ASSAM UNIVERSITY: SILLCHAR
Department of Life Science & Bioinformatics

[M. Sc. Programme under CBCS]

COURSE STRUCTURE

(Effective from 2015-16 Academic Sessions)

Paper	Paper Title	Type	Marks allotted			Credits
			Internal	External	Total	
Semester I						
LS 101	Genetics and molecular biology	Theory	25	75	100	6
LS 102	Cell biology and immunology	Theory	25	75	100	6
LS 103	Biochemistry	Theory	25	75	100	6
LS 104	Environment & conservation biology	Theory	25	75	100	6
LS 105	Practical – I	Practical	12.5	37.5	50	3
LS 106	Practical – II	Practical	12.5	37.5	50	3
Total					**500**	**30**
Semester II						
LS 201	Concepts in biological science*	Theory	25	75	100	6
LS 202	Techniques in biology	Theory	25	75	100	6
LS 203	Microbiology	Theory	25	75	100	6
LS 204	Biotechnology	Theory	25	75	100	6
LS 205	Practical – III	Practical	12.5	37.5	50	3
LS 206	Practical – IV	Practical	12.5	37.5	50	3
Total					**500**	**30**
Semester III (Botany)						
LS 301(B)	Plant physiology	Theory	25	75	100	6
LS 302(B)	Morphology, Differentiation and Systematic Botany	Theory	25	75	100	6
LS 303(B)	Plant diversity	Theory	25	75	100	6
LS 304(B)	A. Microbial ecology B. Taxonomy of angiosperms and medicinal plant studies C. Plant biochemistry and molecular biology	Theory	25	75	100	6
LS 305(B)	Practical I	Practical	12.5	37.5	50	3

LS 305(B)	D. Microbial ecology E. Taxonomy of angiosperms and medicinal plant studies F. Plant biochemistry and molecular biology	Practical	12.5	37.5	50	3
Total					**500**	**30**
Semester III (Zoology)						
LS 301(Z)	Molecular endocrinology	Theory	25	75	100	6
LS 302(Z)	Applied biology	Theory	25	75	100	6
LS 303(Z)	Evolution and behaviour	Theory	25	75	100	6
LS 304(Z)	A. Fishery science & aquaculture B. Molecular genetics C. Molecular neurobiology	Theory	25	75	100	6
LS 305(Z)		Practical	12.5	37.5	50	3
LS 306(Z)	A. Fishery science & aquaculture B. Molecular genetics C. Molecular neurobiology	Practical	12.5	37.5	50	3
Total					**500**	**30**
Semester IV (Botany)						
LS 401(B)	Mycology and plant pathology	Theory	25	75	100	6
LS 402(B)	Molecular genetics and plant breeding	Theory	25	75	100	6
LS 403(B)	Advanced plant biology	Theory	25	75	100	6
LS 404(B)	Projects	Theory	25	75	100	6
LS 405(B)	Practical I	Practical	12.5	37.5	50	3
LS 406(B)	Practical II	Practical	12.5	37.5	50	3
Total					**500**	**30**
Semester IV (Zoology)						
LS 401(Z)	Limnology, wetland biology & biosystematics	Theory	25	75	100	6
LS 402(Z)	Animal physiology	Theory	25	75	100	6
LS 403(Z)	Developmental biology	Theory	25	75	100	6
LS 404(Z)	Project	Theory	25	75	100	6
LS 405(Z)	Practical I	Practical	12.5	37.5	50	3
LS 406(Z)	Practical II	Practical	12.5	37.5	50	3
Total					**500**	**30**
GRAND TOTAL					**2000**	**120**

SEMESTER – I

LS 101: Genetics and Molecular Biology

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit – I: (chromosome inheritance)

1. Mendelian principles : Dominance, segregation, independent assortment, pleiotropy, genomic imprinting, phenocopy, linkage and crossing over, sex linkage
2. Concept of gene : Allele, multiple alleles, pseudoallele, complementation tests, Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.
3. Extra chromosomal inheritance: Mitochondrial and chloroplast genes. Chromosomes deletion, duplication, inversion, translocation, ploidy.
4. Mutation types, causes and detection, mutant types, lethal, conditional, biochemical, loss and gain of function, germinal verses somatic mutants, insertional mutagenesis.

Unit-II: (Genetical inheritance)

1. Microbial genetics: Methods of genetic transfers, transformation, conjugation, transduction, mapping genes by interrupted mating, fine structure analysis of genes.
2. Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Polygenic inheritance, heritability, QTL mapping.
3. The genomes of bacteria, viruses, plasmids; conjugation, transformation, transduction
4. Homologous and non-homologous recombination including transposition.

Unit – III: (Fundamental structure)

1. Structure of nucleic acids: double helical structure of DNA, right handed and left handed structure of DNA, RNA
2. DNA replication: DNA polymerase, replication in prokaryotes and eukaryotes.
3. Genetic code: deciphering the code and preparation of genetic code dictionary, exception to the universality of genetic code.
4. DNA damage and Repair: Mutations – Spontaneous and induced, mechanisms

Unit – IV: (DNA biology)

1. DNA replication, repair and recombination: replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination.
2. RNA synthesis and processing: transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport.

3. Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors
4. Post- translational modification of proteins.

Unit – V: (Gene regulation)

1. Control of gene expression at transcription and translation level: regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing.
2. 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
3. Therapeutic interventions of uncontrolled cell growth.
4. Bioethics: Dos and donts in modern biology, ethical limitation, copyright information,

LS – 101: Suggested Readings:

1. Lodish Molecular Cell Biology
2. Brown Genome (Gen),
3. Friedfelder, D. Molecular Biology, 4th Edition, Jones and Barlett Pub. Inc., USA.
4. Karp,. Cell and Molecular Biology,
5. Genes IX (2007 or later);Benjamin Lewin
6. Alberts-Molecular Biology of the Cell
7. Thrope, B. -Cell Biology, John Willey and Sons, USA.
8. Gardner, E.J. and Saastad, D.P.- Principles of Genetics, 7th Edition,
9. Wollff (ed.). Gene Therapeutics, Researchco Book Center.
10. Daniell L.Hartl & et al ;Genetics,6th edition
11. Benjamin Lewin; Essential Genes

LS 102: Cell Biology & Immunology

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit – I: (Fundamental cell)

1. Structure and differences between prokaryotic and eukaryotic cells.
2. Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.
3. Structural organization and function of intracellular organelles**:** Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.

Unit – II: (Cell structure and cycle)

1. Cytoskeleton: Cell junction and cell adhesion, molecular organization of microtubules, microfilaments and intermediary filaments. Vesicular trafficking: secretory and endocytotic pathway.
2. Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle in yeast and multicellular organism.
3. Microbial Physiology: Growth yield and characteristics, strategies of cell division, stress response.

Unit – III: (Cell communication)

1. Host parasite interaction: Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.
2. Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.
3. Cellular communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.
4. Concept of apoptosis

Unit – IV: (Basic immunology)

1. Basic Elements of the Immune System: Exterior defenses to infection (Skin & mucosal surface, Physiological Barriers, Phagocytic barriers, Inflammation); Innate and adaptive immune system.
2. Cellular (Lymphocytes, Phagocytes, Auxillary cells and others) and Humoral components of the immune system

3. Adaptive Immune System: Primary and secondary lymphoid organs; Lymphocyte heterogeneity - concept of T cell and B cell, Natural Killer cells; Antigens - Structure, properites, types, Epitopes, Haptens
4. Antigen Receptor Molecules: Immunoglobulins (B-cell antigen receptor)- Structure, classes and biological activities; Genetic basis of antibody heterogeneity – Isotypic, Allotypic and Idiotypic variations; T-cell antigen receptor (TCR); Major Histocompatibility Complex (MHC) – Class I and Class II molecules; HLA

Unit – V: (Advanced immunology)

1. Immune Effector Mechanisms: Lymphocyte activation, Antigen presentation, Clonal selection, Immunological memory; Antigen Recognition: Antigen-antibody binding, kinetics, specificity - Affinity and Avidity; monoclonal antibody; Cell-mediated immune reactions
2. Cytokines and Lymphokines: interleukins, interferons, TNF, CSF. Complement system: classical and alternate pathway of activation;
3. Immuno Pathology: Basic ideas about Transplantation and autoimmunity; Immunodeficiency and AIDS; Hypersensitive reactions (Type I, II, III and delayed type (DTH); Acquired immunity –Vaccines

LS – 102: Suggested Readings:

Essential readings:

1. Bruce Alberts et al.- Molecular Biology of the Cell
2. Ivan Roit et al. – Immunology
3. Brnjamin lewin – Genes IX
4. Lodish Molecular Cell Biology
5. A.L. Lehninger – Principles of Biochemistry
6. Friedfelder, D. Molecular Biology, 4th Edition, Jones and Barlett Pub. Inc., USA.
7. Karp,. Cell and Molecular Biology,
8. Thrope, B. -Cell Biology, John Willey and Sons, USA.
9. Gardner, E.J. and Saastad, D.P.- Principles of Genetics
10. Wollff (ed.). Gene Therapeutics, Researchco Book Center.
11. Daniell L.Hartl & et al ;Genetics,6th edition
12. Benjamin Lewin; Essential Genes

LS 103: Biochemistry

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit – I: (Molecular interactions)

1. Introduction to Biochemistry and biomolecules; Structure of atoms, molecules and chemical bonds.
2. Stabilizing interactions: covalent bonds, hydrogen bonds, van der Waals interactions, hydrophilic and hydrophobic interactions
3. Biophysical properties, Water as a solvent; Ionization of acids, bases, pH, buffer, reaction kinetics, thermodynamics, colligative properties
4. Concept of free energy, entropy, enthalpy and Basic Biological reactions

Unit – II: (Proteins and enzymes)

1. Proteins Structure functions: structures of proteins. Ramachandran plot
2. Enzymes: Chemical nature, Nomenclature and classification; coenzymes
3. Mechanism of Enzyme Action: Effects of substrate, temperature, pH and inhibitors on enzyme activity and stability.
4. Enzyme kinetics: Concept of Km and Vmax - Michaelis-Menten equation, Lineweaver-Burk plot and Enzyme inhibition

Unit – III: (Carbohydrates and lipids)

1. Lipids structure functions: fatty acids, and glycerides, phospholipids sterols.
2. Carbohydrate metabolism: glycolysis, TCA cycle, pentose phosphate pathway
3. Oxidation of fatty acids
4. Electron transport system -oxidative phosphorylation, mitochondrial respiratory complexes and supercomplexes

Unit – IV: (Plant biochemistry-I)

1. Photosynthesis**:** Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO2 fixation, C3 and CAM pathways; Photorespiration.
2. Nitrogen metabolism: Nitrate reduction and ammonium assimilation.
3. Plant hormones: structure and function.
4. Secondary metabolites: structure and function

Unit – V: (Plant Biochemistry-II)

1. Sensory photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins
2. Photoperiodism and biological clocks, flower development.

3. Signal communication in plants
4. Plant signaling during development and stress.

LS - 103: Suggested Readings:

1. Mazur, A. (2002). A Text Book of Biochemistry, Benjamin Harrow, Toppan Co. Ltd., Japan.
2. Campbell, (1998). Biochemistry, Purnima Book Distributors, New Delhi.
3. Stryer, L. (2005). Biochemistry.
4. Hans- Walter Heldt (2005) Plant Biochemistry , Academic Press
5. Lehninger Albert L., Cox, Michael M. and Nelson, David L. (2008) Principles of Biochemistry, W.H. Freeman & Co.
6. Alexander, R.R. and Criffithn, J.M. (1992). Basic Biochemical Methods, John Willey and Sons, Singapore.
7. Buchanan B, Gruissem, W and Jones, R. (2002) Biochemistry & Molecular Biology of Plants, Wiley.
8. Lewin, B. (1996). Genes VI, Panima Eds,., Agency, New Delhi.

LS 104: Environment and Conservation Biology

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit – I: (Organization & taxonomy)

1. Levels of structural organization: Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs & systems. Comparative anatomy, adaptive radiation, adaptive modifications.
2. Principles & methods of taxonomy: Concepts of species and hierarchical taxa, biological nomenclature, classical & quantititative methods of taxonomy of plants, animals and microorganisms.
3. Outline classification of plants, animals & microorganisms: Important criteria used for classification in each taxon.
4. Evolutionary relationships among taxa.

Unit – II: (Environmental biology)

1. The Environment: Physical environment; biotic environment; biotic and abiotic interactions.
2. Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
3. Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

4. Population Ecology: Characteristics, growth curves and regulation of a population; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic, age structured populations.

Unit – III: (Ecology)

1. Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.
2. 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.
3. Concept of an ecosystem: Ecosystem and its structural components - Abiotic and Biotic components, Productivity and Energy flow, Lindemann's concept of Community dynamics, Ecological succession- Ecosystem stability, climax community
4. Levels of Organisations: Biosphere organizaton, Emergence theory, Liebig's Law of minimum; Leibig-Blackman concept of Limiting factors, Shelford's Law of Toleranc

Unit – IV: (Applied ecology)

1. Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
2. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.
3. Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).
4. Applied Ecology: Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change and management approaches.

Unit – V: (Conservation Biology)

1. Conservation Biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).
2. Organisms of conservation concern: Rare, endangered species. Conservation strategies. Organisms of health & agricultural importance (Common parasites and pathogens of humans, domestic animals and crops).
3. Concept of sustainability: Wetlands and Fisheries management and conservation with special emphasis on North-East India
4. Biodiversity Conventions and Acts: Application of Remote Sensing in biodiversity assessment.

LS 104: Suggested Readings:

1. Daubenmire, R. (1974). Plants and Environment, John Wiley and Sons
2. Kormondy, E.J. (1978). Concepts of Ecology, Prentice Hall of India
3. Odum, E.P. (1971). Fundamentals of Ecology, W.B. Saunders, Philadelphia
4. Whittaker, R.H. (1975). Communities and Ecosystems, McMillsn
5. Grime, J.P. (1979). Plant strategies and Ecosystem Processes, John Wiley and Sons
6. Mishra, R. (1968). Ecology Workbook, Oxford and IBH (New Delhi).
7. Smith, W.H. (1981). Air pollution and Forests, Springer Verlag (New York).
8. Weaver, J.E. and Clements, F.E. (1983). Plant Ecology, McGraw Hill (USA).
9. Freeman, B. (1989). Environmental Ecology, Academic Press (UK).

LS 105: Practical I

[Full Marks = 50; 6 Contact hours/week; Total credit = 03]

1. Good Laboratory Practices (GLP)
2. Basic concepts on pH and buffers
3. Concept of molarity and normality, Preparation of fixative, stains and solutions of different strength
4. Estimation of DNA by Diphenyleamine reagent
5. Estimation of RNA by Orcinol reagent
6. Estimation of sugars using Anthrone reagent
7. Estimation of amino acids using Ninhydrine reagent
8. Estimation of soluble proteins by Follin-phenol reagent
9. Estimation of nitrate nitrogen by Bruicine reaction
10. Separation and identification of sugars, amino acids and phenolics by paper and thin layer chromatography
11. Effect of temperature, pH and substrate concentration on enzyme activity
12. Estimation of cholesterol contents in biological material

LS 106: Practical II

[Full Marks = 50; 6 Contact hours/week; Total credit = 03]

1. Study of Mitosis in onion root tip.
2. Study of Meiosis in grasshopper/ sand hopper testis
3. Preparation of salivary gland polytene chromosome from Drosophila/Chironomous larva
4. Study of micronucleus in mouse/fish/bird induced by any mutagen
5. Study of lymphocytes and monocytes from blood smears of human/mouse
6. Determination of blood group
7. Demonstration of antigen-antibody reaction in agarose gel
8. Determination of Leaf Area Index of Plant community
9. Estimation of Plant population by quadrate method on land and in water
10. Determination of pH, turbidity, transparency, conductivity of water
11. Estimation of Dissolved oxygen (DO), Phosphate and Nitrate in water
12. Determination of Chlorophyll content in plants

SEMESTER – II

LS 201: Concepts in Biological Science (Open Choice Paper)

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit – I: (Basic Biology)

1. Origin of life, evolution of biomolecules.
2. Concepts of species and hierarchical taxa. Levels of organization of tissues, organs and systems
3. Diversity and basic classification of plants, animals and miro-organisms
4. Biological nomenclature and code

Unit – II: (Evolutionary thoughts)

1. Lamarckian concept of evolution: Lamarkism
2. Darwin's theory of evolution: concepts of variation, adaptation, struggle, fitness and natural selection
3. Elemental forces of evolution: mutations
4. Modern synthetic theory of evolution

Unit –III: (Animal developmental biology)

1. Gametogenesis: Spermatogenesis and oogenesis, Fertilization: Sperm egg interaction and acrosomal reaction
2. Fusion of gametes and egg activation. Cleavage: Types of eggs; overview of types of cleavage, Gastrulation in insects, amphibians, birds and mammals
3. Early development events and sex determination in Drosophila, mammals and other species
4. Programmed cell death, Concept of ageing and senescence

Unit –IV: (Plant Physiology)

1. Plant water relations, Osmotic and water potential. Aquaporins and Plant hydraulic conductivity. Translocation of mineral salts, stomatal physiology.
2. Photosynthesis – in the era of climatic change. Photosynthesis under high CO_2
3. Mechanisms of photophosphorylation in thylakoid membranes, CO2 fixation.
4. Photorespiration and its significance.

Unit –V: (Plant signaling)

1. Plant Signal transduction: Understanding the molecular crosstalk

2. Sugar Signaling in Plant Growth and Development
3. Reactive Oxygen species (ROS) signaling in Plants
4. Plant stress and cell signaling; Senescence and programmed cell death (PCD) in Plants

LS – 201: Suggested Readings:

1. The greatest show on earth by Richard dawkins
2. Organic evolution by Rastogi
3. Gilbert, S. F.. Developmental Biology (8th ed.), Sinaur Associates Inc., Sautherland.
4. Berrill, N.J. Developmental Biology, McGraw Hill Book Co., USA.
5. Taiz, L. and Zeiger E. (2010) Plant Physiology
6. Baluska F. and Mancuso, S. (2009) Signaling in Plants, Springer,
7. Leopod, A.C. and Kreidman, P.E. (1980). Plant Growth and Development.
8. Witherperson, J.D. (1984). Human Physiology, Harper and Row, USA.
9. Weddington, C.H.C. (1985). Principles of Development and Differentiation.
10. Plant Abiotic Stress (2005)- Mathew A Zenks & P.M.hasegawa, Blackwell Publishing
11. Panda, S.K. (2002)(ed): Adv. Stress Physiology of Plants

LS 202: Techniques in Biology

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit – I: (Microscopy)

1. Electron microscopy: Visulization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells
2. Instrumentation and working principle of SEM & TEM, Image formation process, optimum resolution. Different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM,
3. Principle and applications of fluorescence and phase contrast microscopy. image processing methods in microscopy, Confocal Laser Scanning Microscopy & Atomic Force Microscopy

Unit –II: (Biophysics and chromatography)

1. Chromatography: Thin layer, adsorption, partition, ion exchange, gel filtration and affinity.
2. Principles and applications of Mass Spectrometry, GC-MS and HPLC.
3. Principles and applications of differential and density gradient centrifugation.

4. Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR, Molecular structure determination using X-ray diffraction and NMR.

Unit – III: (Nucleic acids and proteins)

1. Isolation, purification and analysis of DNA, RNA and proteins (Southern, Northern and western Blotting; EMSA, SDS-PAGE, gradient gel, isoelectric focussing).
2. In vitro mutagenesis and detetion techniques, gene knock out in bacterial and eukaryotic organisms. DNA sequencing methods, strategies for genome sequencing.
3. Global analysis of gene expression: concepts of transcriptomics (microarray) and proteomics.
4. Primer, PCR, RT-PCR, RFLP, RAPD and AFLP techniques

Unit – IV: (Statistical methods)

1. Importance and scope of statistical method; Common statistical terms: population, sample, variables, data, statistic and parameters; sampling methods and sampling bias; methods of data collection and presentation : (frequency distribution, histogram, polygon, ogive curves and pie diagram)
2. Descriptive statistics: (i) Shape of data – Skewness and curtois, normal distribution (ii) Location of data – measures of central tendency (man, median, mode, quartiles), (iii) Dispersion of data (Measures of variability) – variance, standard deviation, coefficient of variation and standard error
3. Inferential statistics: Testing hypothesis - Chi-square test, t-test, Z-test and F-test, levels of significance
4. Inferential statistics: Analysis of variance (ANOVA); Correlation - positive and negative correlation, co-efficient of correlation; Linear regression and regression equation

Unit – V: (Immunological methods)

1. Immunological techniques: Antibody generation Immuno diffusion, immune-precipitation, direct and indirect immunoassay (ELISA)
2. Radiolabelling techniques: Properties of different types of radioisotopes, detection and measurement of radioactivity (scintillation counter, autoradiography), application of radioisotopes in biological samples
3. Radio receptor assay, Radio immune assay (RIA)
4. Detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.

LS – 202: Suggested Readings:

1. Bisen, P.S. Tools and Techniques in Life Sciences, World Book Enterprise, New Delhi.
2. Sharma, V.K. Techniques in Microscopes and Cell Biology, World Book Enterprise, New Delhi.

3. Cell Biology: Essential Techniques. Rickwood and Harris Researchco Book Center, New Delhi.
4. Ralph, R. Methods in Experimental Biology, International Book Distributors, 9/3, Rajpur Road, 1st Floor, Dehradun – 1.
5. Swarup, H. Laboratory Techniques in Modern Biology, International Book Distributors, Dehradun.
6. Patel, D. Gel Electrophoresis: Essential Data, John Willey and Sons, Singapore.

LS 203: Microbiology

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit – I: (Microbial History)

1. History of microbiology: Theory of spontaneous generation. Experiments Of Pasteur and Tyndall, Koch's Postulates, bacteria isolation form natural sample column, Control of Microbial growth methods a sterilization
2. Role of bacteria in human welfare: Biological concepts, Immunization (Pasteur experiment Antibiosis), (penicillin story), Griffith's experiment Avery and McCarty's experiment, Experiment with viruses
3. Changing concepts in microbiology taxonomy, Earlier systems, Molecular taxonomy, Jackard's similarly coefficients

Unit – II: (Cell organization)

1. The Microbial cell: General organization of cell, Prokaryotes Eukaryotes and Archaea, Cell wall organization on Prokaryotes, Eukaryotes and Archaea, Cell surface appendage spilli, locomotion by flagella chemotactic Movement, Peptidoglycan synthesis inhibitors in different steps
2. Metabolic Pathways: Metabolic versatility of microbes, Anaerobic Carbon metabolism: Anaerobic respiration, Sulphate respiration, Reference to glycolysis, Putrefaction
3. Methane oxidizing and Methanogenic bacteria, Aerobic Carbon metabolism : TCA cycle alternative metabolic pathways

Unit –III: (Viruses and Microbial genetics)

1. Nomenclature and classification of viruses; multiplication and transmission of viruses; and control measures.
2. Viral diseases with reference to encephalitis, hepatitis, AIDS, rabies and foot and mouth diseases.
3. Microbial genes and genomes. Modes of genetic exchange in microbes, Transformation, Transduction, Conjugation, Evolutionary Significance

Unit – IV: (Secondary metabolism)

1. Energy Metabolism: Chemo autotrophs, Hydrogen bacteria, Phototrophic bacteria/Cyanobacteria
2. Microbes in Extreme Environment: The basis of extremophiles and their applications, Life of a thermophile (Thermus, Pyrococcus)
3. Important Secondary metabolites from microbes (Antibiotics, Amino Acids, Biofuels etc)

Unit – V: (Agricultural microbiology)

1. Microbes and Agriculture: Symbiotic Nitrogen fixation Rhizobium, Cyanobacteria (Anabaena, Azolla etc.), Mycorrihiza

2. Clinical Microbiology: Survey of disease causing microbes, Mechanisms of Pathogenesis, Antibiotics and their targets, Immune response elicited by microorganisms

3. Environmental Microbiology: Nature of anthropogenic wastes, Municipal wastes and xenobiotics, Enrichment cultures, Xenobiotic degrading consortia, Bioremediation

LS – 203: Suggested Readings:

1. Lansing M. Prescott. Microbiology, McGraw Hill
2. Brande, A.T. (ed). Microbiology, W.B. Saunders Co.
3. Gebhartt, L.P. and Nicholas, P.S. Microbiology.
4. Rosenberg, E.R. and Cohen, I.R. Microbial Biology, Saunders College Publishing, USA.
5. Modi. Elementary Microbiology, Vol I & II, Panima Book Distributors, New Delhi.
6. Baynet, W. The Genetics of Bacteria and the Viruses.
7. Kelly, D.P. and Carz, N.C.. The Microbe, part II, The Prokaryotes, Cambridge University Press, UK.
8. Dawes and Sautherland. Microbial Physiology, Research Book Center, New Delhi.
9. Malaya, S.R. Microbial Genetics (2nd ed), Panima Publisher, New Delhi.
10. Frazier, M. Food Microbiology, Panima Publisher, New Delhi.

LS 204: Biotechnology

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit – I: (Recombinant DNA technology)

1. Restriction endonucleases (types and characteristics); Cloning vectors- plasmids, phages, phagemids, cosmids, artificial chromosome vectors; Methods of gene transfer
2. Recombinant DNA techniques, cDNA and genomic library, Gene cloning, Methods of gene transfer.
3. Application of recombinant DNA technology - Production of recombinant insulin; Gene therapy

Unit –II: (Animal cell culture technology)

1. Minimal requirement for animal cell culture; Balanced salt solutions and growth medium- physicochemical properties of different culture media.
2. Primary cell culture- cell lines and their maintenance, monolayer and suspension culture; Stem cells culture and their applications.
3. Transgenic animals and its application; Hybridoma Technology

Unit –III: (Plant tissue culture technology)

1. Plant tissue culture media; Initiation and maintenance of callus and suspension cultures; Single cell clone
2. Protoplast culture and somatic hybridization, selection of hybrids; Production of haploids and their utilization; Somaclonal and gametoclonal variations
3. Embryo culture and embryo rescue: Cryopreservation and germplasm conservation
4. Plant genetic engineering: Various methods of gene delivery into Plants, generation and applications of transgenic plants

Unit –III: (Microbial technology)

1. Growth and nutrition : Growth kinetics, Batch an continuous cultures, Nutritional classification of microorganisms, Nutritional uptake by microorganisms (C.N.P)
2. Fermentation: media; sterilization; batch, fed and continuous fermentation; control of bioprocess parameters.
3. Industrial enzymes; Enzyme and cell immobilization-its applications; organic acids production, antibiotics, amino acids and vitamins
4. Microbial food production: Cheese, bread, beer and beverages; Production of single cell protein

Unit – V: (Bioinformatics)

1. Introduction to bioinformatics: Data mining, classification, clustering.
2. Bioinformatics Softwares: Clustal W 1.7, RasMol, Treeview, Alscript, Genetic Analysis Software, Mega, Hex, Auto dock.
3. Nucleotide sequence submission methods and tools (sequin, sakura, bankit), Sequence file formats and conversion tools
4. Entrez, Sequence retrieval system (SRS), Protein identification resource (PIR), Swiss-prot, Expassy. Basics of molecular docking, drug likeliness study.

LS – 204: Suggested Readings:

1. Fogarty, et al. Microbial Enzymes and Biotechnology, Researchco Book Center, New Delhi.
2. Roberta H Smith (2012) Plant Tissue culture- Techniques and Experiments

3. John H. Dodds Ed. (2012) Plant Genetic Engineering, Cambridge University Press
4. H. Jones and John M. Walker, Plant Gene Transfer and Expression Protocols: Methods in Molecular Biology, 49, Humana Press
5. Baxevanis, B. F. F. Ouellette, Bioinformatics – A practical Guide to the analysis of Genes and Proteins, 2nd Ed, John Wiley and Sons Inc., 2001.
6. Wilseman, A. (ed). Principles of Biotechnology, Chapman and Hall, New York.
7. Rajendra, P. Molecular Biology and Biotechnology, World Book Enterprise, New Delhi.
8. M. J. Crispeels and D. E.Sadava, Plants, Genes and Crop Biotechnology, 2nd Ed, Jones and Bartlett Publishers,
9. Bhowjwani S.S. Elsevier, Plant Tissue Culture: Application and Limitations, Amsterdam,
10. Rajaraman, V. (1983). Comparative Programming in FORTAN IV, Prentice Hall of India, New Delhi.

LS 205: Practical - I

[Full Marks = 50; 6 Contact hours/week; Total credit = 03]

1. Graphical representation of data, histograms and frequency curve.
2. Descriptive statistics of distribution mean, median, mode, variance, standard deviation, skewness, kurtosis.
3. Application of chi-square test, contingency tables with Yates correlation.
4. Application of analysis of variance.
5. Acquaintance and demonstration of the functioning of major instruments used in biology.
6. Preliminary knowledge of basic quality control measures and aseptic techniques in tissue culture.
7. Plant and Animal tissue culture media and their preparation.
8. Raising of plants by tissue culture (shoot, leaf, root, apices).
9. Biotransformation of cellulose and production of ethanol
10. Elctrophoresis and restriction analysis of Plant based vectors

LS 206: Practical - II

[Full Marks = 50; 6 Contact hours/week; Total credit = 03]

1. Calibration of microscope and measurement of dimension of microbial cells.
2. Staining of microorganisms: single staining, double staining (Gram's reaction), staining of specific cell structure.
3. Preparation of culture media and sterilization.
4. Isolation of pure and exenic culture of microbes
5. Quantitative enumeration of microorganisma from various habitats (e.g., soil, air, water, food, sewage).
6. Growth of microorganisms in batch culture and calculation of specific growth rate and generation time.
7. Measurement of antibiotic sensitivity using absorbent disc.
8. Bacteriophage isolation and characterization by plaque method.
9. Study of food spoilage by microbes and isolation of the microbes.
10. Microbial assay for amino acids and antibiotics, study of food spoilage by microbes, study of fermentation by microbes Gametogenesis: Spermatogenesis and oogenesis, Fertilization: Sperm egg interaction and acrosomal reaction
11. Prevention of polyspermy, Fusion of gametes and egg activation
12. Cleavage: Types of eggs; overview of types of cleavage, Gastrulation in insects, amphibians, birds and mammals
13. Origin of ectoderm, mesoderm and endoderm.
14. Mechanism of cell movement during gastrulation.

BOTANY – III

LS 301 (B): Plant Physiology

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit-I

1. Water relation in plants: Properties of water, Osmotic and water potential, transpiration, stomatal physiology.Signal transdution in guard cell.
2. Aquaporins and plant hydraulic conductivity
3. Translocation of ions, solutes and macromolecules from soil, Apoplastic and symplastic transport mechanisms, passive and active transports, structure-function relationship of inward and outward ion channels, dual action of ATPases/pumps and modulation of their activity.,Comparison of xylem and phloem transports, phloem loading and unloading of phtoassimilates, source & sink relationship
4. Mineral nutrition in plants.

Unit-II

1. Photosynthesis: Basic principles of light absorption, excitation energy transfer, Light harvesting complexes,Kok curve, Kautsky curve, ETS, O2 and H2 evolution, mechanism of pigment system function, photoinhibition and photoprotective mechanism.
2. Non- cyclic and cyclic electron flow.Proton electrochemical potential, photosynthetic quantum yield and energy conversion efficiency, Mechanisms of photophosphorylation in thylakoid membranes,.
3. CO_2 fixation.-C_3, C_4, and CAM.
4. Photorespiratory pathways and plant productivity,

Unit-III

1. Physiology of nitrogen fixation, NOD factor, Process of nodulation in leguminous plants.Nitrogenase system. Electron transport,
2. Nitrate and Ammonia assimilation.
3. Amino acid biosynthesis.
4. Abiotic stress: Responses to the abiotic stress factors, water and salt stress,Metal (loid) stress, High and low temperature stress; Physiological and molecular mechanisms of acclimation and tolerance to abiotic stress

Unit-IV

1. Plant growth hormones: Auxins, gibberellin, cytokinins, absisic acid, ethylene, JA,SA and Brasinosteroids.
2. Biosynthesis, storage, breakdown and transport of plant hormones.
3. Physiological effects and mechanism of action of plant growth hormones. hormones in defence against abiotic and biotic stresses
4. Mechanism of action of plant growth hormones, hormone receptors, signals transduction and gene expression.

Unit-V

1. History and discovery of phytochromes and cryptochromes and their photochemical and biochemical properties, photophysiology of light induced repsonses, Cellular localization, molecular mechanism of action of photomorphogenetic receptors, signalling and gene expression. Phototropins.Gravitropicsignaling
2. Photoperiodism and its significance, endogenous clock and its regulation.
3. Floral induction and development. Metabolic changes during seed germination.
4. Physiology & Molecular events in Plant senescense, programmed and necrotic cell death:

Suggested Readings:

1. Salisbury, S. and Ross, C.W. (1980). Plant Physiology.
2. Goodwin, T.W. and Nereer, E.I. (1983). Introduction to Plant Biochemistry.
3. Cramer, P.J. (1982). Plant and Soil Water Relationship : a Modern Approach.
4. Buchanan et al. (2005). Biochemistry and Molecular Biology of Plants, ASPB, USA.
5. Teiz and Zeiger- Plant Physiology-5th Edition.
6. Abiotic stress Adaptation in Plants: Physiological, Molecular and Genomic Foundation (2010)- A.Pareek,S.K.Sopory, Hans Bohnert&Govindjee- Springer
7. Hans –Walter Heldt (2005) Plant Biochemistry , Academic Press
8. Leopod, A.C. and Kreidman, P.E. (1980). Plant Growth and Development.
9. Greagny, P.F. (1989). Biochemistry of Photosynthesis.
10. Atkin, (1989). Hormone Action in Plant Development, (1983) Plant Growth Substances.
11. Annual Review of Plant Biology. Academic press.
12. Encyclopedia of Plant Physiology, Springer-Verlag, F.C.
13. Plant Abiotic Stress (2005)- Mathew A Zenks&P.M.hasegawa, Blackwell Publishing
14. Panda, S.K. (2002)(ed): Adv. Stress Physiology of Plants
15. Leopold, A.C. and Kriedman, P.E. (1980). Plant Growth and Develpoment.

LS 302 (B): Morphology, Differentiation and Systematic Botany

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit-I

1. Modified root and stem.Venations.Modification of Calyx. Inflorescence: Types and evolution.
2. Transition to flowering - vegetative to reproductive evocation, floralhomeotic mutations .Axis development in flower.
3. Placentation. Fruit and seed characteristics.
4. Gender expression in monoecious and dioecious plants.Hormonal regulation of sex expression.

Unit-II

1. Regulation of anther and ovule development,
2. Microsporogenesis and microgametogenesis.
3. Megasporogenesis and megagametogenesis. and patterns of gametophyte organization
4. Pollen-pistil interaction: pollen tube growth and guidance, double fertilization, self-compatibility mechanisms, incongruity

Unit-III

1. Male sterility- mechanisms and applications, pollen embryogenesis.
2. Polarity during embryogenesis, endosperm development.
3. Apomixes and polyembryony.
4. Somatic embryogenesis

Unit-IV

1. Principles of classification of Angiosperms.
2. Comparative studies on phylogenetic system of classification with Benthum and Hookers system.
3. Molecular systematics, plant nomenclature, ICN, Concept of species and hierarchical taxa.
4. Herbarium and its significance, activities of BSI. Databases of Plant Names.

Unit-V

1. Phylogeny and floral evolution of selected family with their economic importance (mostly Indian distribution) of following orders: Magnoliales, Ranunculales, Malvales, Euphorbiales, Fabales, Scrophulariales, Lamiales and Asterales of Dicotyledones, Orchidales, Zingiberales of Monocotyledons.
2. Phylogeny and floral evolution of Poales of monocotyledons (Takhtajan, 1980).

3. Floristic region of India, endemism. Botanical gardens of India.
4. Endangered and threatened plants of India.

Suggested Readings:

1. Maheshwari, P. (1950). An Introduction to the Embryology of Angiosperms, McGraw Hill Book Co., New York.
2. Wardllaw, C.W. (1970). Cellular Differentiation in Plants and Other Essays, Manchester University Press, New York.
3. Wareing, P.F. and Phillips, I.J.D. (1983). Growth and Differentiation in Plants, Pregamon Press, New York.
4. Creuquist, A. (1968). The Evolution and Classification of Flowering Plants.
5. Hobri, B.M. (ed.) (1982). Experimental Embryology of Vascular Plants, Narosa Publishing House, New Delhi.
6. Johason, D.A. (1949). PLANTS Microtechnique, McGraw Hill Book Co., New York.
7. Sinnot, E.W. (1960). Plant Morphogenesis, McGraw Hill Book Co., New York
8. Jain, S.K. and R.P. (1977). An Aid to International Code of Botanical Nomenclature.
9. Heywood, V.H. (1968). Modern Methods in Plant Taxonomy, Acadmic Press, London
10. Heywood, V.H. and Moore, D.M. (eds.) (1984). Current Concepts in Plant Taxonomy.
11. William, F. Grant (ed.) (1984). Plant Systematics, Academic Press, London.

LS 303 (B): Plant Diversity

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit-I

1. Principles and systems of classification of Algae.
2. Comparative account of algal pigments, food reserves, flagellation, chloroplasts and eye spots; their taxonomic importance
3. Trends in evolution of thallus structure.
4. Cellular structure of algae (Prokaryotes and eukaryotes). Habitat diversity cell structure and reproduction
5. Pheromones.

Unit-II

1. Classification and phylogenetic relationship of bryophytes.
2. Evolutionary lines of bryophytes.
3. Comparative morphological study of gametophytes.
4. Sporophyte evolution in bryophytes; peristome structure and its significance in classification of mosses.

1. Significance of oil bodies in taxonomy of leafy liverworts.

Unit-III

1. Classification of pteridophytes. Evolutionary trends in ferns; Origin of land flora.
2. Comparative organography, reproduction and phylogeny.
3. Telomic concepts and its application to evolution of sporophyte.
4. Soral evolution, apogamy and apospory, heterospory and seed habit.

Unit-IV

1. Recent trends in classification of Gymnosperms; Evolution of Gymnosperms.
2. Geological history of Gymnosperm flora.
3. Morphology and anatomy of vegetative reproductive organs; Structure and evolution of archegonium in Gymnosperms.
4. Distribution of living and fossil Gymnosperms in India.A general account of Taxales.

Unit-IV

1. Algae and human affairs : Edible algae, algal biofertilizers, phycocolloids, algal blooms and phycotoxins.
2. Bryophytes: Medicinal values; Horticulture; Industry; Pollution indicators and soil binders.Role of Bryophytes in plant succession.
3. Pteridophytes: Medicinal values; Horticulture; Pollution control.
4. Gymnosperms as a source of wood, resins, essential oils, food and drugs.

Suggested Readings:

1. Kumar, H.D. (1991). Introductory Phycology, Panima Book Distributors, New Delhi.
2. Smith, G. (1994). Manual of Phycology, Panima Book Distributors, New Delhi.
3. Johri, B.M. (1999). Gymnosperms.
4. Bryophytes By Ram Udar.
5. Pteridophytes by B. D. Sharma. (1994).
6. Fritsch, F.E. (1945). Structure and Reproduction of Algae, Vols. I & II, Cambridge University Press.
7. Pagilchar, N.S. (1955). An Introduction to Embryophyta, Vol. I Bryophyta, and Vol. II Otendophyta, Vol III, Gymnosperm.
8. Trivedi, B.S. and Singh, D.K. (1965). Structure and Reproduction of the Gymnosperms, ShashidharMalviyaPrakashan, Lucknow.
9. Chamberrlain, C.J. (1934). Gymnosperms : Structure and Evolution, ,University of Chicago Press, Chicago.
10. Morphology of pteridophytes , K.R. Sporne. Morphology of gymnosperms , K. R. Sporne.

LS 304 (B): Microbial Ecology (Special Paper)

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit-I

1. Microbial Evolution and Biodiversity, Population interactions and Ecosystem
2. Microbial community: structure and organization, Habitat and niche, food chain.
3. Quantitative microbial ecology, numbers and Biomass.

Unit-II

1. Physiologicl ecology of microbes, measurement of microbial metabolism.
2. Colonization processes, succession and climax,Dispersal center, duration efficiency, active and passive dispersal.
3. Microbes in their natural habitat, Air, water and soil.

Unit-III

1. Biodegradation of waste, xenobiotics pollutants.
2. Tolerance, competition, parasites.
3. Microbial symbiosis, competition, Interaction between microorganisms and plants.

Unit-IV

1. Microorganisms and biogeochemical cycling with reference to CNP.
2. Bio-fertilizers, microbial control of pests.
3. Microbes in energy recovery fuel and biomass production.

Unit-V

1. Nucleic acid extraction from environmental samples,Prokaryotic systematics. Concept of meta-genomics.
2. Molecular techniques in microbial diversity studies: PCR and variations, microbial fingerprinting and typing, Molecular detection of fungal communities in soil
3. Microbial ecology and genomics, Bioinformatics and web resources for the microbial ecologist.

Suggested readings:

1. A.I. and H. Lechevalier (1978). Microbial Ecology, C.R.C. Press, Clevevand.
2. Alexander, M. (1974). Microbial Ecology, Plenum Press.

3. Campbell, R.E. (1977). Microbial Ecology : A Conceptual Approach, Blackwell Scientific Publisher, Oxford, England.
4. Synch, J.M. and Poole, N.J. (1979). Microbial Ecology, Springer-Verlag, Berlin, West Germany.
5. Atlas, R.M. and Bartha, R. (1998). Microbial Ecology : Fundamental and Applications, Addition Wesley Publishing Co., Researchco Book center.
6. Osborn, A. Mark.; Smith, Cindy J (2005). Molecular Microbial Ecology BIOS Advanced Methods. Taylor & Francis Routledge
7. Bull, A.T. and Slatter, J.H.H. (1982). Microbial Interaction and Communities, Academic Press, England.
8. Benson,(1990). Microbial Applications : Laboratory Mannual in General Microbiology (5th ed.), Researchco Book Center, New Delhi.
9. Costa et al. (1989). Microbiology of Extreme Environments and its Potential for Biotechnology, Research Book Center, New Delhi.
10. Prescot et al. (1993). Microbiology (2nd ed.), Researchco Book Center, Bnew Delhi.

LS 304 (B): Taxonomy of Angiosperm & Medicinal Plants Studies (Spl. Paper)

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit-I

1. Taxonomic keys and methods of Plant Identification.
2. Taxonomy and systematic; Interralationship of taxonomy with other branches of Botany.
3. Terminologies of different taxonomic characters. Methods used in assessing relationship in plant taxonomy. ICN (International Code of Nomenclature for algae, fungi, and Plants), Floras, Monographs and Revisions
4. Speciation of Plants – Allopatric, Sympatric, Hybrid, Apomictic, Abrupt and Phylletic speciation; Mechanism of reproductive isolation

Unit-II

1. Concept of Flora, Monographs, Taxonomic revisions and Taxonomic indexes. Salient features, Morphological diversity, interrelationship and economic importance of the following orders as per Cronquist (1981) system of classification. Magnoliales, Nymphaeales, Trochodendrales, fagales, Caryophyllales, Nepenthales, Ericales, Primulales, Solanales, Lamiales, Asterales, Alismatales, Cyperales, Zingiberales, Liliales, orchidales.

2. Chemotaxonomy, Numerical Taxonomy: Aims and objectives, Characters and Attributes, OTUs, Coding, Cluster Analysis. Molecular phylogeny: application of DNA markers in Angiosperm Taxonomy.
3. Phytogeography, importance of phytogeography to Taxonomy, migration and evolution of floras; Indigenous and Exotic species. Hot spots; Keystone and flagship species.
4. Remote sensing: basic principles and application in floristic studies.

Unit-III

1. Ethnobotany. General concept. Methods of Ethnobotanical data collection and presentation, Ct ,F_{ic},RFC, IS_u, Use value, Ethnobotany in drug discovery efforts.Medicinal plant research scenario in India. Print and online sources of medicinal plant literature.
1. Neutraceuticals: Classification, Sources of Nutraceuticals. Properties, structure and functions of various Nutraceuticals. Nutraceutical remedies for common disorders, scope& future prospects.
2. Pharmacognosy: Definition and scope, Crude drugs of plant origin and their classification.Drugs Developed from traditional medicines..
3. Pharmacological methods for studyingHepato-protective, analgesic, antipyretic, hypnotic and CNS.Bioassays-calculations of doses response relationships, LD_{50}, ED_{50}.

Unit-IV

1. Extraction methods: Crude extracts. Distillation, Separation procedures.Qualitative and quantitative analysis of drug molecules. Chromatography: Principles, working procedure, functions and application of CC, TLC, PC, GC, GLC,SPE, HPLC, HPTLC, Fourier Transform IR and MS.
2. Spectroscopic methods (UV, IR, NMR and A.A. Spectroscopy) in determining structure of bioactive compounds.
3. Secondary metabolites- General structure and classification of major pathways
4. Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.

Unit-V

1. Anticancer, Anti-HIV, Antidiabetic, Hepatoprotective,ACE inhibitors, antiinflamitory, wound healing, antifertility, antioxidant, and CNS depressant drugs of plant origin.
2. Computer aided drug designing.(CADD):Introduction to Drug Design Concept, Lead Discovery Interactions Involved in Drug-Receptor Complex, Physicochemical Properties in Relation to Biological Action, Stereochemical Aspects in Drug Design.Drug Designing on the Basis of Metabolic Pathways. Molecular docking and QSAR.

3. Pharmacogenomics:Introduction to Pharmacogenomics. The Role of Ethnicity in Pharmacogenomics, Pharmacogenomics in Facilitating Drug Discovery
4. Bioprospecting and equitable compensation and Biopiracy. Intellectual Property in Drug Discovery : Patent protection and strategy Requirements for patenting in India, China, Japan, Europe and U.S.A. WIPO, WTO and TRIPS in relation to pharmaceutical research. Controversies in drug patents.

Suggested readings:

1. Foye W, "Principles of Medicinal Chemistry" Lea &Febiger.
2. Delgado J.N., Remers WA eds, "Wilson &Giswolds Text Book of organic Medicinal & Pharmaceutical chemistry" Lippincott, New York.
3. Monographs and relevant review articles appearing in various periodicals and journals.
4. Alex Gringauz-" Introduction to Medicinal Chemistry" Wiley-VCH, Inc. New York.
5. Abraham DJ,ed., Burger's Medicinal Chemistry & Drug Discovery, Vol-I-VI, John Wiley & sons, New Jersey.
6. Smith HJ, Williams H, eds, " Introduction to the principles of Drug Design" Wright Boston.
7. Silverman R.B. " The organic Chemistry of Drug Design and Drug Action" Academic Press New York.
8. Finney, D.J., Statistical Methods in Biological Assays, Hafner, New York.
9. Hunson, J.W., ed. Pharmaceutical Analysis, Modern Methods, part A & B, Marcel Dekker.
10. 4. Schirmer, R.E., ed. Modern Methods of Pharmaceutical Analysis, Vols 1, 2. Boca Raton F.L., CRC Press.
11. Budzikiewicz, et al., Interpretation of Mass Spectra of Organic Compounds, Holden-Day San Francisco.

LS 304 (B): Plant Biochemistry and Molecular Biology (Special paper)

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit-I

1. Bioenergetics : Concept of free energy and law of thermodynamics, enthalpy, entropy, coupled reaction, redox potential, high energy bonds . ATP and its significance , group transferases.
2. Enzymes : nomenclature and classification. Kinetics of unisubstrate enzyme catalyzed reaction, derivation of different plots from Michalis- Menton equation, cooperativity in biochemistry, positive and negative cooperativity.

Unit-II

1. Carbohydrate metabolism: Biosynthesis of starch, sucrose and glycogen and their regulation.
2. Catabolism of glucose, glycolysis, Kreb's cycle, ETS & oxidative phosphorylation

3. Lipid metabolism : biosynthesis of fatty acids and its regulation, fatty acid oxidation.
4. Nucleic acid metabolism: Biosynthesis of purines and Pyramidines and their regulation.

Unit-III

1. Plant Gene : structure, expression and regulation.
2. Gene Cloning, cloning and Expression vectors.
3. Methods of Plant Genetic Engineering, Screening, raising and analysis of transgenic plants.
4. Biosafety for transgenic and GM food`

Unit-IV

1. Phenomics, Genomics; Next generation Sequencing, Comparative genomics
2. Functional genomics, Transcriptomics, Proteomics & Metabolomics, Translational Genomics, Molecular Breeding
3. Bioinformatics principles and tools in Plant biology

Unit-V

1. Plant Signal transduction: Understanding the molecular crosstalk
2. Reactive Oxygen species (ROS) signaling in Plants
3. Plant stress and cell signaling, Epigenetic memory
4. Transporters and ion pumps in plant signaling.

Suggested Readings:

1. Cohn, E. E. and Stumpf, P. K. (eds)- Biochemistry of plants
2. Zubey , G.- Biochemistry
3. Xiong- Bioinformatics
4. Lewin,B.-Genes IX
5. Buchanan et al.-Biochemistry and Molecular Biology of Plants
6. Baluska ,F (2015) Signaling & Communication in plants- Series-(Springer)
7. Hans- Walter Heldt (2005) Plant Biochemistry, Academic Press
8. Ferhst, A- Enzymes Structure and Mechanism
9. Godwin T. W. and Mercer, E. I. – Introduction to Biochemistry of plants
10. Annual Review of Plant Physiology and Plant Molecular Biology- All Volumes
11. Watson J. D et al. – Recombinant DNA-A short Course
12. Encyclopedia of Plant Physiology- All New Volumes.

LS 305 (B): Practical I:

[Full Marks = 50; 6 Contact hours/week; Total credit = 03]

1. Determination of the effect of temperature and chemical treatments on the permeability properties of cell membranes.
2. Study of structure and distribution of stomata of dicot and monocot leaves.
3. Measurement of transpiration rate by cobalt chloride method.
4. Separation of chloroplast pigments by TLC and portioning between solvents. Determination of absorption spectra of the separated pigments.
5. Collection and study of algae from soil, ponds, lakes etc from the Barak valley and hills of South Assam.
6. Collection and identification of bryophytes for vegetative and reproductive structures.
7. Study of morphology and anatomy of vegetative and reproductive tissues of pteridophytes.
8. Comparrative study of anatomy of vegetative and reproductive parts of Cedrus, Pinus, Ginkgo, Thuja, Taxus, Cryptomeria and Gnetum.
9. Study of shoot and root apical meristems od dicots and monocots.
10. Study of anomalous secondary growth.
11. Macro dissection – pollinia (Orchids and Calotropis) embryo and endosperm.
12. Squash preparation of tapatum, microspore and mother cell.
13. Study of pollen viability.
14. Study of microsporogenesis and megasporogenesis.
15. Collection and identification of flowering plants up to genus and species level using flora of Assam and other manuals.

LS 306 (B): Practical II (Special Paper): Microbial Ecology

[Full Marks = 50; 6 Contact hours/week; Total credit = 03]

1. Basic instruments and their principles used in Microbiology.
2. Culture techniques of certain dominant groups of microorganisms.
3. Morphology of dominant microbes isolated from soil, air and litter.
4. Effect of certain physical and chemical factors on growth of microbes.
5. Study of mycorrhizal association and its impact on seedling survival and growth.
6. Isolation of rhizobium from root nodules.

LS 306 (B): Practical II (Special Paper): Taxonomy of Angiosperm and Medicinal Plants Studies

[Full Marks = 50; 6 Contact hours/week; Total credit = 03]

1. Identification of wild Angiospermic Plants
2. Assessing relationship between two genera/ two species collected from wild source.
3. Spot identification of angiospermic plants.
4. Nomenclatural problem analysis.
5. Preparation of Crude drug extraction by Soxhlet apparatus
6. Chemical group test of different plant extracts.
7. Quantification of Total Phenolfrom plant extracts.
8. Quantification of Total Flavonoid, from plant extracts.
9. Quantification of Total alkaloid from plant extracts.
10. Screening of antioxidant potentiality of plant extract.
11. Estimation of superoxide dismutases (SODs), catalases, glutathione peroxidases (GPXs) ,ascorbate and glutathione from plant extracts.
12. Profiling of crude extarcts by TLC and column chromatography.

LS 306 (B): Practical II (Special paper): Plant Biochemistry and Molecular Biology

[Full Marks = 50; 6 Contact hours/week; Total credit = 03]

1. Isolation of protein from tissue samples. Quantitative estimation of protein by Bradford method.
2. Isolation of DNA from tissue and estimation of DNA by diphenyleamine reagent.
3. Gel electrophoresis of plant proteins f.
4. Gel electrophoresis of plant DNA & RNA.
5. Isolation of plasmids from E. coli.
6. Restriction digestion of plasmids.
7. Effect of substrate concentration on the peroxidase activity and derivation of line-weaver-burk plot.
8. Paper chromatography of lipids and amino acids.
9. SDS-PAGE and Isoenzyme analysis
10. Bioinformatic analysis of DNA database.
11. PROJECT

ZOOLOGY – III

LS 301 (Z): Molecular Endocrinology

[Full Marks = 100, 6 Contact Hours /week, Total credit = 06]

Unit – I: Basic Concepts

1. Hormones: Survey of endocrine glands
2. Chemical nature and classification of hormones: Endocrine, Paracrine and Autocrine.
3. Biosynthesis and transport of hormones; Regulations of hormone synthesis and feedback mechanism.
4. Concept of endocrine and Neuroendocrine system, Neuroendocrine system in insects and crustaceans; Endocrine regulation moulting in insects and crustaceans.

Unit – II: Structure and pathophysiology

1. Structure and functions of Hypothalamus; Hypothalamic hormones.
2. Anatomy and physiological actions of hormones secreted by Pituitary, Thyroid, Adrenal, Gonads, pancreas and pineal glands
3. Thyroid hormone synthesis and regulation: Incidence of pathophysiology. Parathyroid and thyrocalcitonin hormone structure and function
4. Hormonal control of glucose and calcium homeostasis.

Unit – III: Mechanism of Action

1. Hormone receptors
2. Mechanism of hormone action: Second messenger, receptor mediated Transmembrane signaling, G- protein and control of adenylate cyclase, cyclic nucleotide cascade.
3. Role of Calcium in hormone action.
4. Steroid hormone regulation of gene transcription and other signal transduction systems.

Unit – IV: Reproductive health

1. Contraception and family planning issues: socioeconomical, behavioural and political factors.
2. Infertility: causes, male and female factors;
3. Artificial reproductive techniques; In vitro fertilization.Handlling of sperms and oocytes;
4. Micromanipulation; Embryo culture and embryo transfer; cryopreservation of gametes and oocytes.

<u>Unit V:</u> Applied endocrinology

1. Genetic analysis and clinical management of hormonal disorders
2. Endocrine disrupting chemicals and hormonal disorders
3. Phytoestrogens
4. Production of hormones by DNA technologies.

Suggested Readings:

1. Turner, C.D. and Bagnara, J.T.(1975). General Endocrinology,W.B. Saunders Co, UK.
2. Bentley, P.L. (1998). Comparative Vertebrate Endocrinology (3rd ed.), Cambridge university Press, UK.
3. Norman and Litwack (1987). Hormones, Academic Press.
4. Gorbman et al. (1983). Comparative Endocrinology, John wiley and Sons, New York

LS 302 (Z): Applied Biology

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit I: Application of immunological principles

1. Engineered antibodies: monoclonal, bispecific, chimeric phage display
2. Vaccination: live & attenuated vaccines, recombinant & naked DNA vaccines
3. Immunodiagnostics

Unit II: Risk assessment and mitigation

1. Risk assessment: hazard identification, toxicity assessment, exposure assessment and risk characterization
2. Bioremediation and phytoremediation
3. Biosensors

Unit III: Bioresource and uses of biodiversity

1. Wildlife and its values: Ecological and economic values
2. Wildlife protection scenario in India: Wildlife protection, biodiversity and forest right acts.
3. Endemic and restricted zone animals: Conservation needs, techniques of wildlife census
4. Conservation breeding: Genetic management in captivity; inbreeding depression;

Unit IV: Introduction to parasitism

1. Parasites: Habitat and environment
2. Host-parasite interactions with special reference to immunity and resistance
3. Mosquito and housefly as vectors of human diseases
4. Outline knowledge of prophylaxis

Unit V: Organisms of health & agricultural importance:

1. Common parasites and pathogens of humans and domestic animals
2. Life cycle, pathogenicity and control of Entamoeba histolytica, Plasmodium sp. of man, Leishmania donovani.
3. Life cycle, pathogenesis and control of Fasciola hepatica, Echinococcus granulesus. Ancylostoma duodenale, Wuchereria bancrofti.

LS 303 (Z): Evolution and Behavior

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit I: Emergence of evolutionary thoughts:

5. Lamarckian concept of evolution
6. Darwin's theory of evolution: concepts of variation, adaptation, struggle, fitness and natural selection
7. Elemental forces of evolution: mutations
8. Modern synthetic theory of evolution

Unit – II: Molecular Evolution:

1. Concepts of neutral evolution, molecular divergence and molecular clocks;
2. Molecular tools in phylogeny, classification and identification;
3. Origin of new genes and proteins;
4. Gene duplication and divergence.

Unit – III: Evolutionary genetics:

5. Population genetics; Populations, Gene pool, Gene frequency and genotype frequency
6. Genetic equilibrium and Hardy-Weinberg Law
7. Migration and random genetic drift
8. Isolating mechanisms and speciation: Allopatricity and Sympatricity evolution

Unit – IV: Brain and Behavior:

1. Neural basis of learning, memory, cognition
2. Sleep and arousal;
3. Timing in behaviour: Circadian and circannual rhythm Biological clocks;
4. Approaches and methods in study of behavior; Proximate and ultimate causation;

Unit – V: Reproductive Behavior:

1. Altruism and evolution-Group selection, Kin selection, Reciprocal altruism
2. Social communication, Social dominance and territoriality
3. Sexual selection and reproductive strategies
4. Parental investment and reproductive success: Parental care

Essential Readings:

1. Futuyama, D.J. (1986). Evolutionary Biology, Sinavar Association Inc.
2. Colbert, E.H. (1984). Evolution of Vertebrates, Wiley Eastern Ltd. (New Delhi).
3. Dobzhansky et al. (1976). Evolution; Surjeet
4. Li, W.H. and Graur, D. (1991). Fundamentals of Molecular Evolution. Sinavar Associates Inc.
5. Stebbins(1966). Process of Organic Evolution. Prentice Hall of India (New Delhi).

LS 304 (Z): Fishery Science and Aquaculture (Special Paper; Option-B)

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit I:(General Ichthyology)

1. History of Indian Ichthyology.
2. Contributions of Indian Ichthyologists in the field of Fishery Science and Aquaculture.
3. Fishery Institutes and Organisations of India: their role in Fisheries development

Unit II: (Fish Taxonomy and Biodiversity, Ichthyogeography)

1. Basic morphometrics and meristics in Fish Taxonomic works.
2. Fish Biodiversity and Bionomics.

3. Classification and Zoogeography of Freshwater Fishes with examples of India with special emphasis on North-East India and Assam.

Unit III: (Fish Anatomy, Fish Biology and Fish Physiology)

1. Basic osteology and musculature. Fish locomotion
2. Fish Nutrition and Growth: Anatomical modifications in relation to feeding habits and habitats. Natural food, prepared food, Digestion of food, Growth pattern, Length-Weight Relationship and Condition Factor
3. Excretion and Osmoregulation in Fish
4. Reproduction: Maturity stages, Fecundity, Breeding cycle, Hormonal action

Unit IV: (Inland Capture Fisheries and Aquaculture)

1. Lotic (including rivers and hill streams) and Lentic (including wetlands, lakes and reservoirs) fisheries of India with emphasis on North-East India. A special study of the `Beel' and `Riverine' Fisheries of Assam.Dams and Reservoirs: their effects,Natural and Induced breeding of fishes: Breeding in rivers and collection of spawn; Composite fish culture, various growth stages, fish behaviour involved while feeding and the appropriate feed and feeding methods; Live feed culture aspects for aquatic organisms (Rotofers, Artemia, Daphinia, Moina, Infozuria and etc), Development of Algal culture as a support activity for aquaculture.(Skeletonema, Chetosirus, Thalasoseria and etc), Role of probiotics in Aquaculture.
2. Extensive and Intensive culture, Pen culture, Cage culture, Raft culture, Raceway culture; Design and construction of Fish farm; Integrated fish farming, freshwater ornamental fishes.
3. Fishing contrivances and gears. Socio-economics of fishermen of India with special emphasis on Assam.

Unit V: (Fish Disease and Aquaculture Biotechnology)

1. Animal cell culture with special emphasis on explant culture of fish organs.
2. Tissue culture media with emphasis on maintenance of Fish cell lines.
3. Basic Fish Immunology
4. Diseases in Freshwater Fishes: Bacterial, Fungal and Viral. Epizootic Ulcerative Syndrome (EUS).
5. Fish Genetics (Hybridization in fishes like producing all male)
6. Stock improvement: Androgenesis, Gynoegenesis, Cryopreservation, Transgenic fish

LS 304 (Z): Molecular Genetics (Special Paper; Option-B)

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit – I: (Structure, organisation & regulation)

1. Molecular Evolution: , DNA, RNA and RNP ; types of DNA and satellite DNA; Types of RNA; miRNA and siRNA, ncRNA
2. Organisation of active chromatin, heterochromatin and euchromatin. Y chromosome and sex determination
3. Regulation of gene expression in prokaryotes: RNA polymerase-promoter interaction, post- transcriptional control, antitermination and attenuation; antisense RNA.
4. Regulation of gene expression in eukaryotes. Role of chromatin in gene expression and gene silencing.

Unit – II: (Microbial genetics)

1. Genetic recombination: conjugation, transformation and transduction.
2. Bacteriophages: Lysogenic and lytic cascade.
3. Lac-operon and Tryptophan-operon,
4. Transposable elements.

Unit – III: (Recombinant DNA technology)

1. Enzymes used in gene cloning.
2. Cloning vectors and Identification of recombinant clones.
3. Techniques in molecular biology – c-DNA library, gene expression analysis (PCR, RT-PCR & DNA microarray)
4. Gene cloning in eukaryotic organisms: transgenic animals. Modern methods for detecting defective genes

Unit – IV: (Xenobiotic metabolism)

1. Concept of Pharmacogenetics and Toxicogenomics
2. Xenobiotic metabolizing enzymes and their role in pharmacology
3. Concept of Metabolomics
4. Cytochrome P450s and Flavin Monooxygenase.

Unit – V: (Cancer biology)

1. Cell Cycle and its regulation. virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.
2. DNA and RNA Tumor viruses.

3. Oncogenes, mechanism of activation of proto-oncogenes; tumor suppressor genes and immortalisation.

LS - 405 and 406 – Suggested Readings:

Essential Readings:

1. Gardner, E. J. and Snustad, D.P. Principles of Genetics ,Wiley, New York.
2. Kornberg, A. ,DNA Replication (2nd ed.), Freeman, San Francisco.
3. Swanson, C.P. et al. Cytogenetics, Prentice Hall of India, New Delhi.
4. Medical Molecular Genetics Blackwell
5. Lewin, B. ,Genes VII, Oxford University Press.

Additional Readings:

1. Drilica, K., Understanding DNA and Gene Cloning (Latest ed.), Wiley, New York.
2. Freifelder, D., Recombinant DNA (Latest ed.), Freeman, San Francisco.
3. Freifelder, D., Microbial Genetics (Latest ed.), Jones and Barlett Publications Inc.,Boston.
4. Watson, J.D. et al. (2004 or latest). Molecular Biology of the Gene, Benzamin/Cummings Publ. Co. inc., California.
5. Lewin, B.M., The Molecular Basis of Gene Expression (Latest ed.), Vol 2, Wiley, New York.
6. Hunt, T. et al. (eds) (latest). DNA Makes RNA Makes Protein, Elsevier, Amsterdam.
7. Schaums Molecular and Cell Biology(2004) Tata Mc Graw-Hill

LS 304 (Z): Molecular Neurobiology (Special Paper; Option-C)

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit – I:

1. The cytology of neurons.
2. Structure and function of glial cells.
3. Blood brain barrier & its role, Circumventricular organs of the brain.
4. Cerebrospinal fluid.

Unit – II:

1. Neurotansmitters, Acetylcholine, Biogenic amine transmitters, amino acid transmitters, Neuroactive peptides, Nitric oxide, other substances.
2. Neurotansmitter release – Triggered by calcium flux.
3. Store and release of neurotransmitter by synaptic vesicles.

4. Synthesis of Neuronal protein and its transportation along the axon.

Unit – III:

1. The resting membrane potential.
2. Propagated signaling: The action potential.
3. Nerve cell generation and survival.

Unit – IV:

1. Distinct functional region of the brain.
2. Implicit memory.
3. Explicit memory.
4. Mutations in single genes can affect certain behaviours.

Unit – V:

1. Seizures and Epilepsy.
2. Myasthenia Gravis.
3. Depression.
4. Alzheimer's Disease.

Suggested readings

(1) Kandel , Schwartz , Jessell ,(2000) Principles of Neural science , McGraw – Hill,

Health Professions Division.

(2) P. Michael Conn (2003) Neuroscience in Medicine , J.B.Lippincott Company , Philadelphia.

(3) Bear , Connors , Paradiso (2007) Neuroscience Exploring the Brain , Lippincott Williams & Wilkins , Wolters Kluwer Company.

(4) A.G. Brown (1991) Nerve Cells and Nervous Systems- An Introduction to Neuroscience , Springer- Verlag London Limited.

(5) Alessandro Guidotti ,(1990) Neurotoxicity of Excitatory Aminoacids , FIDIA Research Foundation Symposium Series Vol : 4., Raven Press, New York.

.(6) Siegel, Albers,Brady, (2007) Basic Neurochemistry : Molecular , Cellular and Medical aspects ,Seventh Edition .Elsevier Ltd.

LS 305 (Z): Practical

[Full Marks = 50; 6 Contact hours/week; Total credit = 03]

LS 306 (Z-A): Practical (Fishery science and Aquaculture)

[Full Marks = 50; 6 Contact hours/week; Total credit = 03]

1. Collection, preservation and identification of freshwater fishes from various water bodies.
2. Study of Length-weight relationship and condtion factor in fishes.
3. Study of food and feeding habits in fishes (Bucco-pharynx, gill rakers, alimentary canal and gut contents).
4. Estimation of various fishery indices: Relative gut length (RLG), Gastrosomatic (Hepatosomatic) Index (HSI), Index of Fullness (IOF), Index of Preponderence (IOP), Gonadosomatic Index (GSI).
5. Basic Fish Osteology: Axial and Appendicular skeleton.
6. Study of Haematological parameters of Fish pertaining to TC, DLC, Hb content, Estimation of SGPT, SGOT, LDH in fish blood.
7. Preparation of permanent slides from fish tissues pertaining to skin, stomach, intestine, heart, kidney and gonads.
8. Explant culture of fish organs and maintenance of fish cell lines
9. Field works related to Fishery Science and Aquaculture with emphasis on visits to Fish farms and Laboratories in NE India and/or outside NE India for observation and hand-on practice on hypophysation and various other techniques and submission of field report.

LS 306 (Z-B): Practical (Molecular Genetics)

[Full Marks = 50; 6 Contact hours/week; Total credit = 03]

1. Mitotic chromosome preparation from mouse/rat bone marrow cells and stages of mitosis from Onion root tips
2. Meiotic chromosome preparation from rat/mouse testis.
3. Aseptic techniques and good cell culture practice
4. Banding technique of mouse/rat chromosome: G- banding and C-banding
5. Study of chromosome aberration induced by mutagens and /or radiation rat/ mouse chromosome.
6. Leukocyte culture technique from peripheral blood of human.
7. Electrophoretic studies of isozymes.
8. Human normal and aberrant mitotic chromosome karyotyping.
9. Barrbody (sex chromosome) test from hair root tip and buccal mucosal cell of human.
10. Analysis of genetic damage using agarose gel electrophoresis

LS 306 (Z-c): Practical (Molecular neurobiology)

[Full Marks = 50; 6 Contact hours/week; Total credit = 03]

1. Preparation of temporary mount of nerve cell.
2. Dissection of nervous system in invertebrates and vertebrates.
3. Dissection iof nervous system of rat/mice as experimental model.
4. Procedure for removal of various parts of brain in mice and other experimental animals for further study.
5. Study of permanent slides on nervous tissue.
6. To learn the use of steriotaxic instrument for neuroscience research.
7. Acquisition of data for various neurolophysiological parameters like EEG, EMG, Evoked potential.
8. Study of blood supply to brain.
9. Perform some behavioural studies on mice.
10. Neutotoxicological studies using animal models.
11. Determination of catalage.

BOTANY – IV

LS 401 (B): Mycology and Plant Pathology

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit-I

1. General features of Fungi, Nutrition and growth.
2. Classification of fungi: recent trends with reference to vegetative structure, phylogeny and affinities of the main groups
3. Sexuality and parasexual cycles.
4. Tools and techniques uses for identification of fungi.

Unit -II

1. Ecology of fungi; soil fungi, rhizosphere fungi, phylosphere andair fungi.Mycorrhizal association and its application in forestry and agriculture. Lichens: Thallus structure, reproduction and economic importance
2. Economic importance of fungi: fungal enzymes- Cellulases, Lipases, proteases;Bio-degradation of cellulose and hemi-cellulose.
3. Fungal primary and secondary metabolites for agriculture and Industry (Acids, Antibiotics, pharmacologically active compounds, anti-fungals)
4. Fungi as Plant Growth Promoter and Disease Suppressor, Biofungicides.

Unit -III

1. Symptomatology and identification of fungal diseases.
2. Symptomatology and identification of bacterial diseases
3. Symptomatology and identification of viral diseases
4. Principles of plant disease control: physical, chemical, biological

Unit -IV

1. Disease development- role of enzymes, toxins, growth regulators
2. Defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors
3. Interrelationship of parasitism and pathogenicity.
4. Molecular basis of pathogen host recognition and regulation. Host genetics in relation to types of pathogenicity.

Unit-V

1. Resistant variety and development of disease resistant plant.
2. Genetic engineering for disease resistance.
3. Quarantine – domestic and international. Quarantine restrictions in the movement of agricultural produce, seeds and planting material;
4. Crop rotation.

Essential Readings:

1. Tarr, S. (1979). Principles of Plant Pathology.
2. Control of Plant Pathogens, A.P.S. books, 3340, Pilot Knob Road, St. Paul, MN 55121, USPI.
3. Aggrios (1998). Plant Pathology (2^{nd}ed.) Panima Book Distributors, New Delhi.
4. Nene, Y.L. and Thapilyal, P.N. (1984). Fungicides in Plant Disease, Central Oxford and IBH Publications Co., New Delhi.
5. Subramanian, C.V. (1983). Hyphomycetes : Taxonomy and Biology, Academic Press, London.

LS 402 (B): Molecular Genetics and Plant Breeding.

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit - I

1. Fine structure of gene.
2. Structure of chromatin: Euchromatin and heterochromatin
3. Exons and Introns,Overlapping & split genes, Pseudogenes, Gene expression,
4. Post transcriptional and translational modification

Unit - II

1. Multiple alleles, pseudoallele, complementation tests.

2. Gene mapping methods: Linkage maps, mapping with molecular markers, development of mapping population in plants.

3. Microsatelite markers and Marker assisted breeding

4. Epigenetics , DNA methylation and demethylation

Unit-III

1. Plant gene structure and expression.
2. Regulation of plant gene expression.
3. Cytoplasmic inheritance involving chloroplast
4. RNA interference and regulatory RNA

Unit - IV

1. Polygnenic traits, multiple factors hypothesis and heritability. Polygenic heritability and its measurements.
2. Gene effect and components of phenotypic variance.
3. Genetic variance and its components, variance due to environment, gene frequency in a population
4. Genetic equilibrium and Hardy-Weinberg law.

Unit - V

1. Objectives of plant breeding, characteristics improved by plant breeding. Centres of Origin
2. Heterosis and inbreeding depression
3. Hybrid seed production, Mutation breeding, Selection and hybridization for crop improvement.

4. Self-incompatibility and male sterility in crop plants and their commercial exploitation.

LS – 402(B) Suggested Readings:

1. Acquaah,G (2012) Principles of Plant genetics & breeding, WileyFreifelder, D. (1990). Molecular Biology, Narosa Publications, new delhi.
2. Watson, J.D. (1990). Molecular Biology of the Gene, 2nd ed., Narosa Publ., ND.
3. Bose (1997). Selection Methods in Plant Breding, Panima Book Distributors, ND.
4. **Jorgensen (2013) Plant Genetics & Genomics: Crops and models-Series**
5. Falconer (1998). Introduction to Quantitative Genetics, Panima Book distributors, ND.
6. Swanson, C.P. et al. (1981). Cytogenetics : The Chromosomes on Division, Inheritance and Evaluation, Prentice Hall India Ltd., New Delhi.
7. Obe, G. (1987). Cytogenetics, Springer-Verlag, New York.
8. Simonds, N.W. (1979). Principles of Crop Inprovement, Longmer, J.K.
9. Hughes,MA (1996) Plant Molecular Genetics, Longman

LS 403 (B): Advanced Plant Biology

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit - I

1. Molecular tools for Identification of Microbes (rDNASequencing , PCR and variations-RT-PCR, Nested PCR, Multiplex, RFLP: Ribotyping, PFGE; RAPD, PCR-RFLP.
2. Methods of Strain Improvement and its applications.
3. General Introduction to IPR,
4. Patenting of biological processes, patenting regulations in India.

Unit - II

1. Plant genome sequencing and functional Genomics
2. High-throughtput genomic and proteomic platforms for novel plant gene and protein s discovery
3. Plant metabolomics
4. Plant systems biology

Unit - III

1. Sequencing Technologies: First Generation, Next Generation and third generation
2. Gene identification and annotation.
3. Comparative and functional genomics.,miRNomics
4. Genome Analysis: Completed genomes, Eukaryotic genomes

Unit - IV

1. Molecular Phylogeny, Application of DNA markers in Angiosperm Taxonomy.
2. Database development for Herbarium.
3. Phylogenetic trees for graphic representation of the evolutionary divergences of organisms.
4. Modern Trends in Taxonomy – Taxometrics, Cytotaxonomy, serotaxonomyCladistics.

Unit - V

1. Phytochemicals from medicinal and aromatic plants: Role in drug discovery

2. Prediction of 3D structure of Proteins: Comparative modeling; Concept of active sites and its identification
3. ADME/Tox and Lipinski Ro5
4. Structure based drug designing:QSAR and molecular Docking

LS – 403(B) Suggested Readings:

1. JonathanPevsnerBIOINFORMATICS ANDFUNCTIONAL GENOMICS, 2nd Edition.

2. Jorgensen (2013) Plant Genetics & Genomics: Crops and models-Series

3. Jay C. Dunlap. FungalGenomics:AdvancesinGenetics, Volume 57

4. Weising, K., H. Nybom, K. Wolff & G. Kahl 2005.DNA Fingerprinting in Plants - Principles, Methods and Applications.CRC Press.

5. Minelli, A. 1993. Biological Systematics. Chapman & Hall, London, UK.

6.Ziwei Huang (2007).Drug Discovery Research.Willey Interscience.

LS 404 (B): Project (Special Paper)

[Full Marks = 100; 6 Contact hours/week; Total credit = 06]

Option A- Microbial Ecology

Option B- Plant Taxonomy and Medicinal Plant studies.

Option C- Plant Biochemistry and Molecular Biology.

LS 405 (B): Practical - I

[Full Marks = 50; 6 Contact hours/week; Total credit = 03]

1. Study of symptoms of bacterial and Viral diseases
2. Preparation of media and culture of plant pathogens.
3. Identification of causal organisms from diseased plant materials (Fungi).
4. Study of morphology of some phytopathogens and antibiotic producing fungi.
5. Demonstration of anatogonistic activity between pathogenic fungi and test organisms.
6. Application of microbes (mycorrhizal and rhizobium) in the growth of crop plants

LS 406 (B): Practical - II

[Full Marks = 50; 6 Contact hours/week; Total credit = 03]

1. Isolation of total bacterial DNA by ethanol precipitation method.
2. Testing the goodness of fit and independent assortment using chisquare test.
3. Study of mitosis in fresh/fixed root tips.
4. Study of meiosis in fixed flower buds.
5. Study of karyotype and preparation of ideogram of Allium cepa /Allium sativum.
6. Plant genomic DNA isolation and genomic PCR.
7. Plant RNA isolation and electrophoresis.
8. Active site prediction of target protein.

ZOOLOGY - IV

LS 401 (Z): Limnology, Wetland biology and Biosystematics

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit 1:

1. Limnology as a Science, its scope and different aspects, Palaeolimnology.
2. Limnologists of the world and contribution of Indian Scientists in the field of Limnology. .2.Status of Limnology in some developing countries with special emphasis on India.
3. Origin and Classification of lakes and wetlands in general.
4. Origin and Classification of Lotic system,
5. Eutrophication; Weed Problems , their consequences and management. Problems of siltation and its management.
6. Basics of remote sensing and GIS technology

Unit II

1. Fluvial dynamics, Physico-chemical features and Biodiversity of major lotic and lentic habitats in India with special emphasis on North-East India and Assam.
2. Wetlands (Beels) of Assam: their classification and distribution.
3. A special study of the Beels of Assam, their physico-chemical characteristics, biodiversity, potentialities, problems and present developmental programmes.
4. Management and Conservation of the wetlands.
5. Management and conservation of Lotic systems.
6. Concept of Aquatic Sanctuary.

Unit lll:

1. Biosystematics and Taxonomy defined; stages of taxonomy; scope of studying Biosystematics. History of Taxonomy. Indian Taxonomists and their contributions.
2. Species concept
3. Zoological classification: purpose, function, components and Linnean hierarchy

Unit IV

1. Taxonomic Museums and Institutions in India and Abroad. Museum maintenance and techniques; Taxonomic Collection, Preservation, Identification, Curating and Catalogueing.
2. Taxonomic Keys
3. Taxonomic Literature
4. Type concept, Classification of Types

Unit V

1. Taxonomy providing evidences of Organic evolution
2. International Code of Zoological nomenclature
3. Recent trends in Taxonomy
4. Molecular Taxonomy.

LS 402 (Z): Animal Physiology

[Full Marks = 100, Contact Hours = 50, Total credit = 05]

Unit – I:

1. An overview of hemopoiesis
2. Structure and function of hemoglobin.
3. Gaseous transport and exchange in blood.
4. Coagulation of blood.

Unit – II: General organization of respiratory system

1. Pulmonary volume and capacities, Alveolar ventilation, rate of alveolar ventilation
2. Gaseous exchange: Diffusion through respiratory membrane and tissue.
3. Neural and chemical regulation of respiration.

Unit – III: General organization of the kidney and structure of nephron

1. Glomerular filtration
2. Tubular reabsorption and secretion
3. Water excretion

Unit – IV: Structure and function of neurons and glial cells.

1. Resting membrane potential and action potential
2. Neurotransmitters.
3. Ultra structure of skeletal muscle fiber, Mechnism of muscle contraction, muscle fatigue.

Unit – V: Basic concept of toxicology; types of toxic agents

1. Basic mechanism of action of toxic agents and dose-response relationship
2. Free radicals - reactive oxygen and reactive nitrogen species; Role of free radicals in cellular metabolism
3. Cellular response to toxic agents - antioxidant defence system -enzymatic and non-enzymatic.

LS – 402(Z): Suggested Readings:

Essential Readings :

1. Hoar, W.S. (1983). General and Comparative Physiology, Prentice Hall of India, ND.
2. Prosser, C.L. and Brown, F. A. (1965). Comparative Animal Physiology, Prentice Hall of India, New Delhi.
3. Arthur, C., Guyton and Hall (1996). Textbook of Medical Physiology (9^{th} ed.), W.B. saunders and Company.
4. Ganong (1991). Review of Medical Physiology (15^{th} ed.), Lange Medical Publications.

LS 403 (Z): Developmental Biology

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

Unit – I: Principles of Developmental Biology

1. Potency, commitment, specification, induction, competence,
2. Determination and differentiation; morphogenetic gradients; cell fate and cell lineages
3. Stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development

Unit – II: Early Development

1. Production of gametes, Gametogenesis: Spermatogenesis and ogenesis, cell surface molecules in sperm-egg recognition in animals
2. Fertilization: Sperm egg interaction and acrosomal reaction ,Species specific recognition of gamates, Prevention of polyspermy, Fusion of gametes and egg activation and zygote formation
3. Cleavage: Types of eggs; overview of types of cleavage ,blastula formation, embryonic fields

Unit – III: Gastrulation

1. Gastrulation: A comparison of process of gastrulation in insects, amphibians, birds and mammals
2. Gastrulation and formation of germ layers in animals ectoderm, mesoderm and endoderm.
3. Mechanism of cell movement during gastrulation.

Unit – IV: Gene and development

1. Pattern formation in Dictyostellium
2. Early events in Drosophila development
3. Drosophila axis formation and embryonic patterning
4. Drosophila segmentation and segment identity (Hox genes)

Unit – V: Programmed cell death, aging and senescence

1. Apoptosis and its role in development, Mechanism of apoptosis
2. Ageing and Senescence, Mitochondrial control of ageing
3. Insulin pathway control of ageing and possible relation to oxygen radicals .
4. "Ageless" animals and environmental control of ageing; Senesence and cell death

Suggested Readings:

1. Gilbert, S. F. Developmental Biology (8th ed.), Sinaur Associates Inc., Sautherland.
2. Berrill, N.J. Developmental Biology, McGraw Hill Book Co., USA.
3. Slack (1991). From Egg to Embryo, Cambridge University Press, UK.
4. Weddington, C.H.C. (1985). Principles of Development and Differentiation.
5. Bronson (1989). Mammalian Reproductive Biology, University of Chicago Press.

LS 404 (Z): Projects

[Full Marks = 100; 6 Contact hours/week; 1.2 credits/unit; Total credit = 06]

A. Fishery science and aquaculture
B. Molecular genetics
C. Molecular Neurobiology

LS 405 (Z): Practical

[Full Marks = 50; 6 Contact hours/week; Total credit = 03]

1. Determination of temperature, and turbidity of water samples.
2. Determination of pH and Conductivity of water samples.
3. Estimation of dissolved oxygen in water samples
4. Estimation of free carbon di-oxide in water samples
5. Estimation of total alkalinity and total hardness in water samples.
6. Estimation of phosphate and in water samples.
7. Estimation of Nitrate in water samples
8. Quantitative estimation of Plankton samples collected from lentic and lotic water bodies.
9. Estimation of chemical oxygen demad in water samples.
10. Field works involving Limnological studies in wetlands/rivers and submission of field report.

LS 406 (Z): Practical

[Full Marks = 50; 6 Contact hours/week; Total credit = 03]

1. Comparison of RBC and WBC number in different vertebrates.
2. Estimation of haemoglobin concentration in vertebrate blood and preparation of haemin crystals.
3. Recording of heartbeat, blood pressure and ECG.
4. Estimation of ascorbic acid in tomato, lemon, and milk.
5. Recording of muscle contraction.
6. Determination of casein content in milk.
7. Regeneration in amphibians.
8. Permanent slide preparation of early chick embryo.
9. Isolation of mitochondria
10. Mitochondrial enzyme assays