequencies, Hardy Weinberg principal for calculating recessive gene frequency, calculating frequency of sex –linked alleles.Molecular Evolution: Evolutionary change by mutation, gene flow, genetic drift, natural selection and non-random mating. Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny,DNA-based phylogenetic trees, classification and identification; origin of new genes and proteins; Gene duplication and divergence. Human molecular clock: deducing evolutionary histories through mitochondrial DNA and Y chromosome. Human phylogeny (Hominid evolution: (Anatomical, Geographical, Cultural), Molecular phylogenetics of Homo sapiens, Peopling of continents (Europe, Africa, Asia) (**5 Lectures)**

Reference Book:

1. Introduction to Genetic Analysis - by Griffiths et al.
2. Concepts of Genetics - by Klug et al
3. Principles of Genetics - by Snustad et al.

Semester 5: **Subject Code: LIF052** **Credits: 3**

Title: Plant Biology (Diversity and Taxonomy)

Specific objectives:

- To understand the diversity and taxonomy of plants
- To understand the adaptations that the primitive plants needed to survive on land.

Learning outcome:

- Detailed understanding about the cellular organization and evolution of plants.

Pre-requisite:

- Compulsory course for 3rd year I. M.Sc., Life Sciences students

Syllabus

UNIT I: Algae: History of algal studies in India, Habit and Habitat, General characters, classification and economic importance. Important features and life histories of members of Cyanophyceae (Oscillatoria, Nostoc), Chlorophyceae (Chlamydomonas, Volvox ,Oedogonium). Important features and life histories of members of Xanthophyceae (Vaucheria) Phaeophyceae (Ectocarpus, Sargassum), Rhodophyceae (Batrachospermum, Polysiphonia). **(12h)**

UNIT II: Fugi and Lichens: General characteristics, classification and economic importance of fungi. Important features and life histories of members of Mastigomycotina (Pythium, Phytophthora); Zygomycotina (Mucor); Ascomycotina (Saccharomyces, Eurotium, Chaetomium, Peziza); Basidiomycotina (Puccinia, Agaricus); Deuteromycotina (Cercospora, Colletotrichum). General account of Lichens. **(12h)**

UNIT III: Bryophytes: General characters, classification and economic importance. Bryophytes as amphibians of plant kingdom, adaptive characters for land habitat displaying heterologous alternation of generations. Characters of bryopsida, hepaticopsida and anthocerotopsida. **L**ife cycles of some members of Hepaticopsida (Marchantia, Pellia, Porella), Anthocerotopsida (Anthoceros), Bryopsida (Funaria Sphagnum, andPolytrichum). Economic importance. **(12h)**

UNIT IV: Pteridophytes: The first vascular plants, salient feature of structures and life cycle of representative members of the classes (Psilotum, Lycopodium, Equisetum, Nephrodium, Pteris and Marsilea). A comparative study of stelar system in pteridophytes. **(10h)**

UNIT V: Plant organization, external and internal, different groups of plants, the basic body plan of flowering plants. Cells and tissues: The shoot, root and leaf meristems and their histological organization and function, types of cell, tissues and tissue systems, chemical and ultrastructure of cell and cell wall. **(12h)**

Reference Books

1. Salisbury, F. B. and Ross, C.W. Plant Biology.
2. Hopkins, W. G and Huner, N. P. A. Introduction to Plant Biology.
3. Mukherji, S and Gosh A. K. Plant Biology

Evaluation:

Components	Weightage (%)
Internals I, II & III	30
Assignment/Seminars/Quiz	10
End Semester Exam	60

Semester 5: Subject Code: LIF053, Credits: 3

Title: Basic Microbiology

Unit I: Introduction to microbiology, The classical golden age of microbiology, the second and third golden age of microbiology, concepts and tools for studying microorganisms, classifying microorganisms, diversity of bacteria and archea, cell shape arrangements, external cell structures, the cell envelope, cell cytoplasm and internal structures,. Methods of microbial identification, cultivation and enumeration of microbes from environment, Ecology of micro-organisms, Ultrastructure of algae, protozoa and viruses. **(12h)**

UNIT II Microbial reproduction and growth, Enzymes and energy in microbial metabolism, catabolism of glucose, the anabolism of carbohydrates, physical and chemical methods of microbial control, Concept of Sterilization. **(10h)**

UNIT III: Stains and staining techniques – Definition of auxochrome , chromophores, dyes, Classification of stains, Theories of staining, Mechanism of gram staining, acid fast staining, negative staining, capsule. **(6h)**

UNIT IV Microbial genetics: DNA and chromosomes,DNAreplication,protein synthesis, genetic recombination in bacteria, genetic engineering, microbial genomics, phenotypes in bacterial genetics, inheritance in bacteria, mutation rates, types of mutations, reversion versus suppression, identifying mutants, genetic analysis in bacteria, properties of plasmid, DNA repair, bacterial cell compartmentalization and sporulation. **(12h)**

UNIT V: The host microbe relationship,pathogenicity of microorganisms, establishment of infection and diseases, infectious disease epidemiology, resistance and the immune system. Vaccines and antibiotics- the history and perspectives of antimicrobial agents, synthetic antibacterial agents, beta lactum family of antibiotics, bacterially produced antibiotics, antiviral, antifungal and antiparasitic drugs, Antibiotics assays and resistance,diagnostic microbiology**.(12h)**

Recommended Books

a) Brock's Biology of Microorganisms by Madigan et al.
b) Microbiology by Prescott et al.
c) Lippincott's microbiology

Semester 5: Subject Code: LIF054, Credits 3

Title- Animal Physiology

Unit I: The Body As A Whole : Organization of the Body , The Chemical Basis of Life, Anatomy of Cells , Physiology of Cells, Tissues.

Unit II: Communication, Control &Integration: Nervous System Cells, Central Nervous System, Peripheral Nervous System, Sense Organs, Muscular System

Unit III: Transportation &Defence: Blood, Anatomy of the Cardiovascular System, Physiology of the Cardiovascular System, Lymphatic System, Immune System, Stress

Unit IV: Respiration, Digestion & Excretion: Anatomy of the Respiratory System, Physiology of the Respiratory System ,Anatomy of the Digestive System, Physiology of the Digestive System, The Urinary System, Fluid and Electrolyte Balance,Acid-Base Balance

Unit V: Reproduction : Male Reproductive System, Female Reproductive System

Course schedule

Lecture No.	Topic(s)/ Units
1-10	Unit 1
11-15	Unit 2
16-26	Unit 3
26-36	Unit 4
36-45	Unit 5

Uniqueness of the course:

The course will provide a conceptual physiological framework for understanding the lives of animals at every level of organisation. It starts with essential chemical and physical laws that govern physiological processes in animals. These provide a foundation to understand the breadth of physiology. The course illustrates how the major physiological systems function and integrate to sustain the lives of animals. Although the basic principles and mechanisms of major physiological systems form the central theme of this course, the importance of integrating knowledge across physiology disciplines with molecular biology, behaviour, ecology and other fields is also emphasised.

Reference Books:

1. Medical Physiology by Guytun and Hall
2. Medical Physiology by Gangong

Learning materials:

Text books

Research and Review articles

E materials

Journal of Animal Physiology

Physiology and Behaviour

Physiological Reviews

1. **Assignments:** will be assigned as per the requirement during classes
2. **Evaluation /Grade Policy:**

Components	Weightage (%)
Internals 1, II & II	30
Assignments/Seminars	10
End Semester Exams	60

Semester 5, Subject Code: LIF055 **Credits: 3**

Title: Microbiology Practical

1. Introduction of Microbiology, Laboratory Safety, Use of Equipment; Sterilization Techniques;
2. Preparation of cotton plugs and preparation of media.
3. Sterilization techniques – dry heat, wet heat, chemical sterilization
4. Culture Media-Types and Use; Preparation of Nutrient broth and agar
5. Culture Techniques, Isolation and Preservation of Cultures- Broth: flask, test tubes; Solid: Pour plates, streak plates, slants, stabs
6. Gram staining, Microscopy methods in the study of microorganisms – Working and care of Microscope
7. Isolation of pure cultures from soil, air and water samples.
8. Effect of pH on the growth of bacteria
8. Measurement of bacterial population by turbidimetry and colony counting by serial dilution of samples
9. Determination of bacterial growth at different salt conditions
10. Determination of minimum inhibitory concentration of antibiotics.
10. Antibiotic Sensitivity tests-disc method
11. Growth Curve in Bacteria and Yeast
12. Preservation of pure cultures: slant preparation, water stock, glycerol stock
13. Biochemical tests for bacterial identification

Semester 5: Subject Code: LIF056: Credits: 3

Title: Virology

1. Origins of virology, viruses as a living system etc.
2. Classification of viruses
3. Organization of viruses: Protein structure and assembly, nucleic acid packaging, geometrical aspects, cosahedral and helical symmetry
4. Virus attachment and entry in to host cells.
5. SKG Cellular and molecular biology of Host virus interaction
6. Genome replication and mRNA production by RNA viruses.
7. Reverse transcription and integration in to the host genome (retroviruses)
8. DNA virus replication strategies.
9. Unique features of viral gene expression
10. Translational control of viral gene expression
11. Viral pathogenesis and cell transformation by viruses.
12. Viral Genetics, Viral vaccines, Antiviral chemotherapy, Persistence of viruses.
13. Hepadnaviruses, HIV, Polyomaviruses (SV40),Baculovirus, Topsoviruses, Potyviruses
14. Virus evolution
15. Viral vectors and gene therapy

Suggested reading:

Principles of Virology by S J Flint, LW Enquest, R M Krug, V R Racanielo and A M Skalka. ASM Press, Wahington DC

Matthews' Plant Virology by Roger Hull. Elsevier Fourth Edition

Semester 6: Subject Code: LIF061, Credits: 3
Title: Biochemistry- Intermediary Metabolism

Specific objectives*:*

- *To understand metabolic pathways, their interrelationship with various metabolism involved in Biochemistry*
- *To understand the mechanisms of pathway regulation at an advanced level.*

Learning outcome*:*

- *Understanding of Biochemistry at the molecular level*

Pre-requisite:

- *Compulsory for the 3rd year I. M.Sc., Life Sciences students*

Syllabus contents:

Unit I: Metabolism: Basic concepts- Anabolism and Catabolism, Role of ATP in metabolism, High energy compounds and intermediates, Common types of reactions involved in metabolism. (5 Lectures)

Unit II: Carbohydrate metabolism: Glycolysis- Aerobic and Anaerobic, Regulation of glycolysis, TCA cycle and its regulation; Glycogen metabolism- Glycogenesis and Glycogenolysis, Glycogen storage diseases; Gluconeogenesis, Pentose Phosphate pathway (HMP shunt) and Glyoxylate cycle (12 Lectures)

UNIT III: Protein metabolism: Biosynthesis of amino acids (Overview only), Catabolism of amino acid nitrogen- transamination, deamination, ammonia formation and the Urea cycle. Catabolism of carbon skeletons of amino acids. Conversion of amino acids to special products. Disorders of amino acid metabolism (14 Lectures)

Unit IV: Metabolism of Lipids: Fatty acid oxidation, Biosynthesis of fatty acids, Elongation and Unsaturation of fatty acids, Comparison of fatty acid oxidation with synthesis; Tri- acyl glycerol biosynthesis, Cholesterol biosynthesis and its regulation, Ketone Bodies (14 Lectures)

Unit V: Nucleic Acid Metabolism: Purine- Biosynthesis, Regulation and degradation; Pyrimidine- Biosynthesis, Regulation and degradation; Formation of Uric acid; Gout; Disorders associated with nucleic acid metabolism (14 Lectures)

Reference Books:

1. Lehninger AL., Nelson DL, Cox MM, **Principles of Biochemistry**, CBS publications
2. Stryer L., **Biochemistry, (Recent Edition)**, WH Freeman and Company, New York.
3. Voet D, Voet G, **Biochemistry,** John Wiley and Sons
4. Zubay G, **Biochemistry,** Maxwell Macmillan International Editors
5. Conn E and PK Stump, **Outlines of Biochemistry,** Willey Eastern Ltd, New Delhi

Evaluation Policy:

Components	**Weightage (%)**
Internal I, II & III	30
Assignment/Seminars/Quiz	10
End Semester Exams	60

Semester 6: Subject Code: LIF062, Credits: 3

TITLE: GENETIC ENGINEERING

Unit–I Restriction endonucleases, cloning vectors, and ligation

Basic steps in gene cloning. Type II Restriction endonucleases. Cloning vectors: plasmids (pBR322 and pUC), phage vectors (λ), cosmids, BACs and YACs. Methods of ligation of insert and vector DNA molecules: cohesive end method, homopolymeric tailing, blunt-end ligation, linkers and adapters.

Unit–II Gene transfer methods, cloning strategies & screening

Gene transfer methods: calcium phosphate coprecipitation, electroporation, lipofection, viruses, microinjection. Host organisms for cloning. Cloning strategies- genomic cloning, cDNA cloning. Screening of recombinants: marker inactivation (antibiotic resistance, blue-white selection), colony hybridization, immunoscreening, screening for protein activity.

Unit–III Expression systems

Factors affecting expression of cloned genes. Expression of insulin in bacteria. Expression in yeast- yeast vectors, GAL system. Baculovirus and Mammalian expression systems (brief account). Tagged proteins and secretion signals. Reporter genes- types and uses.

Unit–IV Transgenic Plants and Animals

Transgenic plant technology: Development of insect resistance, virus resistance, herbicide resistance and stress tolerant plants. Delayed fruit ripening. Terminator technology. Production of vaccines and antibodies in plants. Ethics of genetically engineered crops. Transgenic animal technology: Methods of producing transgenic animals (retroviral, microinjection, engineered stem cell). Application of transgenic animals. Transgenic animals as models of human disease.

Unit–V

Preparation of probes. DNA sequencing. automated method and next-generation sequencing. DNA fingerprinting-principle and applications. Brief outline of RFLP and FISH. PCR: basic reaction and applications. Modified PCR techniques-RT-PCR, real-time qPCR. Basic principles of gene knock-in and knock-out technology. Hazards and safety aspects of genetic engineering.

Text Books

1. Nicholls DTS. An Introduction to Genetic Engineering. 3rd ed. Cambridge Univ Press. 2008.
2. Glick and Pasternak. Molecular Biotechnology. 4th ed. ASM Press 2009.
3. Dale and von Schantz. From Genes to Genomes: Concepts and applications of DNA technology. 3rd ed. Wiley-Interscience. 2011.

References

1. Winnacker EL. From Genes to clones. 4thed VCH Publ. 2003.
2. Watson et al. Recombinant DNA 3rd ed. Sci Am Publ. 2002.

Semester 6: Subject Code: LIF063, Credits: 3

Title: Developmental Biology

Unit I: Basic concepts of development: Differentiation. Determination, trans determination. Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development

Unit II: Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis. Factors influencing cleavage - Fate map. Gastrulation and morphogenetic movements. Morphogenesis of germ layers. Morphogenetic field.

Unit III: Morphogenesis and organogenesis in animals : Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis – vulva formation in Caenorhabditiselegans, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination

Unit IV: Induction and Maturation: Induction, organization, competence and inductive response, Hierarchies of induction, principles of reciprocal action. Control of metamorphosis. Morphophysiology of metamorphosis in insects and frog. Histomorphological changes in regeneration of tail in Amphibians and Reptiles. Limb regeneration in amphibians. Vertebrate lens regeneration. Regeneration in Platyhelminthes and Coelenterates. Concept of growth at cellular, subcellular and organ level.

Text books: Developmental Biology, Scott F Gilbert

Semester 6, **Subject Code: LIF064, Credits: 3**

Title: Immunology

1. **Specific objectives**: To understand the basis of immune functions during physiological and pathological conditions
2. **Learning outcomes**: A student chosen this course will be enlightened by the cellular, molecular basis of various cells, parts of immune system followed by current knowledge of recent trends in immunology
3. **Pre-requisite:**
   - ***a.*** **Compulsory**:

A basic exposure Biology is compulsory.

- ***b.*** **Desirable:** A basic idea of Immunology

4. **Syllabus : Paper name: Immunology**

Unit I: Overview of the immune system- Cells and organs of the immune system. Innate and adaptive immunity. Innate immunity & complement. Recognition of antigen: Antigen recognition by B and T cell receptor, the generation of Lymphocytes antigen receptor, Antigen presentation to T lymphocytes

UNIT II: Hematopoiesis. VDJ joining: T and B cells. B cell maturation & class switching. Somatic hypermutation. Dendritic cells.

UNIT III: MHC: T cell-antigen presenting cell: interactions'-B cells interactions. Chemokine & Adhesion molecules.

UNIT IV: Signal transduction in immune cells.T cell subsets, Regulatory T cells, Th17 cells. Clonal selection, and central tolerance. Peripheral regulation.

UNIT V: The Immune System in Health and Diseases: Failure of host defence mechanism; Acquired immunodeficiency; Allergy and hypersensitivity; Autoimmunity and transplantation Manipulation of the immune system

5. Course schedule

Lecture No.	Topic(s)/ Units
1-10	Unit 1
11-15	Unit 2
16-26	Unit 3
26-36	Unit 4
36-45	Unit 5

6.Uniqueness of the course:

Immunology is the study of our immune system, a highly sophisticated system that defends us against all disease-causing invaders by identifying and neutralizing such threats. Even though we might get sick every now and then, the immune system does an incredible job of warding off infection given how many infectious agents (thousands!) we come into contact with every day. This becomes most apparent when a healthy individual compares himself or herself to an individual with little or no immune response who cannot survive in a normal environment and must rely on specialized rooms much cleaner than even a surgery room. Before the discovery of immunity, we used to associate sickness and disease with various superstitions and beliefs. Only with the discovery of bacteria, viruses, and our own cells did scientists slowly piece together the modern theory of our immune system. Our overall system can be broken down into two sub-systems, each with its own unique cells, molecules, and functions. Our cells are in turn capable of recognizing billions of different patterns of molecules, all of them alien to ourselves, which helps us identify foreign invaders. It is

important to recognize that, as with any system in our body, when the immune system malfunctions, disease can result. In this course we will take a look at what happens when an inappropriate immune response takes place.

Reference Books: References:

1. Mostly, current research reports and reviews will be used as study materials. Recent articles from Annual Review of *Immunology, Current Opinion in Immunology, Nature Immunology etc. will be consulted*.
2. K. M. Murphy, P. Travers and M. Walport, *Janewayâ Immunobiology*, 7th Edn., Garland Science
3. JanewaysImmunobiology. Kenneth Murphy, Paul Travers, Mark Walport. 7th Edition, Garland Science.
4. Kuby Immunology. Thomas J. Kindt, Richard A. Goldsby, Barbara A Osborne. 6th Edition. W.H. Freeman.

6. **Learning materials:**

Text books
Research and Review articles

7. **E-materials:**
   - http://aai.org/Education/Summer_Teachers/Archive.html Teaching Material Archives, The American Association of Immunologists
   - http://onlinelibrary.wiley.com/journal/10.1111/%28ISSN%291600-065X, Immunological Reviews
   - http://www.nature.com/nri/index.html, Nature Reviews Immunology
8. **Assignments:** will be assigned as per the requirement during classes

9. **Evaluation /Grade Policy:**

Components	Weightage (%)
Internals 1, II & II	30
Assignments/Seminars	10
End Semester Exams	60

Semester 6: Subject Code: LIF065, Credits: 3

Title: Immunology Practical

1. Immunoprecipitation,
    - Single Immunodiffusion
    - Double Immunodiffusion
2. Agglutination tests
    - Tube agglutination Tests
    - Slide agglutination Tests
    - Indirect agglutination Test
3. ELISA-Antigen and Antibody capture, Sandwich,
4. Venereal Disease Research Laboratory (VDRL)
5. Rapid Plasma Resonance
6. Widal test
7. Immunoelectrophoresis
8. Hemagglutination Assay

Semester 6: Subject Code: LIF066, Credits: 3

Title: Biochemistry practical

Specific objective*:*

- *To acquire expertise on biochemical techniques*

Learning outcome*:*

- *Quantitative and Qualitative experiments; analysis of carbohydrates, proteins and nucleic acids*

Pre-requisite:

- *Compulsory for the 3rd year I. M.Sc., Life Sciences students*

Syllabus contents:

1. Qualitative analysis of carbohydrates
2. Color reactions of amino acids
3. Estimation of ascorbic acid by titrimetric method using 2,6-dichlorophenol indophenol.
4. Estimation of protein by Lowry et al method.
5. Estimation of DNA by diphenylamine method.
6. Estimation of RNA by orcinol method
7. Quantitative estimations in Blood (Such as Glucose, Cholesterol, Calcium)
8. Clinical Biochemistry- Hb content, Blood grouping and ESR
9. Estimation of Creatinine by Jaffe's method
10. Isolation of Proteins
11. Determination of enzyme activity
12. Effect of pH on Enzyme activity.

Reference Books:

1. Practical Biochemistry – Varley.
2. Practical Biochemistry – Plummer.
3. Introductory practical Biochemistry – S.K. Sawhney, Randhir Singh.
4. Practical clinical Biochemistry – Harold Varley.
5. Introductory practical Biochemistry – S.K. Sawhney, Randhir Singh.
6. Text book of Clinical Chemistry – Tietz.

Evaluation Policy:

Components	**Weightage (%)**
Internal evaluation: Laboratory performance, handling of equipment, results and maintenance of work book	60
Continuous evaluation: Knowledge of experiments, reproducible results and Viva	40

Semester 7: Subject Code: LIF071, Credits: 3

Title: BIOTECHNOLOGY

Unit–I Bioprocess Engineering and Downstream Processing

Introduction to biotechnology. Bioprocess engineering: Isolation and screening of industrially important microbes. Bioreactors- fermentation media. Downstream processing: solid-liquid separation, release of intracellular compartments, concentration of biological products, purification, preservation and stabilization. Industrial production of ethanol.

Unit–II Environmental and Energy Biotechnology

Wastewater treatment- physical, chemical and biological treatment processes. Effluent treatment. Bioremediation, oil spill clean up. Biodegradable plastics. Bioleaching- use of microorganisms in mining. Soil microbiota biogeochemical role of soil microorganisms. Ecological considerations, decay behaviour and degradative plasmids. Microbial degradation of xenobiotics. Renewable sources of energy, biogas production.

Unit–III Enzyme and Food Technology

Immobilization of enzymes: methods, and applications. Biosensors. Use of enzymes in detergents, textiles, leather and food industry. Production of glucose syrup. Methods of food preservation. Elementary idea of canning and packing. Basic principles of food fermentation. Production of beer.

Unit–IV Plant Biotechnology

Growth and development of plant cells and tissues *in vitro*. Callus, suspension, and protoplast culture. Somaclonal & Gametoclonal variation. Haploid production. Cryopreservation and *ex situ* conservation of germplasm. *In vitro* pollination and fertilization, embryo culture, endosperm culture and production of seedless plants. Somatic hybridization. Biofertilisers. Biopesticides (*Bacillus thuringiensis*).

Unit–V Animal Biotechnology

Cell and tissue culture- aseptic techniques, substrates, culture media, freeze storing, transport, contamination. Primary cell culture: disaggregation, separation of viable cells. Secondary culture, continuous cell lines. Commercial applications of animal tissue culture. Manipulation of reproduction in animals. Artificial insemination, embryo transfer, *in vitro* fertilization. Embryo transfer in cattle and applications. Somatic cell cloning - cloning of Dolly. Ethical issues.

Text Books

1. Smith. JE. Biotechnology. Cambridge Univ Press. 5th ed. 2012.
2. Singh B.D. Biotechnology. Expanding horizons. 2004 Kalyani Publ.
3. Ratledge and Kristiansen. Basic Biotechnology 3rd ed. Cambridge Univ. Press 2006.
4. Martin BM. Tissue Culture Techniques- An Introduction. 1994. Birkhauser.
5. Smith RH. Plant tissue culture. 3rd ed. Elsevier. 2013.

Reference Books

1. Mather JP and Barnes D. Animal Cell Culture Methods. Vol 57, Elsevier.

2. Freshney RI. Culture of animal cells: A manual of basic technique. 6th ed. Wiley-Liss, 2010.

Semester 7: Subject Code: LIF072: Credits : 3

Title: Molecular Biology

Specific objectives*:*

- *To emphasize the molecular mechanisms involved in the synthesis of DNA, RNA and protein.*
- *To understand the gene regulations involved in both the prokaryotes and eukaryotes*

Learning outcome*:*

- *Understanding of the molecular biology at an advanced level*

Pre-requisite:

- *Compulsory for the 4th year I. M.Sc., Life Sciences students*

Syllabus contents:

UNIT I: Discovery of DNA- evidence for DNA as the genetic material; Central dogma of molecular biology; Gene transfer in microorganisms- Conjugation, Transduction and Transformation. DNA Replication- Types of replication, evidence for semiconservative replication - Meselson and Stahl experiment. Enzymes and necessary proteins involved in DNA replication (10 Lectures)

UNIT-II: Replication in prokaryotes- replication bubble, bidirectional replication, replicon, DNA polymerases, lagging and leading strand synthesis, Okazaki fragments, Mechanism of replication, action of SSB, primase, DNA gyrase. The fidelity of DNA replication, Overview mechanism of Eukaryotic replication. Telomeres, telomerase and end replication. Inhibitors of Replication (12 Lectures)

UNIT III: Definitions of coding strand, template strand, sense strand and antisense strand, promotor, Transcription in prokaryotes- RNA polymerases, Mechanism of transcription-Initiation, elongation and Termination (Rho- dependent and independent termination), housekeeping genes. Transcription in Eukaryotes- Mechanism, posttranscriptional processing and its significance- capping, tailing, splicing, Processing of rRNA and tRNA. RNA editing. (14 Lectures)

UNIT-IV: Genetic code, wobble mechanism and its significance, Types of RNA molecules, structure of tRNA, composition of prokaryotic and eukaryotic ribosomes, Protein biosynthesis in prokaryotes and eukaryotes- Activation of amino acids, initiation, chain elongation, translocation and termination. translational machinery- Mechanism of initiation-elongation and termination- Regulation of translation (12 Lectures)

UNIT V: Post-translational modifications in prokaryotes and eukaryotes, inhibitors of protein synthesis. Protein modifications, folding and export of proteins; General principles, gene expression and regulations, molecular mechanism of regulation in prokaryotes - operon model. Mutagenesis, DNA damage and repair (10 Lectures)

References books;

1. Freifelder D, **Molecular Biology**, 2nd edition. Narosa Publishing House, India
2. **Fundamentals of molecular evolution,** by Dan Graur and Wen-Hsiung Li (Sinauer Associates, Inc., Publishers Sunderland, Massachusetts)
3. **Molecular Biology of the Cell,** Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. New York: Garland Science; 2002. ISBN-10: 0-8153-3218-1ISBN-10: 0-8153-4072-9
4. Genes VII by B. Lewin Oxford University Press, Cell Press, London
5. Cell and molecular biology by G. Karp, John Wiley & Sons Inc.

Evaluation Policy:

Components	Weightage (%)
Internal evaluation: Laboratory performance, handling of equipment, results and maintenance of work book	60
Continuous evaluation: Knowledge of experiments, reproducible results and Viva	40

Semester 7: Subject Code: LIF073: Credits : 3

Title: Analytical Techniques

Unit I: Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism. Evolution of the cell, From molecules to first cell, From Prokaryotes to eukaryotes, From single cells to multicellular organisms, Functional differentiation of cells/cell types. (5 Lectures)

Unit II: **Principles & methods of taxonomy:** Evolutionary concepts: Lamarckism, Darwinism and Speciation Concepts of species and hierarchical taxa, biological nomenclature, classical & quantititative methods of taxonomy of plants, animals and microorganisms. (4 Lectures)

Unit III: Levels of structural organization: Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs & systems. Comparative anatomy, adaptive radiation, adaptive modifications. (3 lectures)

Unit IV: Outline classification of plants, animals & microorganisms: Important criteria used for classification in each taxon. Classification of plants, animals and microorganisms. Evolutionary relationships among taxa. (3 lectures)

Unit V: Natural history of Indian subcontinent: Major habitat types of the subcontinent, geographic origins and migrations of species. Common Indian mammals, birds. Seasonality and phenology of the subcontinent. Rare, endangered species. Conservation strategies. (3 lectures)

Reference Books:

Campbell, NA, and Reece, JB, Biology, Pearson Benjamin Cummings, San Franscisco.

Raven, PH *et al.,*Biology, Tata McGraw Hill publications, New Delhi.

Semester 7: Subject Code: LIF074: Credits: 3

Title: Vector Biology and Infectious Disease Biology Specific objectives:

To understand the vectors and diseases caused by them

Learning outcomes: A student chosen this course will be enlightened by the Biology of vectors, parasites, their control and treatments available

Pre-requisite:

a. **Compulsory**:

A basic exposure to, invertebrate biology, immunology is compulsory. Students of 3rd and 4th year, IMSc in Life Sciences, Physics, Chemistry and Maths can register.

b. **Desirable:** Knowledge about medical entomology is preferable

Syllabus : Paper name:

Unit I: Introductory: Introduction to vector borne diseases, Vector taxonomy (mosquitoes, sand flies, fleas, ticks and mites etc), Diagnosis of important vector borne diseases, Epidemiology

Unit II: Parasitic vector borne diseases in India: Malaria, Lymphatic filariasis, Visceral leishmaniasis

Unit III: Other vector borne diseases: Dengue and Chikungunya, Japanese encephalitis, Chandipura, Kysanur Forest Diseases, Scrub typhus, Plague, Leptospirosis, Zika, Congo-crimean hemorrhagic fever, West nile

Unit IV: Transmission biology: Vector biology, Vector character, Disease transmission, Identification of pathogens in vectors

Unit V: Vector management : Vector control methods, Integrated vector management, Insecticide resistance, New vector control methods

Unit VI: Climate change impact on vector borne diseases

Course schedule

Lecture No	Topics/Units
1-12	Unit 1
13-24	Unit 2
25-36	Unit 3
37-48	Unit 4
49-60	Unit 5

Uniqueness of the course:

Vector borne diseases are a threat to the community worldwide. Each year2.5 billion people in over 100 countries (WHO reports) die of such diseases. A complete understanding of the spread and control of such vectors are very much essential to Life Sciences students for taking up a research career in medical entomology/vector biology etc. This course is unique in a way that it provides the biology of vectors, diseases caused by them and control. Immunological inputs of some parasites and vector/parasite relationship will also be taught.

Reference Books: References:

1. Service M. W, Medical Entomology for students. Chapman & Hall, London
2. Imms, A. D. A general text book of Entomology. ELBS, London
3. Marquardt, W.C. Biology of disease vectors (2nd Edition). Doody Enterprises, Inc. USA
4. Service, M. W. Mosquito Ecology, Field sampling methods. Applied Science Publishing Ltd., London.

Learning materials:

Text books
Research and Review articles

E-materials:

WHO guidelines ICMR reports
National Academy of Vector Borne Diseases Reports National Institute of Malarial Research reports

Assignments: will be assigned as per the requirement during classes

Evaluation /Grade Policy:

Components	Weightage (%)
Internals 1, II & II	30
Assignments/Seminars	10
End Semester Exams	60

Semester 7: Subject Code: LIF075: Credits: 3

Title: Endocrinology

Objectives: This course emphasizes the general aspects of hormone action and physiological and biochemical effects of individual hormones. Disorders related to hormonal actions are included to understand the regulatory role of hormones.

Unit – I Hypothalamic and Pituitary hormones

classification of hormones and mechanism of action. Hypothalamic and pitutary hormones. Hypothalamic releasing factors. Anterior pitutary hormones: biological actions, regulation and disorders of growth hormone, ACTH, gonadotropins and prolactin. Leptin.

Posterior pitutary hormones-biological actions of vasopressin. Diabetes insipidus and syndrome of inappropriate ADH secretion (SIADH) Oxytocin. Hypopituitarisn.

Unit – II Thyroid and Parathyroid hormones

Thyroid hormones – synthesis, secretion, regulation, transport, metabolic fate and biological actions. Antithyroid agents. Thyroid function tests. Hyper and hypothyroidism. Hormonal regulation of calcium and phosphate metabolism. Secretion and biological actions of PTH, calcitonin and calcitriol. Hypercalcemia and hypocalcemia Rickets and osteomalacia.

Unit – III Adrenal hormones

Adrenal cortical hormones. Synthesis, regulation, transport, metabolism and biological effects. Hypo and hyper function – Cushing's syndrome, aldosteronism, CAH, aderenal cortical insufficiency, Addison's disese.

Aderenal medullary hormones – synthesis secretion, metabolism, regulation and biological effects of catecholamines. Phaeochromocytoma.

Unit – IV Gonadal, Gastrointestinal and Pancreatic hormones

Gonadal hormnones: Biosynthesis, regulation, transport metabolism and biological actions of androgens. Hypogonadism and gynecomastia, Biosynthesis, regulation, transport, metabolism and biological effects of oestrogen and progesterone. The menstrual cycle. Pancreatic hormones-synthesis, regulation, biological effects and mechanism of action of glucagon, somatostatin and insulin. Insulin receptor. Brief account of gastrointestinal hormones.

Unit – V Signal transduction

Cell signaling – Modes of cell signaling – endocrine, paracrine, autocrine. Steroid hormones and nuclear receptor superfamily. Peptide hormones and growth factors. Nitric oxide. Functionas of cell surface receptors – GPCR, receptor protein/tyrosin kinase, receptor linked to protein throsine phosphatase, ser/thr kinases guanyl cyclase. Signal transduction – cAMP pathway, cGMP, phospholopids and calcium, MAP kinase pathway, P13k-Akt and JAK/STAT pathway.

Text Books

1.William Text Book of Endocrinology, S. Melmed et al., 12th ition, Saunders (2011)
2. Murray et al. Harper's illustrated Biochemistry. 29Th . McGraw Hill, 2012
3. Nelson and Cox. Lehninger Principles of Biochemisrty. Freeman, 6 ed. 2012
4. Clinical Chemisrty in diagnosis and treatment Mayne ELBS. (1999)
5 Clinical Chemistry 6 edition W. J. Marshall, M. Lapsley, S. K Bangert 6th dition Mosby (2008)

Semester 7: Subject Code: LIF076_____Credits : 3

Title: Molecular Biology Practical

Specific objective*:*

- *To acquire expertise on molecular techniques*

Learning outcome*:*

- *Understanding of techniques involved in molecular biology*

Pre-requisite:

- *Compulsory for the 4th year I. M.Sc., Life Sciences students*

Syllabus contents:

1. Isolation of genomic DNA from human blood
2. Quantification of DNA using spectrophotometer
3. Agarose gel electrophoresis
4. Primer Designing
5. Polymerase Chain Reaction
6. Restriction digestion plasmid DNA
7. Isolation of DNA fragment from agarose gel
8. Polyacrylamide gel electrophoresis and silver staining of protein.
9. Isolation of genomic DNA from dicot and monocot plants
10. Isolation of RNA from leaves
11. Western blot analysis of expressed plant proteins

Reference Books:

1. Freifelder D, " Molecular Biology ", Jones and Bartlett Publishers Inc. 1987.

Evaluation Policy:

Components	Weightage (%)
Internal evaluation: Laboratory performance, handling of equipment, results and maintenance of work book	60
Continuous evaluation: Knowledge of experiments, reproducible results and Viva	40

Semester 8, Subject Code, LIF082:Credits : 3

Title: Plant Physiology

Specific objectives:

- To understand the basic physiology of the plants
- To gain deeper understanding on the molecular aspects of plant physiology and bio-chemistry.

Learning outcome:

- Detailed understanding about molecular physiology of plants.

Pre-requisite:

- Compulsory course for 4th year I. M.Sc., Life sciences students

Syllabus

UNIT I: Water relations: Properties of water, Soil plant atmosphere continuum. Transport processes in plant: Active and passive transport systems, xylem and phloem transport, intra cellular movement of macromolecules. Photosynthesis: Light dependent and independent reactions, carbon fixation in C3, C4, CAM plants. **(12h)**

UNIT II: Respiration: Overview of cellular respiration, plant mitochondrial electron transport, photo–respiration. Photomorphogenesis: Phytochromes, cryptochromes, photomorphogenesis. **(8h)**

UNIT III: Mineral nutrition and assimilations of inorganic nutrients: Plant mycorrhizal association, nitrogen metabolism, sulfur metabolism, phosphate metabolism. Lipid metabolism in plants: Fatty acid biosynthesis, membrane lipid biosynthesis, lipid desaturation, triacylglycerols, complex lipids, cell wall lipids. **(12h)**

UNIT IV: Plant hormones: Introduction and concept, types of growth regulators. (a) Auxin: The master growth hormone, Avena coleoptiles bioassay, discovery, distribution, roles and functions, auxin mutants, perception, and binding proteins, signal transduction, auxin responsive genes/promoters/factors. Model for gene regulation, derepression of early auxin genes, polar auxin transport. (b) Gibberellins: Foolish seedling disease, location, forms, functions, mechanism, signal transduction and mechanism of action of Gibberellins- alpha-amylase as an example, commercial applications.(c) Cytokinins: Location, functions and mechanism of action, commercial applications.(d) Ethylene: Discovery, locations and functions, mutants, mechanism of actions, applications.(e) Abscisic acid: Natural stress hormone, discovery, location and functions, mutants, mechanism of action.(f) Brassinosteroids, Jasmonic acid, Salicylic acid and Polyamines. **(14h)**

UNIT V: Plant immune system: Genetic basis of plant pathogen interactions, Plant defense system, systemic acquired resistance, MAM, PAM, PAMP-Triggered Immunity (PTI) and effector-triggered immunity (ETI), hypersensitive response. **(8h)**

Recommended Books

1. Plant Physiology - by Frank Salisbury, Cleon Ross
2. Introduction to Plant Physiology - by W.G. Hopkins
3. Plant Physiology - by Taiz and Zeiger
4. Plant-pathogen Interaction - by N. Talbot
5. Biochemistry and Molecular Biology of Plants - by Buchanan et al

Evaluation:

Components	**Weightage (%)**
Internals I, II & III	30
Assignment/Seminars/Quiz	10
End Semester Exam	60

Semester 8: Subject Code: LIF083 Credits: 3

Title: Neurobiology

Specific objectives:

- To understand the basic physiology of the Brain , and its cells
- To gain deeper understanding on the molecular aspects of functioning of nervous systems during physiological and pathological conditions

Learning outcome:

- Detailed understanding about molecular physiology of Neurons and its supporting cells

Pre-requisite:

- Compulsory course for 4th year I. M.Sc., Life sciences students

1. **Introduction:** To cellular and molecular basis of nervous system and its uniqueness.
2. **Neural Development:**
    a. Turning embryonic stem cells into neurons
    b. Glial guided neuronal migration, Path finding Axon guidance
3. **The macroscopic Organization of the Birth:**
    a. Functional Anatomy of the brain
    b. Cellular heterogeneity of nervous system
    c. Blood Brain barrier and its disorder
4. **Synaptic Transmission: Electrical and Chemical transmission**

Membrane Potentials (Resting and Action Potentials)

    a. Ion Channels and Voltage -gated Channels
    b. Synapse formation
    c. Neurotransmitters (synthesis, storage and Function)
    d. Disorders of Synaptic Transmission
5. **Cognitive Neurosciences:**
    a. Role of limbic System in cognition,
    b. cellular and molecular basis for learning and memory
    c. Synaptic Plasticity

Suggested reading:

1. Kandel E.R, Schwartz J.H, Jessell T.M. principles of Neural Science. McGraw-Hill Companies.
2. Siegel GJ, Agranoff BW, Albers RW, Molinoff PB. Basic Neurochemistry. Raven Press.
3. Scott B, Price D.L. Basic Neurochemistry
4. Purves D. Neurosciences.

Evaluation:

Components	Weightage (%)
Internals I, II & III	30
Assignment/Seminars/Quiz	10
End Semester Exam	60

Lecture Schedule

Lecture No.	Topic(s)/ Units
1-12	Unit 1
13-24	Unit 2
25-36	Unit 3
37-48	Unit 4
49-60	Unit 5

Semester 8: Subject Code: LIF084: Credits: 3

Title: Advanced Microbiology

UNIT I: Clinical Microbiology, Survey of disease causing microbes, Mechanisms of Pathogenesis, Antibiotics and their targets, Immune response elicited by microorganisms Staphylococci, streptococci, gram positive rods, Neisseria, gastrointestinal gram negative rods, other gram negative rods, clostridia and other anaerobic rods, spirochetes, mycoplasma, chlamydiae, mycobacteria and actinomycetes, rickettsia. **(12h)**

Unit II: Characteristics and classification of fungi, classification and characteristics of protozoa , and helminthes. Viruses: Introduction to viruses, Non enveloped DNA viruses, Enveloped DNA viruses, Hepatitis B and Hepatitis D(delta viruses), Positive strand RNA viruses, Retroviruses and AIDS, Negative strand RNA viruses, Double stranded RNA viruses: the retroviridae, Unconventional infectious agents. **(10h)**

UNIT III: Diseases: Airborne bacterial diseases, food born and water born bacterial diseases, soil borne and arthropod born bacterial diseases, sexually transmitted and contact transmitted bacterial diseases, virus infections of the respiratory tract skin, viral infections of blood, lymphatic, gastrointestinal and nervous systems, fungal intoxications, fungal diseases of the skin, fungal diseases of the skin, lower respiratory tract, protozoan diseases of skin, digestive, urinary, blood and nervous system, the multicellular helminthes and helminthes infection.
(12h)

Unit IV: Microbes in Extreme Environment: The basis of extremophiles and their applications, Life of a thermophile (Thermus, Pyrococcus).Microbes and Agriculture: Symbiotic Nitrogen fixation Rhizobium, Cyanobacteria (Anabaena, Azolla etc.), Mycorrihiza. **(8h)**

Unit V: Industrial Microbiology: Major industrial products from microbes, Beverages, Antibiotics, Secondary metabolites, Recombinant products Environmental Microbiology: Nature of anthropogenic wastes, Municipal wastes and xenobiotics, Enrichment cultures, Xenobiotic degrading consortia, Bioremediation. **(10h)**

Recommended Books

a) Brock's Biology of Microorganisms by Madigan et al.
b) Microbiology by Prescott et al.
c) Lippincott's microbiology

Semester 5 Subject Code: LIF055 Credit
Title: Microbiology Practicals

1. Introduction of Microbiology, Laboratory Safety, Use of Equipment; Sterilization Techniques;
2. Preparation of cotton plugs and preparation of media.
3. Sterilization techniques – dry heat, wet heat, chemical sterilization
4. Culture Media-Types and Use; Preparation of Nutrient broth and agar
5. Culture Techniques, Isolation and Preservation of Cultures- Broth: flask, test tubes; Solid: Pour plates, streak plates, slants, stabs
6. Gram staining, Microscopy methods in the study of microorganisms – Working and care of Microscope
7. Isolation of pure cultures from soil, air and water samples.
8. Effect of pH on the growth of bacteria
8. Measurement of bacterial population by turbidimetry and colony counting by serial dilution of samples
9. Determination of bacterial growth at different salt conditions
10. Determination of minimum inhibitory concentration of antibiotics.
10. Antibiotic Sensitivity tests-disc method
11. Growth Curve in Bacteria and Yeast
12. Preservation of pure cultures: slant preparation, water stock, glycerol stock
13. Biochemical tests for bacterial identification

Recommended Books

a) Brock's Biology of Microorganisms by Madigan et al.
b) Microbiology by Prescott et al.
c) Lippincott's microbiology

Semester 8: Subject Code: LIF085: Credits: 3

Title: Bioinformatics& Biostatics

Unit I: Introduction to bio-informatics **Unit II**: Databases and Database searching
Unit III: Algorithms behind pairwise sequence alignments: Dynamic programming, Smith-Watermann, Needleman-Wunsch, Heuristic, BLAST, FastA, applications, Multiple sequence alignments: Importance, progressive sequence alignment, ClustalW, statistical parameters governing clustalW, applications.
Unit IV: Phylogenetic tree construction and different approaches: Introduction, importance, classification and parts of tree, predicting number of root and unrooted trees, orthologs and paralogs, different methods to construct phylogenetic tree, Neighbour-Joining (star decomposition method), transitions and transversions, substitutions matrices, bootstrapping, **Unit V:** Simple Statistics & Effect Statistics; Confidence Limits, Statistical Models; Repeated-Measures ANOVA, Principal Components · Factor Analysis · Cluster Analysis; Estimating Sample Size

Reference books

a) Introduction to bioinformatics – Arthur M. Lesk
b) Bioinformatics – David Mount
c) Essential bioinformatics – Jin Xiong
d) Statistics at the Bench: A Step-by-Step Handbook for Biologists by Martina Bremer

Semester 8: **Subject Code: LIF086,** **Credits: 3**
Title: Plant Physiology practicals

Specific objectives:

- To learn the methodologies and experimental protocols for understanding the physiology of plants.

Learning outcome:

- To understand and to gain experience in scientific approaches that are used for plant physiology research.

Pre-requisite:

- Compulsory course for 3rd year I. M.Sc., Life Sciences students

Syllabus contents

1. Identification of C3 and C4 plants.
2. Effect of plant growth regulators on seed germination
3. Isolation of chloroplasts and estimation of photochemical activity.
4. Determination of total chlorophyll content.
5. Estimation of starch content by Anthrone reagent.
6. Spectrophotometric estimation of Indoleacetic acid in plant tissues.
7. Drought and salt stress treatments to plants.
8. Western blot analysis for analysing changes in protein levels.
9. Determination of nitrate reductase activity in crop plants under low water regimes.
10. DNA isolation from leaves by CTAB method.
11. Determination of succinic dehydrogenase activity.
12. Determination of peroxidase activity.

Reference Books:

1. Practical text-book of Plant Physiology by Daniel Trembly Macdougal
2. Methods in Physiological Plant Pathology by A. Mahadevan and Sridhar
3. Practical Plant Physiology by Sivakumar, Boominathan and Chandrasekhar
4. A laboratory manual of Plant Physiology, Biochemistry and Ecology by Akhtar Inam

Evaluation

Components	Weightage (%)
Internal evaluation: Laboratory performance, handling of equipment, results and maintenance of work book	50
Continuous evaluation: Knowledge of experiments, reproducible results and Viva	50

Semester 9: Discipline Specific Electives , Totally 18 credits, 3 credits per paper

1. Cancer Biology
2. Clinical Biochemistry
3. Nano -Biotechnology
4. Neuroimmunology
5. Plant Desiccation Tolerance
6. Genomics and Proteomics

Extra elective papers:

- Principals of Drug Design,
- Chemical Crop Protection,
- Bioemediation,
- Bioenergy,
- Bio-metals,
- Nutritional Biochemistry,
- Epigenetics,
- Plant Microbe Interaction,
- Plant Biotechnology,
- Plant Breeding

Semester 10: Seminar, Assignment and Project: 12 credits