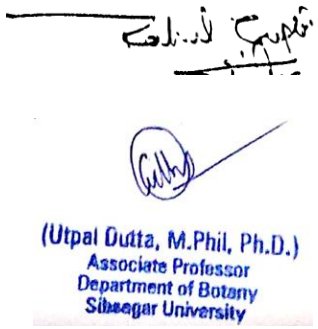
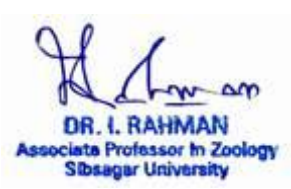
Syllabus: M.Sc. in Life Sciences (CBCS)





P.G. Department of Life Sciences

Digboi College (Autonomous)

Accredited 'A+' grade with CGPA 3.49 by NAAC

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PG DEPARTMENT OF LIFE SCIENCES, DIGBOI COLLEGE (AUTONONMOUS)
OUTLINE OF POST GRADUATE SYLLABUS (CBCS MODE) revised in the BOS held on __24/06/2025

1. The Preamble:

Present-day Life Sciences is a fusion of the traditional components with the modern aspects of biochemistry, molecular biology and biotechnology. Over the years, Life Sciences has shown enormous gain in information and applications owing to tremendous inputs from research in all its aspects. With the global need for conservation, field biologists have contributed significantly in assessing and exploring newer dimensions for animal diversity. New insights on various dimensions of the biological world have been gained by utilizing modern tools and techniques for biological research. Concern for ever-increasing pollution and climate change is at its highest than ever before. Keeping the above-mentioned advancements and rich resources in North East India in view, a revised curriculum is offered by Digboi College (Autonomous) at the postgraduate level as per the National Education Policy-2020 so that the postgraduate Life Sciences students of Digboi College (Autonomous) shall have the benefit of a balanced, carefully-crafted course structure taking care of different aspects of Life Sciences, namely animal diversity, physiology, cell biology, genetics, evolution, biochemistry, molecular biology, developmental biology, reproductive physiology, comparative anatomy, chronobiology, ecology and economic Life Sciences. All these aspects have been given due weightage over the eight semesters. The postgraduate students need to acquaint themselves with various tools and techniques for exploring the world of animals. Keeping view of employment entrepreneurship, skill-based courses of sericulture and aquaculture have been introduced. These courses shall provide the students hands on experience and professional inputs. On the whole, the curriculum is a source of lot of information and is supported by rich resource materials. It is hoped that a student postgraduating in Life Sciences with the new curriculum will be able to explore the rich animal diversity of North East India.

2. Introduction:

Digboi College (Autonomous) PG syllabus of Life Sciences is designed as per the guidelines of CBCS. This Two Year Post Graduate Programme (CBCS) in Life Sciences consists of Core Course, Discipline Specific Elective, Multi-Disciplinary Generic Elective Courses (GE), Ability Enhancement Courses (AEC), Internship, Field Studies, Research Ethics, Research Projects to acquaint the students with balanced knowledge on the animal, plant resources, environment, contemporary issues and entrepreneurship.

It is expected that, on successful completion of this two-year programme students will be skilled in multidisciplinary aspects for exploration and sustainable utilize Nation of natural resources of

NE region of India.

3. Aims of Two-Year Post-Graduate Programme (CBCS) in Life Sciences:

1. To introduce the students with the rich world of animal diversity with a focus on biodiversity of North east India.

2. To enable the students to explore the potential of natural resources for human welfare and their use in a sustainable way.

3. To develop capabilities of students for critical evaluation of contemporary issues related to environment and conservation.

4. To generate skilled human resources for biological entrepreneurship.

4. Post Graduate Attributes of the CBCS in Life Sciences:

Disciplinary Knowledge

The graduates should have the ability to demonstrate comprehensive knowledge and understanding of both the theoretical and applied components of animal science and allied areas of study in a multidisciplinary context.

Students should have the ability to connect relevant disciplines, and recent trends in biological and contemporary issues.

Communication Skills

The graduates in Life Sciences should have the ability to present and express information, thoughts, experiments and results clearly and concisely for effective communication of any issues related to animals and nature.

Moral and Ethical Awareness/Reasoning

Ability to recognize ethical issues that are pertinent to one's work and pledge not to engage in unethical behaviour such as plagiarism, copyright and infringement of intellectual property rights; ability to appreciate recent developments in various fields and one’s research with honesty and integrity in all aspects.

Multicultural Competence

Ability to correlate and compare recent developments in various branches of animal science worldwide; ability to collaborate research in various fields of biology with other researchers from allied organisations; acquisition of knowledge on traditional practices of different ethnic communities.

Information/Digital Literacy

The graduates of Life Sciences should have the ability to utilize Information and Communications Technology (ICT) tools, biological databases and computer and softwares in solving biological problems.

Reflective Thinking and Problem Solving:

After completion of graduation in Life Sciences the students will be able to understand the value of animal diversity, need for conservation of animals, bio-prospecting and sustainable utilization of natural resources for human welfare.

Critical Thinking

The graduates of Life Sciences should be competent for critical analysis of problems related to animals and nature, sustainable uses of biological resources and their conservation strategies.

I. FIRST SEMESTER *(C=Credit, M=Marks)

Course	Course Code	Course Name		C	M
Core Course-I	**LS-C-101**	Biochemistry & Molecular Biology		4	100
Core Course-II	**LS-C-102**	Cell Biology & Genetics		4	100
Core Course-III	**LS-C-103**	Biological Techniques, Biostatistics & Computational Biology		4	100
Core Course-IV	**LS-C-104**	Practical Course: Biochemistry & Molecular Biology and Biological Techniques		2	50
Core Course-V	**LS-C-105**	Practical Course: Cell Biology & Genetics, Biostatistics & Computational Biology		2	50
Discipline Specific Elective-I	**LS-D-106**	A.	Biochemistry-I: Intermediary Metabolism	4	100
		B.	Fish & Fisheries-I: Fish Biology		
		C.	Entomology-I: Insect Diversity and Evolution		
		D.	Plant Ecology-I: Principle and Concept of Plant Ecology		
		E.	Genetics & Crop Improvement-I: Genetics & Cytogenetics		
		F.	Microbiology-I: General Microbiology		
		G.	Angiosperm Systematics-I: Fundamentals of Angiosperm Taxonomy		
Discipline Specific Elective-II	**LS-D-107**	A.	Practical course based on LSD106 A	2	50
		B.	Practical course based on LSD106 B		
		C.	Practical course based on LSD106 C		
		D.	Practical course based on LSD106 D		
		E.	Practical course based on LSD106 E		
		F.	Practical course based on LSD106 F		
		G.	Practical course based on LSD106 G		
Ability Enhancement Course-I	**LS-A-108**	A.	Biodiversity Management-I: Understanding Biodiversity	2	50
		B.	Public Health Entomology-I		
				Total Credits=24	

Instructions:

- **For Discipline Specific Elective Course, Zoology Students may choose any one option from A, B, and C. Botany Students may choose any one option from D, E, F and G. Option, once selected, will not be allowed to change in subsequent semesters.**
- **For the Ability Enhancement Course, students may choose any one option from A and B. Option, once selected, will not be allowed to change in the third semester.**

II. SECOND SEMESTER *(C=Credit, M=Marks)

Course	Course code	Course Name		C	M
Core course-VI	**LS-C-201**	Environmental Biology & Microbiology		4	100
Core course- VII	**LS-C-202**	Toxicology, Pest Management, Bioethics and IPR		4	100
Core course- VIII	**LS-C-203**	Taxonomy, Evolutionary Biology & Biodiversity		4	100
Core course- IX	**LS-C-204**	Practical Course: Environmental Biology & Microbiology		2	50
Core course- X	**LS-C-205**	Practical Course: Toxicology, Pest Management, Taxonomy, Evolutionary Biology & Biodiversity		2	50
Discipline Elective Course-III	**LS-D-206**	A.	Biochemistry-II: Protein Chemistry and Enzymology	4	100
		B.	Fish & Fisheries-II: Capture Fisheries and Aquaculture		
		C.	Entomology-II: Insect Physiology		
		D.	Plant Ecology-II: Habitat Ecology		
		E.	Genetics & Crop Improvement-II: Crop Improvement		
		F.	Microbiology-II: General Microbiology		
		G.	Angiosperm Systematics-II: Applied Angiosperm Taxonomy		
Discipline Elective Course-IV	**LS-D-207**	A.	Practical course based on LSD206 A	2	50
		B.	Practical course based on LSD206 B		
		C.	Practical course based on LSD206 C		
		D.	Practical course based on LSD206 D		
		E.	Practical course based on LSD206 E		
		F.	Practical course based on LSD206 F		
		G.	Practical course based on LSD206 G		
Generic Elective- I	**LIF-GE-208**	A: Nutrition & Health B. Plant Tissue Culture		4	100
				Total Credits=26	

Instructions:

- **For the Discipline Specific Elective Course, Option selected in first semester will be continued in second semester.**

III. THIRD SEMESTER (ZOOLOGY) *(C=Credit, M=Marks)

Course	Course Code	Course Name	C	M
Core Course-XI	**LS-C-301Z**	Animal Physiology	3	75
Core Course-XII	**LS-C-302Z**	Immunology	3	75
Core Course-XIII	**LS-C-303Z**	Developmental Biology	3	75
Core Course-XIV	**LS-C-304Z**	Practical Course: Animal Physiology & Immunology	1.5	38
Core Course-XV	**LS-C-305Z**	Practical Course: Developmental Biology	1.5	37
Discipline Specific Elective-V	**LS-D-306Z**	A. Biochemistry-III: Intermediary Metabolism B. Fish & Fisheries-III: Fish Biology C. Entomology-III: Insect Diversity and Evolution	4	100
Discipline Specific Elective-VI	**LS-D-307Z**	A. Practical course based on LSD306Z A B. Practical course based on LSD306Z B C. Practical course based on LSD306Z C	2	50
Generic Elective	**LIF-GE-308**	GE-II: Computational Biology	4	100
Ability Enhancement Course-II	**LS-A-309**	A. Biodiversity Management-II: Conservation of Biodiversity Or Field Study B. Public Health Entomology-II: Field Study Survey	2	50
				Total Credits=24

Instructions:

- **For the Discipline Specific Elective Course, the Option selected in the first semester will be continued in the third semester.**
- **For the Ability Enhancement Course, the Option selected in the first semester will be continued in the third semester.**
- **A project work carrying 100 marks should be allotted to each student of the DSE Course at the beginning of the 3rd semester. The report is to be submitted in the Paper LS-D 406B and LS-D-406Z of 4th Semester.**

III. THIRD SEMESTER (BOTANY) ***(C=Credit, M=Marks)**

Course	Course Code	Course Name		C	M
Core Course-XI	**LS-C-301B**	Mycology, Plant Pathology, Crop Protection		3	75
Core Course-XII	**LS-C-302B**	Algae & Bryophytes		3	75
Core Course-XIII	**LS-C-303B**	Pteridophyte & Gymnosperm		3	75
Core Course-XIV	**LS-C-304B**	Practical Course: Mycology, Plant Pathology, Crop Protection and Algae		1.5	38
Core Course-XV	**LS-C-305B**	Practical Course: Bryophyte, Pteridophyte & Gymnosperm		1.5	37
Discipline Specific Elective-V	**LS-D-306B**	D.	Plant Ecology-III: Applied Plant Ecology	4	100
		E.	Genetics & Crop Improvement-III: Advanced Cytogenetics		
		F.	Microbiology-III: Molecular Microbiology		
		G.	Angiosperm Systematics-III: Diversity and Conservation of Angiosperms		
Discipline Specific Elective-VI	**LS-D-307B**	D.	Practical course based on LSD306B D	2	50
		E.	Practical course based on LSD306B E		
		F.	Practical course based on LSD306B F		
		G.	Practical course based on LSD306B G		
Generic Elective	**LIF-GE-308**	Computational Biology		4	100
Ability Enhancement Course-II	**LS-A-309**	A.	Biodiversity Management-II: Conservation of Biodiversity Or Field Study	2	50
		B.	Public Health Entomology-II: Field Study Survey		
Total Credits=24					

Instructions:

- **For the Discipline Specific Elective Course, the Option selected in the first semester will be continued in the third semester.**
- **For the Ability Enhancement Course, the Option selected in the first semester will be continued in the third semester.**
- **A project work carrying 100 marks should be allotted to each student of the DSE Course at the beginning of the 3rd semester. The report is to be submitted in the Paper LS-D 406B and LS-D-406Z of 4th Semester.**

IV. FOURTH SEMESTER (ZOOLOGY) *(C=Credit, M=Marks)

Course	Course code	Course Name		C	M
Core course- XVI	**LS-C-401Z**	Physiology of Reproduction		3	75
Core course- XVII	**LS-C-402Z**	Molecular Endocrinology		3	75
Core course- XVIII	**LS-C-403Z**	Animal Behaviour		3	75
Core course- XIX	**L-SC-404Z**	Practical Course: Molecular Endocrinology & Physiology of Reproduction		1.5	37
Core course- XX	**L-SC-405Z**	Practical Course: Animal Behaviour		1.5	38
DSE VII: Project Work	**LS-D-406Z**	A.	Biochemistry-IV	4	100
		B.	Fish & Fisheries-IV		
		C.	Entomology-IV		
Total Credits=16					

Instructions:

- **For the Discipline Specific Elective Course, the Option selected in the first semester will be continued in the fourth semester.**

IV. FOURTH SEMESTER (BOTANY) *(C=Credit, M=Marks)

Course	Course code	Course Name		C	M
Core course- XVI	**LS-C-401B**	Taxonomy of Angiosperm and plant improvement		3	75
Core course- XVII	**LS-C-402B**	Development and Reproduction In Angiosperms		3	75
Core course- XVIII	**LS-C-403B**	Plant Physiology		3	75
Core course- XIX	**LS-C-404B**	Practical Course: Taxonomy of Angiosperm and plant improvement		1.5	37
Core course- XX	**LS-C-405B**	Practical Course: Plant Physiology, Development and Reproduction In Angiosperms		1.5	38
DSE VII: Project Work	**LS-D-406B**	D.	Plant Ecology- IV	4	100
		E.	Cytogenetics & Plant Breeding-IV		
		F.	Microbiology- IV		
		G.	Angiosperm Systematics-IV		
Total Credits=16					

Instructions:

- **For the Discipline Specific Elective Course, the Option selected in the first semester will be continued in the fourth semester.**

Generic Elective Courses (To be opted by students of other departments)
LSG-1: Nutrition and Health
LSG-2: Plant Tissue Culture
LSG-3: Computational Biology

SEMESTERWISE DISTRIBUTION OF CREDITS

SEMESTER	CORE COURSE (CC)	DISCIPLINE SPECIFIC ELECTIVE (DSE)	ABILITY ENHANCEMENT COURSE (AECC)	GENERAL ELECTIVE (GE)	TOTAL
I	16	06	02	-	24
II	16	06	-	04	26
III	12	06	02	04	24
IV	12	04	-	-	16
GRAND TOTAL	**56**	**22**	**04**	**08**	**90**

Kishor Halai

Course Coordinator
M.Sc Life Sciences
Digboi College

FIRST SEMESTER

LS-C-101: BIOCHEMISTRY & MOLECULAR BIOLOGY

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Section-A: Biochemistry

Unit 1: Types and features of Chemical bonds; Law of thermodynamics, concept of free energy in biological system, high-energy compounds and their biological significance; classification, structure and functions of carbohydrates, lipids, proteins & amino acid; Levels and structural organization of proteins.

Unit2: Metabolism: Cori cycle, glycolysis, gluconeogenesis , Krebs cycle and their energetic; Outline of catabolic routes of amino acids; Oxidative deamination, decarboxylation, transamination; urea cycle; β-oxidation of fatty acids and synthesis of fatty acids (Palmitate). concept of Electron transport system & ATP synthesis; phosphorylation (substrate level, oxidative and photophosphorylation).

Unit 3: Enzymes; classification, properties, mechanism of action, factors affecting enzyme activity; Michaelis-Menten equation; Line-weaver & Burk plot, significance of Km; Enzyme inhibition; Cofactors and coenzymes.

Section-B: Molecular Biology

Unit 4: Nucleic acid as genetic material; structure, properties and types of DNA (A, B and Z) and RNA (hn RNA, mRNA, tRNA and rRNA); C- value Paradox; Genome organization in 'prokaryotes' and eukaryotes; DNA replication: semiconservative, enzymology of DNA replication; Basic concept of end replication problem and DNA synthesis by reverse transcriptase; regulation of gene expression in 'prokaryotes'; operon concept, structure and function of lac.operon.

Unit 5: Transcription and Translation: RNA polymerase in 'prokaryotes' and eukaryotes; RNA transcription; RNA processing & splicing; Genetic code and its features; initiation, elongation and termination of protein biosynthesis; Post-translational modification of proteins.

Unit 6: Basic methodologies of manipulating DNA & Genes: cutting, separating and visualizing DNA pieces, Southern blotting, foot printing, RFLP, DNA sequencing, polymerase chain reaction (PCR).

LS-C-102: CELL BIOLOGY & GENETICS

L	T	Credit: 4
48	16	Marks: 100 (In=40, End=60)

Section-A: CELL BIOLOGY

Unit 1: Plasma membrane and Transport: Membrane proteins, lipids & Membrane fluidity, Membrane transport: diffusion, facilitated diffusion, active transport; Carriers & Channel Proteins; ATP driven pumps, Aquaporins, Ion channels and electrical properties of plasma membrane.

Unit 2. Structure and function of cytoskeletons, dynamics of microfilaments, Role of actin & microtubule cytoskeleton in cell shape, intracellular motility, motor proteins, Functions of intermediate filaments. Protein sorting and transport to the endoplasmic reticulum (ER), Golgi body and lysosomes; Protein glycosylation within ER and Golgi body and protein secretion. Phases of cell cycle, checkpoints and regulators of cell cycle progression, Programmed cell death. Genetic rearrangement in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus induced cancer, carcinogens, metastasis.

Unit 3: Cell communication and signaling: General principles of cell communication, cell adhesion and role of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation. Cell-cell fusion in normal and abnormal cell. Regulation of hematopoiesis. Receptors, G-proteins and GTPase cycle and its regulation, G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways.

Section-B: GENETICS

Unit 4: Deviations of Mendelism, pleiotropy, penetrance and expressivity, Phenocopy multiple alleles and multiple genes; Chromosomal mechanism of sex determination, sex-linked, sex limited and sex influenced characters; cytoplasmic inheritance, Linkage and crossing over: phase, group, mechanism and stages of occurrence of crossing over; gene mapping in eukaryotes, three-point test-cross. Epigenetics: concepts and molecular basis.

Unit 5: Mutation: numerical and structural chromosomal mutation, autoploidy and alloploidy, spontaneous and induced mutation; mutagens and their action, Gene mutation, frame shift and substitutional mutation, DNA damage and repairing.

Unit 6: Concept of population genetics and Hardy-Weinberg law, Human genetics: genetic disorders and syndromes, euthenics, eugenics and euphenics; Genetic counselling; Basic idea on human genome project (HGP), genomic library and gene targeting.

LS-C-103 : BIOLOGICAL TECHNIQUES, BIOSTATISTICS & COMPUTATIONAL BIOLOGY

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Section-A: BIOLOGICAL TECHNIQUES

Unit 1: Microscopy: principles and operation: dark field phase contrast, Fluorescence and electron microscopy (SEM & TEM), Radiation Biology: concept, radioisotopes of biological interest, principles and functions of Geiger Muller Counter, Scintillation detectors and autoradiography.

Unit 2: Separation techniques: Centrifugation: ultra-centrifugation, density gradient centrifugation; Chromatography; Electrophoresis & electro-focussing: types, principles and applications, Spectroscopy: principles and applications of Colourimetry, spectrophotometry, flame photometry; Atomic absorption Spectroscopy, XRD, NMR.

Unit 3: Recombinant DNA technology: principles and methods: Amniocentesis, transgenic plants and animals; Application of genetic engineering in Agri, medicine and Industries.

Section-B: BIOSTATISTICS & COMPUTATIONAL BIOLOGY

Unit 4: Sampling of statistical data; Central tendencies and dispersions: Basic probability concepts: Theoretical distributions (binomial, poisson and normal distribution), Correlation: Regression; Tests of significance (z, t & chi-square test). Analysis of variance and design of experiment (CBD &RBD).

Unit 5: Introduction to Bioinformatics, Biological Databases, Sequence Analysis and Alignment, Phylogenetic analysis, Basics of computational phylogenetic analysis. Computational gene prediction methods.

Unit 6: Protein structure prediction methods, Homology modeling. Basics of Computer Aided Drug Designing, Drug-target interaction: Molecular Docking and QSAR.

LS-C-104: Practical. Course on BIOLOGICAL TECHNIQUES, BIOSTATISTICS & COMPUTATIONAL BIOLOGY **Credit: 2**

Marks: 50 (In=20, End=30)

1. Preparation of solutions of different normality, molarity and dilutions.
2. Colourimetric estimation of protein, glucose and inorganic phosphates.
3. Estimation of ascorbic acid by titrimetric method.
4. Preparation of buffers.
5. Measurement of enzyme activity.

6. Determination of Km.
7. Effect of temperature on enzyme activity.
8. Effect of time on enzyme activity.
9. Estimation of RNA.
10. Separation of amino acid by paper chromatography.
11. Demonstration of basic equipments: microscope, colourimeter, spectrophotometer, pH-meter, electrophoresis and centrifuge.

LS-C-105: Lab. Course on BIOLOGY OF THE CELL & PRINCIPLES OF GENETICS, BIOSTATISTICS & COMPUTATIONAL BIOLOGY **Credit: 2**

Marks: 50 (In=20, End=30)

Fixation, block preparation, sectioning and staining of tissues.

1. Localization of neutral mucopolysaccharides in cell by periodic acid Schiff reaction.
2. Localization of non-sulphated acid mucopolysaccharides in cells by alcian blue technique.
3. Localization of general lipid by Sudan Black B method.
4. Detection of neutral lipid by sudan III/oil Red O technique.
5. Localization of metachromatic substances in cells by Toluidine blue technique.
6. Preparation of fixatives for chromosome study, pre-treatment, stains; squashing and smearing techniques.
7. Study of permanent slides of different stages of mitotic cell division, giant chromosomes and specimens of genetical significance viz. xenia, cytoplasmic inheritance and representations of crosses due to modifications of Mendelian ratios.
8. Mitotic chromosome study in plant materials like onion/pea/lilium etc. and animal materials like frog tadopole/chironomus larva.
9. Sex chromatin study in human hair follicle and buccal epithelial cells.
10. Meiotic chromosome study in the flower buds of onion/maize and grasshopper testes.
11. Working out of some genetical problems related to theory syllabus.
12. Sampling of biological data for statistical calculation.
13. Biostatistical calculations on averages, deviations (sd, variance, se)
14. Problems related to probability, problems related to correlation and regression.
15. Testing of statistical hypothesis (X^2, t and F-test), ANOVA (one way).
16. Sequence alignment, molecular Phylogenetic Analysis
17. Lipinski and ADMET Analysis
18. Molecular Docking Analysis
19. QSAR Analysis

DISCIPLINE SPECIFIC

ELECTIVE LS-D-106: A. BIOCHEMISTRY-I

INTERMEDIARY METABOLISM

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Unit 1: Types and features of biochemical reactions. Bioenergietics: redox reaction, redox potential and free energy, oxidative and photophosphorylation and their mechanism. Structure of ATPase and Chemiosmotic theory of ATP synthesis.

Unit 2: Metabolism of Carbohydrates: Regulation of Glycolysis, Kreb's Cycle, HMP pathway, glycogenesis, glycogenolysis; Glyoxylate cycle.

Unit 3: Lipids: β oxidation of saturated and unsaturated fatty acids, ω– oxidation; metabolism of ketone bodies, biosynthesis of saturated fatty acids, its regulation; metabolism of eicosanoids and cholesterol and Disorders of lipid metabolism.

Unit 4: Metabolism of amino acids phenylalanine, histidine, tryptophan and Arginine.

Unit 5: Metabolism of Purines and Pyrimidines, its regulation, Disorders of nucleic acid metabolism (Gout, Lesch Nyhan syndrome).

Unit 6: Interrelationship of carbohydrate, lipid and protein metabolism, Inborn errors of metabolism.

LS-D-106: B. **FISH & FISHERIES-I**

FISH BIOLOGY

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Unit 1: Classification of fishes: Various trends in the classification of fishes; Classification of major groups of living fishes; General anatomy of fish.

Unit 2: Organization of skin and function; Origin and types of scales; Types of muscles, their structure and functions; Role of musculature, fins and tails in locomotion.

Unit 3: Food and feeding habits of cultivable fishes; Modifications of alimentary canal and other organs associated with food and feeding habits; Physiology of digestion, absorption and assimilation; Structure and function of gills; Accessory respiratory organs in fishes; Structure and function of gas bladder.

Unit 4: Heart and circulatory vessels; Components of fish blood; Structure of different parts of brain; Cranial nerves and their functions.

Unit 5: Endocrine organs; Osmoregulatory and excretory organs; Physiology of excretion and osmoregulation in fresh water, brackish water and marine fishes.

Unit 6: Determination of age in fishes; Absolute and relative growth, growth curve, length- weight relationship, condition factor and their significance; Sexual dimorphism;

Maturity cycle and gonadal development; Reproductive strategies and parental care; Types, causes and mode of migration in anadromous and catadromous fishes

LS-D-106 C: Entomology I

The course on insect diversity and evolution attempts to expose the students to insect diversity and their classification, beneficial and harmful insect groups, insect societies and the fundamentals of insect morphology. The students will understand the value of insects and will have the skill of identifying insects belonging to different order.

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Insect diversity and evolution

1. Introduction to Insects: Importance, morphology, external features. 6

2. General classification of insects, basis of classification, Classification upto infraorder (Orthoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera). Origin and evolution of insects. Approaches of insect classification (Morphological, biochemical, molecular) 15

3. Harmful insects: Pests of tea and citrus, classification , life cycle, mode of infestation , nature of damage. 10

4. Comparative studies of mouthparts, antenna, leg, wing, genitalia in different orders 9

5. Beneficial insects (Sericigenous insects, Honey bee, Lac): Economic importance, classification, Rearing techniques. Insects of forensic importance. 10

6. Insect societies: Basic concept, groups of social insects and their societies (Termites, Honey bees and aphids) 10

LS-D-106: D. PLANT ECOLOGY-I

PRINCIPLES AND CONCEPTS OF PLANT ECOLOGY

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Unit1: Definition, division of plant ecology, tools used in studying ecosystem diversity and complexity, environmental monitoring; development of plant ecology at national and international level.

Unit2: Autecology and population dynamics: ecological clock with detail phonological analysis, population characteristics and dynamics, regulation of population density, r–k selection, species interaction and competition; gene ecology: ecads and ecophenes, ecotypes- characteristics, formation, kinds, delimitation and significance of ecotypes, ecospecies and coenospecies.

Unit3: Synecology: origin, development and structure of vegetation, methods and purpose of vegetation study; plant community- characteristics, development and classification, analytic and synthetic characters of plant community, life forms and biological spectrum; concept of ecotone, flagship and keystone species.

Unit4: Community dynamics (Plant succession): definition, causes, kinds and theories of plant succession, the climax concept, differences of young and mature communities and their ecological efficiency.

Unit5: Soil and plant relationship: soil formation, soil horizons, physico – chemical properties of soil, soil nutrients and plants; the rhizosphere concept, rhizosphere population, role of soil microorganisms in functioning and restoration of ecosystem, major soil types of India with special reference to the soil of Assam.

Unit 6: Phytogeography: principles of phytogeography, static phytogeography and the broad vegetation belts; dynamic phytogeography – basis of dynamic phytogeograghy; endemism: concept, age and area hypothesis, endemic flora of the world with special reference to India, plant migration and barriers.

LS-D-106: E. CYTOGENETICS AND CROP IMPROVEMENT-
I GENETICS & CYTOGENETICS

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Unit1: Cell theory and exceptions, Gross structure and chemistry of eukayotic and prokaryotic chromosomes, specialized chromosomes and their cytogenetic significances, mitotic apparatus. Synaptenemal complex, chromosome theory of inheritance, concept of karyotype and idiogram.

Unit 2: Polygenic inheritance: Previous knowledge of mendelism and modifications, inheritance of kernal colour of wheat, corolla length in tobacco, transgressive variation.

Unit 3: Multiple alleles: alleles, multiple alleles and isoalleles, sexual incompatibility in plants, blood group alleles in man, multiple alleles and complex loci.

Unit 4: Linkage, recombination and gene mapping: Morgan's works on Drosophila, Coupling and repulsion hypothesis, cytological evidence of crossing over, gene mapping, interference and coincidence.

Unit 5: Genetical control of sex: Chromosomal basis of sex determination, balanced theory of sex determination, environmental and hormonal control of sex, concept of sex linked, sex limited and sex influenced characters.

Unit 6: Extranuclear transmission of traits; maternal effect and maternal inheritance, Killer trait in paramecium, Co_2 sensitivity in Drosophila, plastid inheritance and male sterility in plants, organeller genetics - episomes, mitochondria and chloroplast.

LS-D-106: F.
MICROBIOLOGY-I
MICROBIOLOGY

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Unit 1: Classification of Microorganisms; New approaches to bacterial taxonomy; Basis of microbial classification; Bergey's manuals; Advantages and limitations of DNA and RNA systematic, ribotyping.

Unit 2: Bacteria: Bacterial cell wall structure; synthesis of cell wall polymers (flow chart-peptidoglycan from NAG and NAM); Nutrition; Kinetics of bacterial growth;

pure culture and cultural characteristics.

Unit 3: Microbial metabolism: Free energy; Biochemistry of fermentation (Alcohol and lactic acid fermentation), pathways and energetics ofcarbohydrate breakdown (EMP-pathway, HMP shunt, Entner-Douderff (E-D) pathway, kreb cycle); Pasteur effect; protein degradation (proteolytic degradation to aminoacids; deamination; Transamination; decarboxylation); Electron transport system; phosphorylation; Mechanism of phosphorylations.

Unit 4: Bacterial photosynthesis: photosynthetic bacteria (oxygenic and anoxygenic); photosynthesis (oxygenic and anoxygenic) in bacteria (pigments; light reactions; photophosphorylations); CO2 - fixation.

Unit 5: Virus: Process of infection; Function of DNA and RNA in viruses; Replication of viruses (replication of different types of nucleic acids in viruses). Lysogeny ; Viroids, prions, Interferons.

Unit 6: Control of Microorganisms: Physical, chemical and biological; Antibiotics; modes of action of antibiotics; Drug resistance in bacteria; principles of microbial bioassay.

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LS-D-106.G: Fundamentals of Angiosperm Taxonomy

L	T	Credit: 4
48	16	Marks: 100 (In=40, End=60)

Unit 1:
Basics of Taxonomy and Systematics: Aims and Principles of Systematics, Alpha and Omega Taxonomy. Historical background of plant classifications,

Unit 2:
Botanical Nomenclature: History, Basic Principles, Major Rules (Author's citation, Principles of Priority, Effective and Valid Publication, Typification). Methods of naming. International Code of Nomenclature for Algae, Fungi and Plants (ICN, formerly ICBN): presently effective code at time of study (e.g. Shenzhen code 2018). Taxonomic hierarchy. Introduction to Draft Biocode and Phylocode.

Unit 3:
Taxonomic literatures: Classical literatures, general index, monographs and revisions, floras and manuals.

Unit 4:
Types of Plant classifications: Artificial, Natural, Phenetic and Phylogenetic; Critical account of the systems of classifications of Bentham & Hooker, Takhtajan (1987 and 1997)

Unit 5:
Angiosperm phylogeny group (APG): History and principle of APG systems. A brief account on any recent APG system(s) of classification,

Unit 6:
General survey of the following taxa of Angiosperms with special reference to their characteristics, interrelationships, evolutionary trends: Magnoliaceae, Orchidaceae, Cyperaceae, Poaceae, Zingiberaceae, Fabaceae, Brassicaceae, Lamiaceae, Asteraceae (As per APG-IV, 2016).

LS-D-107: A. Practical Course on BIOCHEMISTRY-I

Credit: 2

Marks: 50 (In=20, End=30)

1. Fractionation of tissue by differential centrifugation.
2. Estimation of protein, carbohydrate, free phosphate in biological samples.
3. Estimation of ascorbic acid (Colourimetric).
4. Estimation of cholesterol.
5. Estimation of urea in biological samples.

LS-D-107: B. Practical Course on FISH AND FISHERIES-I

Credit: 2

Marks: 50 (In=20, End=30)

1. Identification of locally available fishes.
2. Study of museum specimens.
3. Dissection:
   (a) Cranial nerves (5^{th}, 7^{th}, 9^{th} & 10^{th}) of cat fishes and carps.
   (b) Urino-genital system of male and female fishes.
   (c) Weberian ossicles
   (d) Afferent and efferent vessels of carps and catfishes.
4. Study of Accessory respiratory organ of the following fishes:
   (i) Clarias, (ii) Heteropneustes, (iii) Anabas, (vi) Channa.
5. Studies of gastrosomatic index, gonadosomatic index, K-factor, length-weight relationship of fecundity and other body parameters.

LS-D-107 C: Entomology I (Practical course on Insect diversity and evolution) Practical course:

Credit: 2

Marks: 50 (In=20, End=30)

1. Study of mouth part of grasshopper, mosquitoes, house flies, butterflies
2. Mounting of different types of legs, arolium, pulvillus, empodium and antenna of insects
3. Dissection and mounting of sting apparatus of honey bee
4. Identification of exopterygote insects upto species level
5. Identification of endopterygote insects upto species level
6. Study of different castes of termites/aphids (social insect)
7. Classification and Identification of beneficial and harmful insects based on theory
8. Submission of insects of different orders, life cycle of aphid/termite

LS-D-107: D. Practical Course on PLANT ECOLOGY-I

Credit: 2

Marks: 50 (In=20, End=30)

1. To study the floristic composition of different stands with respect to biotic disturbances as grazed, protected and extensively disturbed areas.
2. To determine the minimum size and number of quadrat necessary for sampling herbaceous vegetation.
3. To study the percentage frequency of species in different stands and comparison with Raunkiaer's Frequency Classes thereof.
4. To study the vegetation of a grassland community by 'Physiognomic method' – the biological spectrum method.
5. To study the Importance Value Index (IVI) of species in different stands.
6. To study the Species Diversity Index (SDI) in a grassland community.
7. To study the Leaf Area Index (LAI) of different species in a community.
8. To study the Stomatal Index (SI) of some species growing in various habitats.
9. To determine the Association Index (AI) of species in different habitats.
10. To determine the Similarity Index (SI) and Dissimilarity Index (DI) of species in different habitats.
11. To study the primary productivity of a fresh water ecosystem by light and dark bottle method.

LS-D-107: E. Practical Course on GENETICS AND CROP IMPROVEMENT-I

Credit: 2

Marks: 50 (In=20, End=30)

1. Preparation of fixatives and stains used in cytological works, killing and fixing of tissue and organs and their preservative, use of pretreatment for chromosome spreading.
2. tudy of mitosis by squash techniques using suitable stains like acetocarmine, acetoorcein, haematoxyline, fuelgen techniques etc. in plant materials (squash from root tips or shoot tips of common economic and crop plants).
3. Study of meiosis by smearing techniques using suitable stains. in plant materials (smear from PMC's of common economic and crop plants).

LS-D-107: F. Practical Course on Microbiology-I

Credit: 2

Marks: 50 (In=20, End=30)

1. Gram Stain, capsule stain
2. Pure culture technique
3. Growth of bacteria
4. Fermentation of carbohydrates
5. Identification of appropriate antibiotic against microbe.

LS-D-107.G: Practical Course on Angiosperm Systematics-I

Credit: 2

Marks: 50 (In=20, End=30)

1. Work out, drawing, description and identification of plant specimens from a selected group of families and their identification using artificial Keys.
2. Comparative description of 3 – 4 angiosperms, and their identification using Keys. Preparation of a Key for those plants
3. Preparation of taxonomic keys at family, generic, and species levels based on locally available plants.
4. Work out, drawing, description and identification of plant specimens from selected group of families and their identification using artificial Keys.
5. Comparative description of 3 – 4 angiospermic plants, their identification using Keys. Preparation of a Key for those plants
6. Preparation of taxonomic keys at family, generic and species level based on locally available plants.

ABILITY ENHANCEMT COURSE (AEC-1) LS-A-108: A. **BIODIVERSITY MANAGEMENT-I**

Understanding Biodiversity

Credit: 2

Marks: 50 (In=20, End=30)

Unit 1: The biodiversity concept, megadiversity countries of the world, reduction in biological diversity, present scenario.

Unit 2: Monitoring and documentation of biodiversity: Measuring biodiversity, biodiversity indices (shannon-weiner, Margaleff and Simpson)

Unit 3: Biodiversity Utility: Value of biodiversity as natural resources, as genetic resources, instrumental resources, means of abiotic resource optimization.

Unit 4: Conventions on biological diversity.

LS-A-108: B. PUBLIC HEALTH ENTOMOLOGY-I

Credit: 2

Marks: 50 (In=20, End=30)

Unit 1: Public health and vector, vector identification , classification and biology (flea, bug, mosquitoes, lice).

Unit 2: Mode of transmission of insect borne communicable diseases .

Unit 3: Epidemiology of vectorborne diseases of public health importance, occurrence, causative agent, transmission and control (malaria, Japanese encephalitis, Dengue , Filariasis, chikungunya).

Unit 4: Vector surveillance and integrated management

BOOKS RECOMMENDED (Latest Edition): **LS-C-101 (Biological Chemistry & Molecular Biology)**

1. Lehninger, Principles of Biochemistry , Nelson and Cox W.H. Freeman and Co., New York
2. Biochemistry, Berg, Tymoczko and Stryer W.H. Freeman and Co., New York
3. Molecular Biology of Cell, Elbert, Johnson, Lewis, Raff, Robertes and Walter: Garland Sc. (Taylor and Francis Gr.)
4. Harper's Illustrated Biochemistry, McGraw Hill Medical Publication.
5. Fundamentals of Biochemistry, A. C. Deb: New Central Book Agency Pvt. Ltd. Kolkata.
6. Fermentation Technology. M.L. Srivastava; Narosa Publishing House, New Delhi.
7. Principles of Fermentation Technology, Stanbury, Whitaker and Hall, Elsevier.
8. Biomolecules, Mohan P. Arora: Himalaya Publishing House.
9. Molecular Biology of the Cell .Alberts B., Bray D., Lewis J., Roberts K. & Watson, J. D. Garland Publishing, Inc. New York.
10. Genomes-2 .T. A. Brown, Wiley –Liss, USA.
11. Essentials of Molecular Biology. Freifelder, D 2nd edn, Jones & Barlett Publishers, USA.
12. Microbial Genetics . Freifelder, D. Jones & Barlett publishers, USA.
13. Genetic Engineering . S. Mitra. McMillan.
14. Human Genome Analysis . M. Hallen. IOS Press.
15. Genetics: Analysis of Gene & Genome . D. A. Hartl & E.W. Jones .5th edn. Jones & Barlett Publishers, USA.
16. Cell & Molecular Biology . G. Karp. Portland Press, USA.
17. Gene VIII. Lewin, B. John Wiley & Sons, USA.
18. Genes & Genomes Singer M. & Berg, P. University Science Books, USA.
19. Biochemistry and Molecular Biology. William Elliott and Daphne Elliott. Oxford University Press.USA.
20. Immunology.S.S. Lal and S. Kumar. Rastogi Publication. India.
21. Immunology by C.V.Rao. Narosa Publishing house Pvt. Ltd. India

LS-C-102: Cell Biology & Genetics

1. The Cell : A Molecular Approach. Geoffrey, M.Cooper, Robert E, Hausman: ASM Press USA.
2. Molecular Biology of Cell,Albert B., Bray D, Lewis J, Roberts K &- Watson, J.D.: Garland publishing. Inc. New York.
3. Molecular Biology of theogene .Watson J.D. Tania A. Baker, Stephen P.Bell, Alexander Gann, Michael Levine, Richard Losick.
4. Molecular Cell Biology Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A . Kaiser, Monty Kreeger, Matthew P.Scott, S. Lawrence Zipursky, James Darnell . W. H. Freeman and Company
5. Cell and Molecular Biology .R.C. Rastogi . New Age International (P) Limited .
6. Genetics. P.K. Gupta , Rastogi publication
7. Principles of Genetics .E. J. Gardener & D. P. Snustad. John Wiley & Sons.
8. Principles of Genetics. Robert H. Tamarin. Tata McGraw Hill.
9. Theory and Problem of Genetics. S.L. Elrod and W.D. Stansfield. Tata McGraw Hill.

LS-C-103 (Techniques in Biology, Biostastics & Bioinformatics)

1. Electron Microscopy, Bozolla, J.J. & Russel L. D. Jones & Barlett Publications, USA.
2. Biophysical Chemistry (Part 1, 2, 3.) D. W. H. Freeman & Co., USA.
3. Basic Electron Microscopic Techniques, Hayat, M.A. Van Nostrand Reinhold Co., New York.
4. Priniciples & Techniques of Scanning Electron Microscopy (Vol I), Hayat, M.A. Van Nostrand Reinhold Co., New York.
5. Principles of Instrumental Analysis, Holt,WB Saunders & Co. USA.
6. Biological Physics, Nelson .W. H. Freeman & Co., USA.
7. Statistical Methods. Snedecor, G.W. & Cochran, W. G. . The Iowa State Univ. Press, Ames.
8. Introduction to Biostatistics. Sokal, R.R & Rohlf F.J. W.H. Freeman & Co., San Francisco.
9. Experimental Design & Data Analysis for Biologists. Quinn, G.P. & Keough, M.J. Cambridge University Press, UK.
10. Biostatistical Analysis, Zar, J.H. Pearson Education India.
11. Elementary Biostatistics .Biswas, S.P.
12. Biostatistics. Fischer .Prentice Hall International.

13. Biostats Basics, Gould .W. H. Freeman & Co., USA.

LS-D-106 (A. Biochemitrsy-I)

14. White chemicals background for biological sciences, 33rd. prentice hall of India Pvt. Ltd.
15. L. Stryer, Biochemistry, Toppan company Ltd. Tokyo, Japan, 1975.
16. A.L.Lehninger- Biochemistry, Macmillan company N.Y. 1972.
17. Word macromolecules- structure and function, Prentice hallof India, Pvt. Ltd.
18. Martin, D.W., P.A.Mayes, Herper's review of biochemistry Moruzen V. W. Rodwell.
19. Freifelder D. Molecular Biology 2nd edn. Jones & Barlett Publishers, USA.
20. Freifelder D. Physical Biochemistry W. H . Freeman & Co. USA.
21. Lehneiger, A. L., Principles of Biochemistry 4th edn. Macmillan, N.Y.
22. Lubert Stryer Biochemistry 4th Edition, W.H. Freeman & Company
23. Murray R.K. et al. Harper's Biochemistry 258
24. 5th edn, Prentice Hall International.
25. Nelson & Cox, Lehninger's Principle of Biochemistry , Pearson Publications.
26. Lanner; Intermediary metabolism and its regulations, Prentice hall
27. Kanungo, M.A. Biochemistry of ageing –Academic Press.
28. D, C. Wharton & R. E. Mc Oarty- Experimental and methods in biochemistry. Macmillan Company, N.Y.
29. Molecular Biology of the Cell. Alberts B., Bray D., Lewis J., Roberts K. & Watson, J. D. Garland Publishing, Inc. New York.
30. Genomes-3 .T. A. Brown, Wiley –Liss, USA.
31. Essentials of Molecular Biology. Freifelder, Narosa Publishing House, New Delhi
32. Cell and Molecular Biology by Phillip Sheeler & D. E. Bianchi, John Wiley & Sons, Inc. New York.
33. Biochemistry and Molecular Biology, by W. H. Elliott & D.C. Elliott, Oxford University Press, New Delhi.
34. Gene XI. Lewin, B. John Wiley & Sons, USA.
35. Biochemical Methods, Sadasivam, S. & A. Manickam, New Age Int. (P) Ltd. New Delhi.

LS-D-106 (B. Fish & Fisheries-I)

1. G. Helfman, Bruce B. Collette, D.E. Facey, B. W. Bowen: The Diversity of Fishes: Biology, Evolution, and Ecology, John Wiley & Sons
2. R. J. Wootton: Fish Ecology, Springer
3. W. Vishwanath, W.S. Lakra and U.K. Sarkar: Fishes of North East India, NBFGR Publication, Lucknow.
4. D. Kapoor, R. Dayal and A.G. Ponniah: Fish Biodiversity of India, NBFGR Publication, Lucknow.
5. R.H. McConnell: Ecological Studies in Tropical Fish Communities, Cambridge University Press.
6. Matty: Fish Endocrinology.
7. T.K. Govindan: Fish Processing Technology, Oxford & IBH, New Delhi
8. Peter B. Moyle Joseph J. Cech Jr.: Fishes–An Introduction to Ichthyology, Prentice Hall, N.Y.
9. R.K. Rath: Freshwater Aquiculture, Scientific publishers.
10. Hoar and Randall: Fish Physiology, Academic Press, London.
11. Hwett: Textbook of Fish Culture, Breeding and Cultivation of Fish, Fishing News books Ltd. Surrey England.
12. Bardach, Miller and Passino: Ichthyology, John Wiley &Sons, N.Y.
13. H.L. Choudhury & S.B. Singh: Induced Breeding of Carps, ICAR New Delhi
14. W.F. Royce: Introduction to the Practice of Fishery Science, Academic Press, N.Y.
15. V.G. Jhingran:Fish and Fisheries of India, Oxford & IBH, New Delhi.
16. Kyle: The Biology of Fishes.
17. R.G.Wetzel: Limnology,W.G.Saunders, N.Y.
18. M. J. Mannig. and M. F.Tatner: Fish Immunology Academic Press. N.Y.
19. J. S. D. Munshi and G.M.Hughes: Air-breathing fishes of India. Their structure, function and life history. Oxford & IBH. Publishing Co.
20. R.R.Stickney: Principles of Warm Water Aquiculture, John Wiley & Sons, N.Y.
21. CBL Srivastava: A Text Book of Fishery Science and Indian Fisheries, Kitab Mahal , Allahabad.
22. B.A. Whitton: River ecology, University of California Press.
23. G.V. Nikolsky: The Ecology of Fishes, Academic Press, N.Y.
24. S.P.Biswas: Manual of Methods in Fish Biology, South Asian Publishers, New Delhi.
25. S.P.Biswas : Fundamentals of Ichthyology, Narendra Publication House. New Delhi.

LS-D-106 (C. Entomology-I)

Suggested reading:

1. A general text book of entomology, Imms , A. D., Chapman & Hall, UK
2. Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F.,M Saunders College Publication, USA
3. Principles of Insect Morphology, Snodgrass, R. E., Cornell Univ. Press, USA
4. The Insect Societies, Wilson, E. O., Harvard Univ. Press, UK .
5. Daly and Doyen's Introduction to Insect Biology and Diversity. 3rd Edition. Oxford University Press, Oxford, UK. Whitfield, J. B. and A. H. Purcell III. 2014.

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LS-D-106 (D. Plant Ecology-I)

1. Plant Ecology, Weaver, J. E. & F. E. Clements, Tata McGraw-Hill Co. New Delhi.
2. Concept of Ecology, Kormondy, E. J. Prentice Hall of India, Pvt Ltd. New Delhi.
3. A Text Book of Plant Ecology, Ambasht, R. S. Students' Friends & Co, Varanasi
4. Manual of Plant Ecology, Misra, K, C, Students' Friends & Co, Varanasi
5. Plant Ecology and Soil Science, Shukla, R. S. & P, S. Chandal, S. Chand & Co. Ltd. New Delhi-110055.
6. Plant Ecology, Batra, V, Oxford Book Co.Jaipur, India.
7. Ecology and Environment, Sharma, P. D., Rastogi Pub. Mrrrut-250002,
8. Fundamentals of Ecology, Odum, E. P. Saunders Co, Philadelphia.
9. Concept of Ecology, Verma, P. S. & Agarwal, S, Chand & Co. New Delhi-110055.
10. Fundamentals of Ecology, Dash, M. C. , Tata McGraw Hill Co. Ltd, New Delhi
11. Modern Concept of Ecology, Kumar, H. D. Vikas Pub. House Pvt. Ltd. New Delhi – 110014
12. Practical Methods in Ecology and Environmental Science, Trivedy, R. K. & P. K. Goel, Enviro Nedia, Karad, India.
13. Environment-Problems and Solutions, Ashthana, D. K. & M, Ashthana S. Chand & Co. Ltd, New Delhi-110055
14. Ecology and Sustainable development, Ramakrishnan, P. S. National Book Trust, India.
15. Sustainable Agriculture, Arunachalam, R. & R. N. Seetharaman, Agrobios India, Jodhpur – 342003
16. Agrotechnology of Medicinal Plants, Sarma, R. S. Daya Pub House, Delhi-110035
17. Hand Book of Agriculture, Sharma, R. P., ICAR, New Delhi.
18. Medicinal Plant Cultivation – Purohit, S.S. & S.P. Vyas, Agrobios India, Jodhpur, 342003.

19. A Text Book of Agro Ecology – Waite Steave, 2010-2011, Dominant Pub & Distri,New Delhi -110002.
20. Drug Plants of India – Agarwal, V. S. Vol-I, Kalyani Pub, Ludhiana.
21. Organic Farming for Medicinal and Aromatic Plants – Ed. Tarafdar, J. C., K. P. Tripathi, & Mahesh Kumar, Scientific Pub. Jodhpur – 342001.
22. Organic Farming for Sustainable Agriculture, Dahama, A. K. Agrobios India, Jodhpur–342003
23. Medicinal Plants –Field and Lab. Manual, Farooq, F. Int. Book Distri, Dehradun–248001
24. A Hand Book of Soil, Fertilizer and Manure, Gupta, P. K. 2004, Agrobios India, Jodhpur – 342003
25. Soil Series of Assam, NBSSLU, ICAR & Dept. of Agri, Govt of Assam.
26. Environmental Science-S. C. Santa, Rep. New Central Book Agency, (P) Ltd. 8/1 Chintamoni Das Lane, Kolkota 700009 (India).
27. Biodiversity Conservation-P.C.Kotwal & Banerjee, Rep. Agrobios, Jodhpur-342002, India.
28. Biodiversity Principles & Conservation-D. Kumar & M. Asija , Agrobios, Jodhpur, 342002, India.
29. River Pollution in India and its Management, K.Gopal & A.K.Agarwal, APH Publishing Corporation –New Delhi-110002.
30. Chemical and biological methods for water pollution studies, R. K. Trivedi & P. C. Goel, Enviro Media, Karad, 415110, India.
31. Soil chemical analysis-M.L.Jackson, Prentice Hall of India Pvt. Ltd.

LS-D-106 (E. Cytogenetics and Crop Improvement-I)

1. Gupta, P.K., Genetics, Rastogi.
2. Gupta, P.K., Cytogenetics, Rastogi.
3. Stickbuger, Genetics, Tata Mcgraw Hill.
4. Singh, B.D, Fundamentals of Genetics, Kalyani.
5. Mitra, S., Genetics, a blue print of life, Tata Mcgraw Hill.
6. Singh, B.D., Plant Breeding, Kalyani.
7. Gupta, P.K., Cytology, Genetics & Evolution, Rastogi.
8. Narayanswami, Plant Tissue Culture, Tata Mcgraw Hill.
9. Jha, T.B. & Ghosh, B., Plant Tissue Culture-Basics & applied, University Press.
10. Ahluwalia, K.B., Genetics, New age.

11. Lewin, B, Gene VIII, Johan Wiley & Sons, USA.
12. Singh, Plundan. Essential Plant Breeding, Kalyani.
13. Friedfester, D. Molecular Biology, Jones & Barlett.
14. Friedfester, D,Microbial Genetics, Jones & Barlett.
15. Cytology and Genetics, Sen & Kar
16. Cytogenetics, Evolution and Plant Breeding, Sukla & Chandel
17. Genetics, Hartwell, Hood, Goldberg
18. Genes VIII, Lewin
19. Handbook of Plant Tissue Culture, Masearenhas (ICAR)

LS-D-106 (F. Microbiology-I)

1. Microbiology by N.J. Pelczar, Jr. E.C.S.Chan and N.R. Krieg; Mac Graw Hill Book Company.
2. General Microbiology by R.Y.Stanier, M. Doudoroff and E.A. Adelberg; Mac Millan India.
3. Microbiology by L.M.Prescott,J.P.Harley and D.A.Klein . McGraw Hill.
4. Text Book of Microbiology by R. Ananthanarayan and C.K. Joyaram Panikar . Orient Longman, Madras.
5. General Microbiology byC.B. Power and H.E. Daginawala ;Himalaya Publishing House, India.
6. A text book of Microbiology by R.C. Dubey and D.K. Maheswari., S.Chand & Co. Ltd.
7. Microbiology: An Introduction – G.J.Tortora, B.R.Funke and C.L.Case. Pearson Education
8. Microbiology by P.D.Sharma .Rastogi Publications.
9. Bergey's mannual of Systematic Bacteriology, 2nd Edition.
10. Bergey's mannual of Determinitive Bacteriology, 9th Edition.
11. Molecular Virology by G.A.Knight . MC Graw Hill Book Company.
12. General Virology by S. Luria and J. Darnoll.
13. Genes XI by B. Lewin , Oxford University Press , India.
14. Petroleum Microbiology by R.M. Atlas , Mac Millan Publishing Company.
15. Prescot and Dunn's Industrial Microbiology by G. Reed ; AVI, Publishing Company.
16. Annual Review of Microbiology.
17. Annual Review of Biochemistry.
18. Agricultural Microbiology by G. Rangaswami and D.J.Bagyaraj; Prentice Hall.

19. Basic Environmental Microbiology- M.L.Srivastava .Shree Publisher and Distributors.
20. Biotechnology by K.Trehan.
21. Microbial Genetics by Freifelder, Narosa Publishing.
22. Genetic Engineering by Mitra, McMillan.
23. Immunology by Nandini Shetty.
24. Biotechnology of Microbes & Sustainable Utilization – R.C. Rajak.
25. Dairy Microbiology – Robinson.
26. Experiments in Microbiology, Plant Pathology & Biotechnology – Aneja, K.R.
27. General Microbiology – Ingraham, Whellis&painfer.
28. Industrial Microbiology – Mehrotra&Aneja.
29. Microbial Physiology – Moat.
30. Microbiology: A Laboratory Manual – Sherman.
31. Molbio by A.Upadhyay and K. Upadhyay, Himalaya Publishing House.

BOOKS RECOMMENDED for ANGIOSPERM TAXONOMY

1. Plant Taxonomy, 2 edition; O. P. Sharma. McGraw Hill Education (India) Private Limited;
2. Plant Systematic, 3rd Ed.; Gurcharan Singh. Oxibh
3. Plant Systematics (2021). A.K Pandey & S. Kasana. Jaya Publishing House, Delhi.
4. Practical Taxonomy of Angiosperms, 2010 Ed.; R. K. Sinha. I K International Publishing House Pvt. Ltd
5. Practical Manual of Angiosperm Taxonomy, 2003 Ed; Sundara S. Rajan. Anmol Publications Pvt Ltd.
6. The Herbarium Handbook, 3rd edn. 1998. Bridson, D. & Forman, L. Royal Botanic Gardens, Kew, UK.
7. The Herbal Flora of Assam & North Eastern India. Vol-III, 2005 Ed; S.N.Sharma. Spectrum Publications
8. The Kew Tropical Plant Identification Handbook (Paperback) 2nd Eds; Timothy Utteridge; Gemma Bramley. Kew Publishing
9. The Kew Plant Glossary: An Illustrated Dictionary of Plant Identification Terms, 2010 Ed; Henk J. Beentje. Royal Botanic Gardens
10. Indian Grasses, 2001 Ed; T.J. Symonds. Scientific Publishers Journals Dept
11. Indian Trees, 2011 Ed; Dietrich Brandis. Natraj Publishers
12. DNA Fingerprinting in Plants: Principles, Methods, and Applications, 2005 Ed; Kurt Weising, Hilde Nybom, Markus Pfenninger, Kirsten Wolff, Günter Kahl. CRC Press

13. Genomes 4, 4th Ed; T.A. Brown. Garland Science;
14. Principles and Techniques of Biochemistry and Molecular Biology, 2010 Ed; Wilson/Walker. Cambridge University Press
15. Records of the Botanical Survey of India, Volume 1 (Paperback), 2012 Ed; Botanical Survey Of India. Ulan Press
16. Records of the Botanical Survey of India, Volume 2 (Paperback), 2012 Ed; Botanical Survey Of India. Ulan Press
17. Records of the Botanical Survey of India, Volume 3 (Paperback), 2012 Ed; Botanical Survey Of India. Ulan Press
18. Practical Biotechnology: Methods and Protocols (Paperback) , 2015 Ed; Janarthanan, S Vincent. Universities Press (India) Private Limited
19. Essential Molecular Biology: v.1: A Practical Approach (Paperback) 2000 Ed; T.A. Brown. Oxford University Press
20. Introduction To Mathematical Taxonomy (Paperback), 2004 Ed; G Dunn, Bs Everitt. Dover Publications Inc.
21. Fundamentals Of Molecular Evolution (Paperback), 2000 Ed; Dan Graur, Wen-Hsiung Li. Sinauer Associates
22. Introductory Laboratory Practice and Field Work in Taxonomy; Special Morphology, and Ecology of the Higher Plants (Paperback) 2010 Ed; Karl McKay. Wiegand General Books.
23. Field Botany: A Hand-Book for the Collector Containing Instructions for Gathering and Preserving Plants and the Formation of the Herbarium (Paperback). 2011 Ed; Walter Porter Manton Nabu Press
24. Practical Manual of Angiosperm Taxonomy (Paperback)2003 Ed; S. Sundara Rajan. Anmol Publications Pvt Ltd
25. Field Manual on Herbarium Techniques (Hardcover) 2008 Ed; Singh H.B., Subramaniam B. National Institute of Science Communication and Information Resources, New Delhi
26. Plant Ecology and Phytogeography. 2016 Ed, V Kumaresan, N Arumugam. Saras Publication
27. Plant Names: A Guide To Botanical Nomenclature (Paperback), 2007 Ed; Peter Lumley, Robert Cross, Roger Spencer. CABI

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LS-A-108 A (Biodiversity Management-I)

1. River Ecology by B.A. Whitton, University of California Press.
2. Limnology by R.G.Wetzel,W.G.Saunders N.Y.
3. Biodiversity : Principles & Conservation – Kumar & Asijia
4. Biodiversity Global Concerns – R.K. Sinha
5. Biodiversity of Assam–Bhagabati, Baruah & Kalita. EBH Publisher, Guwahati.
6. Biodiversity: Strategies for conservation – L.K. Dadhick & A.P. Sharama
7. The Wildlife of India by E.P. Collins.
8. Mountain Wildlife by Perry.
9. Animals in Danger by Zuber.
10. Animals of India by S.N. Prater.
11. Birds of India and Pakistan by S. Ali.
12. Fish and Fisheries of India - by Jhinran
13. Wildlife Conservation and Modern Zoo by Woodraffed.
14. Wildlife Management in India – Hosetti

LS-A-108 B. AEC (Ability enhancement course)
Public Health Entomology-I

1. Medical and Veterinary Entomology Mullen, G. ,Durden, L., Academic Press,
2. USA
3. Medical and Veterinary Entomology, Kettle, D. S., Cabi Press, USA
4. Medical Entomology for students, Service, M. Cambridge University Press, UK .

SECOND SEMESTER

LSC201: ENVIRONMENTAL BIOLOGY & MICROBIOLOGY

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Section-A: ENVIRONMENTAL BIOLOGY

Unit 1: Scope of ecology; concepts of limiting factors; nutrient cycling with special reference to carbon, nitrogen & phosphorus cycles. Ecosystem dynamics and management: diversity, stability and complexity of ecosystem, energy flow concept and methods of measurement of productivity.

Unit 2: Population dynamics: population attributes, biotic potential and environmental resistance, population growth forms, survivorship curves, age structure, population fluctuations, interactions and regulation of population; concept of ecological niche, niche width and overlap, fundamental and realized niche; concept of meta population, demes and dispersal.

Unit 3:Environmental degradation and management: Global environmental issues (deforestation, green house effect, depletion of ozone layer); Concept of EIA; Use of GPS, GIS and remote sensing in environmental management.

Section-B: MICROBIOLOGY

Unit 4: History, classification of microorganisms; Bacteria: structure of bacterial cell, reproduction, growth curve, continuous growth and synchronous growth.

Unit 5: Archaea: characters and uses; Actinomycetes: general characters; Antibiotics :characters, some important antibiotics, their sources and actions; Viruses: general characters, chemical nature, structure of TMV, bacteriophage and HIV virus, life cycles of viruses (Lytic and lysogenic); classification of virus.

Unit 6: Applied microbiology: Study of microbial population in air, air sanitation; microbial population in water, indication of faecal pollution, water purification; Contamination of milk, testing of milk for different microbes, pasteurization; Concept of microbial ecology of soil, rhizosphere, mycorrhiza. Free-living and symbiotic types of Nitrogen fixation , Rhizobium and nodule; Biofertilizers. Industrial production of alcohol, vinegar; Use of microorganisms for bioassay;

LSC 202: Toxicology and pest management, Bioethics and IPR

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Section-A: Toxicology and pest management

Unit1: Definitions: Pesticide definition, classification. Group characteristics of chemical pesticides Definition of pests and their classification. New generation pesticides: Pesticides of plant origin, neonicotinoids, pheromones, repellents, antifeedants, growth regulators, their mode of action and significance in pest management

Unit2: Pesticide modes of action: Nerve impulse transmission in axon and synapse, Pesticide action on nerve impulse transmission, Principles of toxicology, Dose-response relationship, pesticide metabolism-Phase I and II reactions (Cyt p450 and glutathione-s-transferase).

Unit3: Toxic effects: Adverse effects of pesticides. Insect resistance to insecticides, Integrated pest management: Concepts & principles, pest control methods.

Section-B: Bioethics and IPR

Unit 4: Historical perspective of Bioethics, Conflicting issue (GMO, GMP, Cloning, environmental hazards), Principles and guidelines for research in human and animals. Indigenous knowledge system and biopiracy.

Unit 5: Agreement and treaties: GATT & TRIPs Agreement, Madrid Agreement, Hague Agreement , WIPO Treaties.

Unit-6: Intellectual Property Rights and their types. Indian Paten Act 1970 and recent amendments paten cooperation treaty, Patent filling and granting procedure.

LSC203: Taxonomy, Evolutionary Biology and Biodiversity

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Section-A: Taxonomy

Unit 1: Definition of taxonomy, Species concept: typological, nominalistic, biological and evolutionary; Species category: polytypic species, subspecies; Mechanisms of speciation.

Unit 2: Concepts of structural, biochemical and molecular systematic; Sources of taxonomic characters (Numerical, geographical, ecological & parasitological). Molecular techniques in taxonomy.

Section-B: Evolutionary Biology & Biodiversity

Unit 3: Emergence of evolutionary thinking**:** Lamarck, Darwin: Variation, adaptation, natural selection. Genes in population and Hardy-Weinberg equilibrium, Forces of evolution, mutation, migration, non-random mating, genetic drift, Natural selection (Fitness),

Unit 4: Modern evolutionary synthesis; Origin of basic biological molecules; Concept of neutral evolution and molecular clocks. Chemical evolution – origin of life in the light of chemical evolution. Adaptive radiation; Phylogenetic tree: reading and using, the tree of life.

Unit 5: Biodiversity: Definition & type of biodiversity: species, genetic and molecular diversity. Biodiversity hotspots in India and global mega diversity regions.

Unit 6: Biogeographical realms of the world, geographic origins and distribution of species, Biogeographical Zones of India

LSC204: Practical Course on ENVIRONMENTAL BIOLOGY & MICROBIOLOGY

Credit: 2

Marks: 50 (In=20, End=30)

1. To record the atmospheric temperature, relative humidity (RH), light intensity.
2. To study the physical and chemical characteristics of soil (C, N, content, base deficiency and pH of soil by rapid soil test method.
3. To determine the minimum size and number of the quadrat necessary for sampling the herbaceous vegetation by “species - area – curve” method.
4. To determine the frequency, density and abundance of the primary producers of a grassland community by quadrat method.

5. To determine the abundance and density of soil fauna.
6. To determine the standing crop biomass of a grassland ecosystem by harvest method.
7. Sterilization technique, Study of some instruments used in microbiology laboratory: Microscope, Autoclave, Incubator, Hot air oven, Laminar airflow, UV-chamber, Colony counter.
8. Staining of microorganisms - Gram's stain.
9. Preparation of different types of media.
10. Microbial count of air.
11. Dilution plate technique to count the total number of microorganisms in soil and water.
12. Study of bacteria: curd, nodule.
13. Biochemical tests of microorganisms present in soil and water.

a) Nitrate reduction test b) Nitrite utilization test c) Starch hydrolysis test d) Indole production test e) V-P rest f) Methyl red test.

LSC205: Lab Course on Toxicology and pest management, Taxonomy, Evolution & Biodiversity

Credit: 2

Marks: 50 (In=20, End=30)

1. Estimation of LD50/LC50 of synthetic pesticides using probit analysis
2. Pesticide residue analysis of contaminated soil, vegetable and water using TLC/GLC/HPLC
3. Submission of brief report on pest management techniques based on survey at farmer/manager's level
4. Proxy filing for patent
5. Morphotaxonomy and chemotaxonomy of closely related plants.
6. Comparison of hemin crystals of fish and amphibian.
7. Study of fossil specimens
8. Study of important flora (orchids, aromatic and medicinal plants) of the region.
9. Study of common animal species of the region
10. Estimation of biodiversity by Shannon, Margaleff and Simpson's biodiversity index.

DISCIPLINE SPECIFIC ELECTIVE –II

LSD206: A. BIOCHEMISTRY –II

PROTEIN CHEMISTRY & ENZYMOLOGY

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Unit1: Structure of protein in relation to their biological activity, primary, seconday, tertiary and quaternary structure, maintenance of secondary structure, Ramachandran Plot, protein folding, determination of amino acid sequance.

Unit 2: Biosynthesis of protein, direction of chain growth, Inhibitors of protein biosynthesis, Co-translational and Post translational modification of protein. Protein purification,

Unit 3: Enzymes: Energetics of enzyme catalyzed reaction single and bisubstrate reactions, mechanism of action, Allosteric enzymes, Enzyme induction and inhibition (competitive, non competitive and uncompetitive), purification of enzymes.

Unit 4: Enzyme kinetics; Michalis-Menten plot, Live weaver Bulk plot, Hill plot, Regulation of enzyme activity, restriction enzymes, RNA as an enzyme, Isoenzyme and their significance. Regulation of metabolism by enzyme.

Unit 5: Biochemical aspects of Differentiation, Development and ageing, Theories of ageing, Biochemical and Molecular changes associated with ageing of animals.

Unit 6: Mechanism of protein and steroid hormone action, role of cAMP and G-protein in metabolism, prostagandins

LSD206: B. FISH & FISHERIES-II

CAPTURE FISHERIES AND AQUACULTURE

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Unit 1: River systems of India and their fisheries with special reference of the Brahmaputra river system; Ecology of riverine environment; Dams and their effects on fish migration; Fisheries of lakes and reservoirs; Classification and ecology of lakes and reservoirs; Commercial exploitation and recent advances in reservoir management; Cold water fisheries; Ecology and fisheries of beels.

Unit 2: Definition, origin and classification of estuarine fisheries resources of India with special reference to Chilka lake and backwater lagoons in Kerala; Physical and chemical oceanography, marine fishery activity sites in India; Marine fishery yield assessment, scope for further increase in production; Biology and fisheries of oil sardine, Indian

mackerel and Bombay duck.

Unit 3: Construction and layout of fish ponds: Classification of ponds, choice of ground – topographical conditions, quality of water requirement, installation planning; Layout of the pond bottom, the dyke, draining installation - monk, bypass channel, water inlet, weir; Reclamation of swamps.

Unit 4: Ecology of fish pond: Abiotic and biotic components; Food chain; Concept of productivity, methods of measuring productivity, classification of water bodies on the basis of their productivity; Layout and design of nursery, rearing and stocking ponds; Predatory and weed fishes and their control; Fertilization, aquatic insects and their control; Supplementary feeding.

Unit 5: Culture of air-breathing and other predatory fish (*Clarias Heteropneustes, Anabas, Monopterus, Pangasius* and *Ompok),* Integrated aquaculture (paddy cum fish culture; duck-cum and pig-cum fish culture); Culture of pearl and frog; sewage fed fisheries; Composition of sewage and sludge; Treatment of sewage: physical, chemical and biological processes; Rearing techniques and production in sewage ponds.

Unit 6: Fish preservation and by-product: Causes of fish spoilage: biochemical changes during fish spoilage; Principle and practice of fish preservation; By-products of fishes; Symptoms of different fish diseases and their aetiology; prophylactic measures, control and therapeutics; Fish quarantine.

LSD206: C. ENTOMOLOGY-II

The course on insect physiology exposes the students to basic bioprocesses of the insect body, certain biomolecules and their functions. They will develop a sense how insect physiology can be infused into research of high order including in model insects.

Insect Physiology

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Unit 1: Integument: Structure of insect cuticle , cuticular modifications, chitin biosynthesis; Physiology of moulting, sclerotization; 8

Unit 2: Insect blood: Cell types and structure, plasma composition, insect immunity: cellular and humoral immunity, signalling in immune response to pathogenesis. 12

Unit 3: Insect Senses: Insect nervous system, neuromuscular junction, Ach:n-Ach and m-Ach receptor, ion channels, nerve impulse transmission, graded response, Mechanoreceptor, Chemoreceptor, Auditory organ (Chordotonal organ, Johnston's organ and tympanic membrane), Vision: structure and physiology 10

Unit4: Digestive and excretory system; Structure and modifications. Salivary and other digestive secretions, physiology of digestion and excretion 10

Unit5: Respiratory and reproductive system: Tracheal system and gaseous exchanges, aquatic respiration; Male and female reproductive systems, hormonal control of reproduction, special types of reproductions 10

Unit6: Insect hormones: chemistry, synthesis, degradation, mechanism of action ; Hormonal control of growth, metamorphosis, osmoregulation. Diapause and its regulation.

LSD206: D. PLANT ECOLOGY -II

HABITAT ECOLOGY

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Unit1: Aquatic ecology: fresh water environment, structure, function and physico-chemical nature of major fresh water bodies of N. E. India with special reference to the Kazaringa, Dibru soikhowa, Manas, Diporbil,and Logtok lake; estuaries and marine habitats.

Unit 2: Terrestrial ecology: terrestrial environment and its physico – chemical nature in comparison to fresh water habitats; major biomes of the world with special reference to tropical rain forest , tropical deciduous forest, coniferous forest, tropical savanna and grassland, temperate grassland and desert biome.

Unit3: Plant adaptation: ecological significance of plant adaptation, adaptation induced by soil, water, light, and biotic factors; plant and plant communities as indicators of cropland, mineral resources, and pollution.

Unit 4: Habitat degradation (land and forest): land use pattern in India, integrated land use planning, soil degradation, forest cover and forest survey of India, deforestation, demand and supply of wood, afforestation- strategy to demand of forest.

Unit 5: Plant ecology and climate change: plants and climate, plants' interaction with environment, vegetation and natural resources, environmental responses of plants, researches on vegetation changes with climate.

Unit 6: Deep ecology: definition, deep ecology platform, development, sources of deep ecology, deep ecology movement, misconception in deep ecology, criticism of deep ecology, links with other philosophies.

LSD206: E. CROP IMPROVEMENT –II

MUTATION and CROP IMPROVEMENT

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Unit 1: Mutation: (a) at chromosomal level: euploidy and aneuploidy, deletion, duplication, translocation and cytogenetics and breeding behaviour of translocation heterozygote and deficiency, position effect, induction of polyploidy; (b) at molecular level: Frame shift and substitution mutation, DNA damage and repair, Spontaneous and induced mutation; mutagens and their mode of action and (c) at biochemical level: One gene - one enzyme hypothesis, biochemical degradation of phenylalanine in man, biochemical mutation in *Neurospora*.

Unit 2: Genetic basis of plant breeding: Genetic consequence of hybridisation, quantitative inheritance, population structure, Hardy Weinburg Law, combining ability, heritability, genetic advance, genetic base, choice of breeding methods, germplasm activities and exploration.

Unit 3: Breeding procedure for self pollinated, cross pollinated and vegetatively propagated plants, mutation and ploidy breeding including haploidy in crop improvement; Heterosis, dominance and over dominance hypothesis, inbreeding depression,

estimation of heterosis, types of hybrids and development of hybrid seeds. Concept and utility of distant hybridisation.

Unit 4: Breeding for disease and insect resistance, Types of genetic resistance, vertical and horizontal resistance, mechanism of disease and insect resistances, factors or genes of resistance, source of resistance, breeding methods, advantage and limitations of resistance breeding.

Unit 5: *In vitro* technique in plant breeding: cell and tissue culture, primary culture, cell line, cell clones, callus culture, somaclonal variation, micropropagation, somatic embryogenesis, haploidy, protoplast fusion and somatic hybridisation, transgenesis, artificial seeds, application and achievements of *in vitro* techniques in plant breeding.

Unit 6: Breeding of wheat, rice, sugarcane, cotton, potato and major pulses in India with special reference to their origin, classification and production of improved varieties.

LSD206: F. MICROBIOLOGY-II

APPLIED MICROBIOLOGY

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Unit 1: Microbial Ecology: The ecology of micro organisms in different environmental conditions; Role of microorganisms in biogeochemical cycles; Role of rhizosphere and phylloplane microorganisms; Biochemistry of N2– fixation.

Unit 2: Microbiology of air and water: Aerobiology; Air sanitation, Microbiology in relation to water pollution; Coliform group and its importance in water pollution; Bacterial analysis of water (Detection of coliform group in water); Purification of water; waste water (sewage) treatments.

Unit 3: Food Microbiology: Microbiology of milk and milk products; spoilage and preservation of foods;. Food produced (fermented foods) by microbes.

Unit 4: Petroleum Microbiology: Microbial community in Petroleum, Utilization of petroleum by microorganisms; petroleum prospecting with the help of microorganisms; microbial oil recovery.

Unit 5: Medical Microbiology: a) Some important diseases caused by bacteria, actinomycetes, virus and fungi; b) Bacterial toxins; c) Diseases, symptoms, pathogenecity, laboratory diagnoses and control of the diseases caused by the following organisms: *Corynebacterium diphtheriae, Clostridium tetani, Vibrio cholerae, Mycobacterium tuberculosis, Polio virus, Hepatitis virus*.

Unit 6: Industrial Microbiology: Importance of microorganisms in industry, Industrial process of Microbial fermentation of alcohol, citric acid and lactic acid; Industrial enzymes; foods from waste (single cell proteins); Manufacture of antibiotics in industry (Penicillin, Streptomycin).

LSD206.G: Applied Angiosperm Taxonomy

L T Credit: 4

48 16 Marks: 100 (In=40, End=60)

Unit 1:
Sources of taxonomic characters: Morphology, Leaf architecture, Palynology, Anatomy and ultrastructure, Embryology, Cytology, Phytochemistry, Serology.

Unit 2:
Herbarium techniques: methods of collection, identification, preparation of herbarium specimens, and documentation. Arrangement of Herbarium, Virtual herbaria

Unit 3:
Tools of taxonomy: Botanical keys, construction of taxonomic keys, Serological techniques used in assessing the relation between OTUs, Techniques of Chemotaxonomy, GIS, GPS

Unit 4:
Computer applications in taxonomy: Numerical taxonomy, statistical tools in taxonomy, Bioinformatics applications in taxonomy: Sequence alignment, molecular phylogeny.

Unit 5:
Molecular tools in taxonomy: DNA Hybridisation, RFLP, RAPD, AFLP, DNA sequencing.

Unit 6:
DNA Barcoding: PCR and PCR primer designing, molecular markers; Role of chloroplast DNA and mitochondrial DNA in taxonomy, Process of DNA Barcoding, DNA Barcode databases

LSD207: A. Practical Course on BIOCHEMISTRY-II

Credit: 2
Marks: 50 (In=20, End=30)

1. Estimation of protein by Bradford method.
2. Estimation of amino acids
3. Determination of pK and I^{PH}
4. Separation of amino acids by Thin Layer Chromatography
5. Assay of activity of an enzyme in biological samples
6. Electrophoretic separation of protein using PAGE
7. Purification of proteins using column chromatography.

LSD207: B. Practical Course on FISH AND FISHERIES-II

Credit: 2
Marks: 50 (In=20, End=30)

1. Biological survey of pond.
2. Analysis of soil sample: pH, texture and porosity.
3. Analysis of physico-chemical parameters of pond water.
   (a) Conductivity, (b) turbidity, (c) dissolved oxygen, (d) current flow,
   (e) alkalinity, (f) hardness, (g) TDS, (h) TSS, (i) Nitrate-nitrite (j) Phosphate.
4. Study of bucco-pharyngeal region of following fishes:
   (i) Labeo, (ii) Punitus, (iii) Channa, (iv) Heteropneustes
5. Gut content analysis of *Labeo, Punitus, Channa* and *Heteropneustes.*
6. Gonadosectomy in fishes
7. Identification and reports on locally available aquatic weeds.

Kishor Halai

Course Coordinator
M.Sc Life Sciences
Digboi College

LSD207C: Practical course: **Entomology II**

Credit: 2
Marks: 50 (In=20, End=30)

1. Dissection of alimentary canal of honey bee, house fly, bacterial chamber in termite
2. Dissection of male and female reproductive system in moths/cockroach
3. Permanent mount of salivary gland of mosquito/ silk worm , hypopharyngeal gland of honey bee
4. Dissection of stomatogastric nervous system in cockroach, Nervous system of house fly
5. Study of haemocyes, hemocyte count (Total and differential)
6. Protein extraction and estimation in haemolymph
7. Protein profile in haemolymph by polyacrylamide gel electrophoresis
8. Qualitative estimation of chitin in integument

LSD207: D. Practical Course on PLANT ECOLOGY-II

Credit: 2
Marks: 50 (In=20, End=30)

1. To study the stratified biomass of different species in different habitats.
2. To study the primary productivity of grassland by harvest method.
3. To study the productivity of plants by leaf – disc –method.
4. To study the effect of sampling size on the vegetation analysis.
5. To study the root shoot ratio of plants growing in different habitats.
6. Estimation of chlorophyll content at various stages of growth of the plants.
7. To study the texture, colour, humus and organic matter content in different soil samples.
8. To determine the moisture content, bulk density, porosity, and water holding capacity of different soil samples.
9. Estimation of total nitrogen content in different soil samples.
10. Estimation of nitrogen content in plants.
11. Estimation of phosphorous content in various soil samples.

LSD207: E. Practical Course on GENETICS AND CROP IMPROVEMENT-II

Credit: 2

Marks: 50 (In=20, End=30)

1. Application of Colchicine for chromosome doubling in suitable plant species.
2. C- Metaphase and counting of chromosomes, karyotype studies and preparation of idiograms .
3. Study of anaphasic separation; chromosomal breakage, laggard, chromatin bridge and unequal separation.
4. Floral biology study, techniques of emasculation, selfing and hybridization techniques.
5. Pollen studies-morphology, viability, artificial germination and storage, seed testing and use of mutagens.

LSD207: F. Practical Course on Microbiology-II

Credit: 2
Marks: 50 (In=20, End=30)

1. Microbial population of soil and rhizosphere
2. Microbial population of water
3. Coliform water testing (Microbial) – Presumptive, confirmed, completed
4. ONPG and MUG testing of water
5. Curd Bacteria, Isolation of lactic acid bacteria
6. Biochemical activities of microbes
7. Enzymes in soil – Dehydrogenase, Phosphatase, Nitrate reductase

LSD207.G: Practical course on Angiosperm Systematics II

Credit: 2
Marks: 50 (In=20, End=30) 1.

1. Chemotaxonomic variation in plant families.
2. Molecular tools in solving taxonomic problems: RFLP/ RAPD/ AFLP.
3. Use of DNA Barcoding for plant identification
4. Classification of plants based on numerical taxonomic characters.

GENERIC ELECTIVE

LIF-GE-208 **Credit-4**

Marks: 100 (In=40, End=60)

Students of M.Sc. Life Sciences will select this course from other departments.

BOOKS RECOMMENDED (Latest editions)

(Microbiology)

1. General Microbiology by R.Y. Stanier, M. Doudoroff and E.A. Adelberg. Mac Millan India.
2. Microbiology by M.T. Pelczar,Sr., E.C.S. Chan and N.R. Kreig Tata McGraw - Hill.
3. A text Book of Microbiology by R.C. Dubey and D.K. Mahoswoui, S. Chand and Company.
4. A text Book of Microbiology by P. Chakraborty New Central Book agency.
5. Prescott, Hauley and Klein's Microbiology. McGraw –Hill Higher Education
6. Experiments in Microbiology, Plant Pathology by K.R. Aneja New Age International (P) Ltd.
7. Bergey" Manual of determinative Bacteriology (9^{th} edition)
8. Microbiology by P.D.Sharma .Rastogi Publications.

(Taxonomy and Evolution)

1. Concept of Species. Slobodehikoff
2. Introduction to Evolution .Harper and Row. New Work.
3. Methods & Principles of Systematic Zoology . Mayer E. & Linsley E.G. McGraw Hill, N.Y.
4. Taxonomy: A text and reference Book . Black Welder R.E.- John Wiley.
5. Theory and Practice of Animal Taxonomy by Kapoor, V.C.Oxford & IBH Publishing Co.Pvt Ltd. New Delhi.
6. Principles of Systematics .Mayer, E.
7. Principles of Angiosperm Taxonomy .Daves P.H. & Heywood V.H, Oliver & Boyd, London

(Environmental Biology)

1. Concepts of Ecology-by E.J. Karmondy
2. Ecology -by C. Krebs
3. Ecology Work Book - by R. Misra.
4. Environmental Chemistry-by A.K.Dey
5. Fundamentas of Ecology - by E.P. Odum.
6. General Animal Ecology by Ananthakrishnan, T.K.and T.R.Viswanathan (1978).
7. Climate and Plant Distribution – Woodword
8. Soil Conservation in India – Gupta & Whytri
9. Tropical Ecosystems: Ecology & Management – Shing & Singh
10. Field Biology and Ecology- Benthon & Weaver
11. Environmental Pollution – S.M. Shafi.
12. Remote Sensing – Sahu & Solanki
13. Handbook of Agricullture – ICAR
14. Modern Concept of Ecology-by H.D. Kumar
15. Plant Ecology and Soil sciences-by Sukla and Sandal
16. Population Ecology-by M. Begon & M. Mortimer.
17. Practical methods in Plant Ecology and Environmetal Sciences- by R.K. Trivedy.

(Biodiversity conservation)

1. River Ecology by B.A. Whitton, University of California Press.
2. Limnology by R.G.Wetzel,W.G.Saunders N.Y.
3. Biodiversity : Principles & Conservation – Kumar & Asijia
4. Biodiversity Global Concerns – R.K. Sinha
5. Biodiversity of Assam–Bhagabati, Baruah & Kalita. EBH Publisher, Guwahati.
6. Biodiversity: Strategies for conservation – L.K. Dadhick & A.P. Sharama
7. The Wildlife of India by E.P. Collins.
8. Mountain Wildlife by Perry.
9. Animals in Danger by Zuber.
10. Animals of India by S.N. Prater.
11. Birds of India and Pakistan by S. Ali.
12. Fish and Fisheries of India - by Jhinran
13. Wildlife Conservation and Modern Zoo by Woodraffed.
14. Wildlife Management in India – Hosetti

(Toxicology, pest management, Bioethics and IPR)

1. Toxicology and Risk Assessment: A Comprehensive Introduction, Greim H., and Snyder, R.(ed), John wiley and Sons, UK
2. The Complete Book of pesticide management, Whitford, F., Wiley Interscience, John Wiley and Sons, UK
3. Safer Insecticides, Hodgson, E,. and Kuhar, R.J.,(ed), Marcel Dekker Inc., New York, USA
4. Pesticide Application methods, Matthews, G, A., Blackwell Science, London, UK
5. Pesticide Biochemistry and Physiology, Wilkinson, C.F., Plenum Press, New York, USA
6. Metabolic pathways of agrochemicals Part II, Robers, T.R., and Hutson, D.H. The Royal Society of Chemistry, UK
7. Fundamentals of Toxicology. Pandey, K, Shukla UP and Tridevi, SP. New Central Book Agency Limited. 2012

Entomology II

Suggested reading:

1. The Principles of Insect Physiology, Wigglesworth, Vincent B, Chapman & Hall Ltd. USA.

2. The Insects: Structure and function, Chapman, R. F., Cambridge University Press, UK

3. Physiological system in Insects, Klowden, M. J., Academic Press, USA

4. The Insects, An outline of Entomology, Gullan, P. J., and Cranston, P. S., Wiley Blackwell, UK

5. Insect Physiology and Biochemistry, Nation, J. L., CRC Press, USA

THIRD SEMESTER (ZOOLOGY)

LSC301Z: ANIMAL PHYSIOLOGY **Credit: 3**

Marks: 75 (In=30, End=45)

1. Respiration in vertebrates, respiratory pigments; exchange and transport of gases, mechanism of breathing in mammals. Structure, type and function of nephrone; role of hormone in urine formation.
2. Physical and chemical composition of blood. Blood groups and blood coagulation, blood volume and its regulation. Types and comparative anatomy of heart in vertebrate, cardiac cycle and its regulation, blood pressure and heart diseases.
3. Nervous system- central and peripheral N.S.; ultra structure of neurones, generation of impulse -resting and action potentials, transmission of impulse, axonal, synaptic and neuromuscular transport of neuronal cells. Gastrointestinal digestion- secretion and regulation of gastrointestinal juices. Digestion and secretion of carbohydrate, protein and lipid.
4. Physiology of stress and adaptation - Concept of homeostasis and maintenance of volume and composition of body fluid. Concept of osmoregulation and adaptation to high altitude. Mountain sickness and acclimatization.

LSC302Z: IMMUNOLOGY **Credit: 3**

Marks: 75 (In=30, End=45)

Unit 1: Types of immunity: innate and aquired immunity, active and passive immunity, primary and seconday immune response, humoral and cell mediated immune response; clonal nature of immune response- monoclonal and polyclonal antibody; antigens - characteristics, antigenicity and immunogenicity, factors affecting immunogenicity, epitopes, haptanes, adjuvents, superantigens.

Unit 2: Immunoglobulin: molecular structure, classes and functions, Ig gene arrangements, antigen-antibody interactions, quantification of antigen/antibodies by RID, RIA and ELISA.

Unit 3: Complement system: characteristic features, activation pathways and its biological consequences, structure and function of MHC I and MHC II molecules.

Unit 4: Immunodeficiency disorders: congenital and acquired immunodeficiency disorders, immunological tolerance and autoimmune diseases, vaccine and vaccination.

LSC303Z: DEVELOPMENTAL BIOLOGY **Credit: 3**

Marks: 75 (In=30, End=45)

Unit 1:

Gamatogenesis: Cells in the seminiferous tubules; formation of spermatids; differentiation of the spermatozoa; Oogenesis - growth of the oocytes; nuclear activity during the growth of the oocyte; accumulation of food reserves in the cytoplasm of the oocytes; i*n vitro* oocyte maturation; hormonal control of gametogenesis

Unit 2:

Fertilization: approach of the spermatozoon to the egg; reaction of the egg; the essence of activation; components of the spermatozoon in the egg interior; changes in the organization of the egg cytoplasm caused by fertilization; *in vitro* fertilization.

Unit 3:

Cleavage: chemical changes during cleavage; totipotency and nuclear transfer experiments; distribution of cytoplasmic substances in the egg during cleavage; the morphogenetic gradients in the egg cytoplasm, Concepts of determination: mechanism of cellular determination, competence and induction: mechanism of action of the inducing substances

Unit 4:

Cell differentiation and development: process & significance, hormonal regulations of metamorphosis, Regeneration, Genes and aging, Role of biotic, abiotic and symbiotic regulation of development, Stem cell concept: embryonic & adult stem cells, stem cell niches, stem cells and their alternatives in medical treatments

LSC304Z: Practical Course on ANIMAL PHYSIOLOGY & IMMUNOLOGY

Credit: 1.5

Marks: 38 (In=15, End=23)

1. Preparation of Hemin crystal of frog / fish.
2. Counting of total RBC of frog / fish.

3 Counting of total WBC of frog / fish

4. Determination of ABO and Rh. blood group of human being/ rat.
5. Determination of oxygen consumption of fish.
6. Determination of oxygen consumption of cockroach and estimation of RQ.
7. Effect of temperature, P^H on amylase activity in human saliva.
8. Qualitative detection of sugar and albumin in urine.
9. Dissection and histology of lymphoid organs in rat/mouse.
10. Antigen - antibody reaction - Double radial immunodiffusion.
11. Study of bone - marrow cells from mouse.
12. Phagocytosis in spleen macrophages.

LSC305: Practical Course on DEVELOPMENTAL BIOLOGY

Credit: 1.5

Marks: 37 (In=15, End=22)

1. Induced breeding in frog/fish.
2. Study of embryonic development of chick by window method.
3. Study of regeneration of cutaneous wounds in fish.
4. Permanent slide preparation and study of permanent slides of developing chick embryo at various intervals of development.
5. Study of following permanent slides:
   a) Amphioxus: Late larva (W.M.).
   b) Amphibia: Frog ovary (T.S.), frog egg uncleaved (S.S.), blastula(S.S.), early gastrula (S.S.), late clevage (S.S.), gastrula(S.S.), meural food (T.S), tadpole(W.M.), embryo 7mm (S.S.), embryo 4mm (W.M.),tadepole eye region (S.S.), tadpole heart region (S.S.).
   c) Aves: Chick ovary (T.S.), chick testes (T.S.), sperm smear, whole mount of following states of chick development 13hrs, 18 hrs.,21 hrs., 33 hrs., 36 hrs., 38 hrs., 48 hrs., 66 hrs., 72 hrs., 84 hrs., 96 hrs., 120 hrs.
   d) Chick embryos T.S. at different intervals: 33 hrs.,48 hrs.(heart region), 58 hrs., 72 hrs. (Diencephalen region), 72 hrs.(heart region).
   e) Mammals: Sperm smear, spermatogenesis (T.S.of testes), Oogenesis (T.S. of ovary).
6. Permanent mounting of certain larval stages of invertebrates and vertebrates.

DISCIPLINE SPECIFIC ELECTIVE-III

LSD306Z: A. BIOCHEMISTRY-III

MOLECULAR BIOLOGY

Credit: 4

Marks: 100 (In=40, End=60)

Unit1: Organisation of DNA in chromosomes, Molecular structure, physico chemical properties of DNA, DNA-replication, DNA polymerase in Prokarytes and Eukaryotes, DNA sequencing, satellite DNA, Palindrome sequences, repetitive DNA.

Unit2: Organisation of gene in Prokaryotes and Eukaryotes; Split genes, Overlaping genes, pseudogenes, transposable genetic elements, plasmids, Regulation of prokaryotic gene expression - inducible and repressible operon systems; Concept of eukaryotic gene expression and its difference with prokaryotic; Regulation of gene expression at transcription and translation level.

Unit3: Transcription of RNA, sense and antisense strand, RNA polymerase in Prokarytes and Eukaryotes, types and functions of RNA, RNA processing, spliceosome, catalyzed RNA splicing, Ribozyme, RNA editing, RNA sequencing. Reverse transcriptase and its significance.

Unit4: DNA damage and repair; Alterations in DNA molecule, repair of incorrect bases, repair of thymine dimmers, recombination repair, SOS repair.

Unit5: Immunology; Clonal selection theory, Hybridoma technology and production of monoclonal antibodies Heavy and light chain gene of Ig, Molecular basis of diversity. Interferons - Type and mechanism of action.

Unit 6: Recombinant DNA technology; Importance of microorganisms in recombinant DNA technology, PCR, DNA finger printing; Transfer of genetic material (transformation, conjugation and transduction), Restriction enzymes; Principle and methods of gene cloning and genetic engineering (basic steps for human welfare), cDNA and gene targeting.

LSD306Z: B. FISH AND FISHERIES-III

FISH TECHNOLOGY, ECONOMICS AND EXTENSION

Credit: 4

Marks: 100 (In=40, End=60)

Unit 1: Induced breeding: Purpose, technique of induced breeding, influence of abiotic factors, Recent advances in induced breeding; Concept of hatchery, designing of Chinese and cemented hatchery, management of hatcheries.

Unit 2: Requirement of micro and macro nutrient of cultivable species; Effect of malnutrition, basic principle of fish feed formulation, preparation and mode of fish feed storage, use of unconventional feed as source of nutrients;

Unit 3: Fish stock improvement through selective hybridization; Androgenesis and gynogenesis; polyploidy; Sex reversal and sterility; Transgenesis; Cryopreservation of gametes and embryos.

Unit 4: Present status and scope of development of fishing technology in India; Types of fishing crafts and gears in marine and inland waters, their maintenance and operation; Economics of fishing operations; Modern transportation system; Management and conservation of inland fisheries resources; Fisheries legislation.

Unit 5: Principles of economics as applied to aqua products; Law of demand and supply, consumer surplus; Law of returns, market demand and prices; International trade and export promotion; Existing system of fish marketing; Use of modern marketing and transportation for aqua products.

Unit 6: Role of cooperatives and Fish Farmer's Development Agencies (FFDA); Advertising and modern selling methods; Fisheries extension and transfer of technology; Institution and agencies involved in fisheries extension.

LSD306Z: C. ENTOMOLOGY-III

INSECT ECOLOGY AND APPLIED ENTOMOLOGY

Credit: 4

Marks: 100 (In=40, End=60)

The course on Insect ecology and agricultural entomology will expose the students to the role of insect in maintenance of different ecosystems, the fundamentals of insect plant interaction, important pests and their management. The students trained will have understanding about interaction of nature, plant and insects and will be equipped with knowledge to be engaged with pest control organizations.

Unit I: Ecology and biodiversity of insects: Insect biodiversity and their functioning in terrestrial ecosystem and nutrient cycling. Insect population dynamics (growth pattern, population status, Life table, Survivorship curve, dispersal), type of distribution (Random, clumped, regular), factors influencing dispersal and succession. 9

Unit 2: Insect – plant interaction: Herbivory-Diet breadth, feeding guilds, Concept of co-evolution between plant and insects; Mutualism, Pairwise coevolution. Host plant selection by insec : Physical barrier, Plant allelochemicals. Plant resistance to insect: Constitutive and induced, mechanism of resistance, non-preference, antixenosis, antibiosis, tolerance. 9

Unit 3: Tritrophic interactions, host plant response to herbivory: Lipoxygenase, Mevanolate, Shikimic acid pathway. chemosensory basis of host plant selection, odour detection, olfactory signalling pathway, molecular basis of odour coding. 7

Unit 4: Storage entomology: Storage loss: biotic factors, sources of infestation, role of temperature and moisture in infestation; Biology of major stored grain pests; Biochemical changes in stored commodities due to pest infestation; Principles of safe storage. 7

Unit 5: Pests of paddy, cabbage, brinjal, classification, life cycle, mode of infestation. Concepts of integrated pest management, Biological control, Basic concept in entomopathogen (Baculovirus, *Bacillus thuringiensis*) and their mode of action, Insect cell line culture and their importance in pest control, Pest quarantine, Insecticide Act of India, Principles of insecticide formulation. 14

Unit 6: Importance of microorganism to recombinant DNA technology, DNA replication , Transcription, Restriction enzymes , DNA sequencing, DNA-DNA hybridization technique ,DNA finger printing, Transfer of genetic material (transformation, conjugation and transduction); Principle and methods of gene cloning and genetic engineering ; Gene regulation in prokaryotes and eukaryotes ;Transgenic plants for pest resistance-genes (B.t. toxin, trypsin inhibitor, alpha- amylase inhibitor-lectins), microbial production of recombinant molecules: principles and practice, sericulture and biotechnology 14

LSD307Z : A. BIOCHEMISTRY-III (MOLECULAR BIOLOGY)

Credit: 2
Marks: 50 (In=20, End=30)

1. Estimation of RNA
2. Estimation of DNA
3. Estimation of protein
4. Separation of proteins using SDS-PAGE.
5. Isolation of DNA from biological samples.
6. Restriction digestion analysis of DNA using agarose gel electrophoresis
7. Study of Ag-Ab reaction using ELISA
8. Immunodifusion and Immunoelectrophoresis

LSD307Z: B. Practical Course on FISH AND FISHERIES-III

Credit: 2

Marks: 50 (In=20, End=30)

1. Induced breeding experiment in fish.
2. Histological study of guts/gonads
3. Preparation of fish weed using locally available feed ingredients
4. Mounting of the following materials:
   Cypris, Daphnia, Diatoms, Ctenoid, Cycloid, Placoid and Rhomboid scales,
   Spirogyra, Nostoc, Navicularia.
5. Collection of fish parasites, their mounting, and identification.
6. Study of commonly used fishing gears.
7. Determination of age in fishes.
8. Identification of permanent slides.

LSD307Z: C. Practical Course on ENTOMOLOGY-III

Credit: 2
Marks: 50 (In=20, End=30)

1. Collection and identification of insects used as biocontrol agent, insect pests of agricultural importance
2. Determination of insect population density by random,line transect collection method
3. LC50 determination of insecticide by using filter paper method against stored grain pest
4. Estimation of protein, fat and carbohydrate in edible insects.
5. Identification of mosquitoes . Development of formulation of insecticide/repellent
6. Estimation of phenol, terpene in resistant and susceptible cultivars
7. Protein profiling using gel electrophoresis in herbivorous insect/defense induce plant
8. Assignment on study and submission of life cycle of a pest of local importance

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GENERIC ELECTIVE-II

LIF-GE-308:

Credit: 4

Marks: 100 (In=40, End=60)

Students of M.Sc. Life Sciences will choose this course from other departments.

ABILITY ENHANCEMENT COURSE-II

LS-A-309: Biodiversity Management- II: Conservation of Biological Diversity

Credit: 2
Marks: 50 (In=20, End=30)

LS-A-309: Public Health Entomology-II

Credit: 2
Marks: 50 (In=20, End=30)

FIELD STUDY/SURVEY

BOOKS RECOMMENDED:

LS-C-301Z (Animal Physiology)

1. Respiratory Physiology of Vertebrates by Goran E. Nilsson.Cambridge University Press.
2. Text book of Medical Physiology, Guyton & Hall .Saunder
3. Text Book of Animal Physiology .Nagabhusham, Kodarkar, Sarojini; Mohan Primlani for Oxford & IBH Publishing co. Pvt. Ltd., New Delhi.
4. Environmental and Metabolic Animal Physiology (4^{th} Edition) By C. Ladd Prosser; John Wiley & Sons, Inc.
5. Vertebrate: Comparative, Function and Evolution; by Kardong K.V.; McGraw Hill Higher Education, ISBN:- 0072528303.
6. Samson Wright's Applied Physiology Edited by C.A.Keele. Oxford Medicine Publication.
7. Comparative animal physiology .Prosser and Brown,Academic press

LS-C-302Z (Immunology)

1. General Immunology .E. L. Cooper:, Pergamon Press.
2. Essential Immunology .I.M. Roitt:, Blackwell Scientific Publication.
3. Immunology. J. Brostoff and D.K. Grower Medical Publishing.

LS-C-303Z (Developmental Biology)

1. An introduction to embryology – B.I. Balinsky, W.B.Saunders Co. Philadelphia.
2. An introduction to embryology – William A. Blanc, American academy of Pediatrics.
3. Principles of development and differentiation – C.H. Waddington. Collier Macmillan Ltd.
4. Chemistry and Physiology of fertilization – Aebert Monray. Holt, Rinehart and Wintson publisher Newyork.
5. Analysis of development – Willer, Weiss, Bamburger.
6. Regeneration –Elizabeth D. Hay. Holt, Rinehart and Wintson publisher Newyork.
7. Molecular and Cellular aspect of development – Engene Bell. Harper and Row, Newyork.
8. Oogenesis – C.P.Raven. Pergamon press.
9. Laboratory manual of embryology – Robert Rugh. Burgess publishing Co.
10. Experimental embryology Robert Rugh. Burgess publishing Co.
11. Selected topics in development – Barth. Addison-Wesley Pub. Co.
12. Foundation of embryology – B.M.Patten & B.M.Carlson. McGraw-Hill Book Company.
13. Practical studies of animal development – E.S.Billet & A.E. Wild Chapman & Hall, London.

LS-D-306ZC: Entomology III

Insect Ecology and Applied entomology

Suggested reading:

1. Chemical Ecology of Insects, Carde, R. T., and Bell, W. J., Chapman & Hall, New York, USA
2. Insect Plant Biology, Schoonhoven, L. M., van Loon, J.A., &Dicke, M., Publisher Oxford University Press, USA
3. Interrelationship between insects and Plants, Jolivet, P., CRC Press, USA
4. Entomology & Pest Management, Pedigo, L. P.,Prentice Hall, New Jersey, USA
5. Concepts of IPM, Norris, Caswell-Chen and Kogan, Prentice-Hall, USA
6. Agricultural insects pests of the tropics and their control, Hill, D. S., Cambridge University Press, UK

THIRD SEMESTER (BOTANY)

LS-C-301B: MYCOLOGY, PLANT PATHOLOGY, CROP PROTECTION

L	T	Credit: 3
24	8	Marks: 75 (In=30, End=40)

Unit 1: Fungi: Cell structure, flagella, cell wall composition, diversity in thallus structure, reproduction in fungi, reproductive structures and sexuality, parasexuality, degeneration of sex in fungi, classification; economic importance of fungi: medicinal industrial use of fungi, fungi as biocontrol agents, mycorrhiza.

Unit 2: Systematic study of the structure, reproduction and classification of each group: *Myxomycetes, Chytridiomycetes, Hypochytridiomycetes, Oomycetes, Zygomycetes, Ascomycetes, Basidiomycetes, Deuteromycetes.* Economic importance of Lichen.

Unit 3: General account of diseases caused by plant pathogens, causes of plant diseases, stages in disease development, environmental factors and dissemination of diseases. Geographical distribution of diseases; Etiology; Symptomology. Physiology of parasitism: Role of enzymes, toxins and genetics on disease development

Unit 4: Plant disease management: Regulatory, role of quarantine, Plant quarantine in India cultural, methods like Tillage,crop rotation,trapcrops,fertilizer applications, land fallowing, timely sowing, and proper soil selection, physical, methods like Heat and soil solarisation chemical, methods used and examples of Bactericides, Fungicides, Insecticides, Nematicides, Acaricides , Molluscicides and Rodenticides, biological and integrated control of plant diseases; Symptoms, causal organisms, disease cycle and control measures of damping of seedlings, stem gall of coriander; grey blight of tea, red rot of sugarcane, bacterial blight of rice, viral disease of potato.

LS-C-302B: ALGAE & BRYOPHYTE

L	T	Credit: 3
24	8	Marks: 75 (In=30, End=45)

Unit 1: Algae: Cell Structure, flagella, pigments and their distribution, pyrenoids and eye spots, diversity in thallus organization; Types of reserve foods in Algae.

Unit 2: Classification of algae , Reproduction (types and evolution) and life-cycles; Economic importance of algae: Food, feed, industry, biofertilizers, medicine and algal bloom.

Unit 3: Diversity of thallus structure, reproduction and classification of the following: *Myxophyceae, Chlorophyceae, Xanthophyceae, Bacillariophyceae, Phaeophyceae* and *Rhodophyceae*.

Unit 4: Classification and comparative study of morphology, anatomy and reproduction of *Hepaticopsida, Anthocerotopsida* and *Bryopsida.* Evolution of sporophytes; dehiscence and spore dispersal mechanisms; Ecological and Economic importance of Bryophytes

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LS-C-303B: PTERIDOPHYTES AND GYMNOSPERMS

L	T	Credit: 3
24	8	Marks: 75 (In=30, End=45)

Unit 1: Paleobotany**:** Fossils & the process of fossilization, Study of (a) *Rhynia, Lepidodendron, Sphenophyllum.* (b). *Calymatotheca, Cycadeoidea and Cordaites.*

Unit 2: Systematic study: Structure, Reproduction and Affinities of (a). *Lycopsida, Sphenopsida, Filicopsida* (b). *Cycadales, Ginkgoales, Coniferales, Gnetales, Ephedrales*

Unit 3: Diversity and Economic Importance: Classifications, Diversity and Distribution of Gymnosperms in India with special reference to N.E.India.

Unit 4: Economic Importance: Economic Importance of Pteridophytes & Gymnosperms

LS-C-304B: Lab Course on Mycology, Plant Pathology and Algae

Credit: 1.5

Marks: 38 (In=15, End=23)

1. Working out the following Algae for studying the external morphology and anatomy with special emphasis in reproductive structures present: *Ulothrix, Coleochaete, Pithophora, Cladophora, Vaucharia, Ectocarpus, Fucus, Batrachospormum, Polysiphonia, Oscillatoria, Rivularia, Gloeotrichia. Nostoc.*

2. Working out the following fungi for studying the external morphology and anatomy with special emphasis in reproductive structures present: *Rhizopus, Peziza, Ascobolus, Morchella, Puccinia, Polyporus, Agaricus, Auricularia, Helminthosporium, Melamospora.*

3. Study of symptoms of host parasite relationship, vegetative and reproductive structures and collection of the pathogens with the fresh and preserved specimens, Herbaria, semipermenant /permanent slides of the following diseases: Blights of potato, Brown spot of rice rust of wheat (uredo & teleutospore), Grey blight of tea (*Poistaloria*), Bean rust (*Uromyces*), White rust of *Brassica* (*Albugo*), Gall Of coriander(*Protomyces*), *Alternaria* diseases of *Crucifers*, Wilt diseases of *Legumes*.
4. Measurement of reproductive structures under microscope and Camera Lucida drawing.
5. Preparation of permanent slides for submitting in the examination.
6. Collection and preservation of specimens for submission (herbarium and bottle specimens)

LS-C-305B: Lab Course on Bryophyte, Pteridophyte & Gymnosperm

Credit: 1.5

Marks: 37 (In=15, End=22)

1. **Bryophytes**: Working out the following Bryophytes for studying the external morphology and anatomy with special emphasis in reproductive structures present: *Riccia, Marchantia, Porella, Anthoceros, Sphagnum, Polytrichum,Funaria*
2. **Pteridophytes**: Study of *Psilotum ,Selaginella, Isoetes , Equisetum, Ophioglossum, Pteris , Angiopteris, Lygodium, Gleichenia, Marsilea, Azolla.*
3. **Gymnosperms:** Working out the following specimens belonging to Gymnosperms for studying the external morphology and anatomy with special emphasis in reproductive structures present in *Cycas, Pinus, Ginkgo, Taxus, Cryoptomeria, Ephedra, Gnetum.*

BOOKS RECOMMENDED: (LS-C-301-305)

1. Alexopoulus - Introductory mycology, Willey.
2. Anatomy of Dicolyledons Vol. I & II. - C.R. Metcaff.
3. Arnold - An Introduction to Paleobotany, McGraw Hill.
4. Bessey - Morphology and taxonomy of fungi, Hafner. Pub. Company.
5. Bower - Primitive land plants, Macmillan.
6. Butler & Jones - Plant pathology, Macmillan.
7. Campbell - Evolution of lands plants, Standford Univ. Press.
8. Chapman - Introduction to study of Algae, Macmillan.
9. Cochrane - Physiology of fungi, Willey.
10. Coulter & Chamberlain - Morphology of Gymnosperms, Chicago Uni. Press.
11. Eames - Morphology of vascular plants, McGraw Hill.
12. Experimental embryology: Embryogenesis in vascular plants - V. Raghavan.
13. Families of flowering plants Vol. I & II, by J.Hutchinsons, Mc Millan, London, 1967.
14. Fritsch: Structure and reproduction in Algae, Vol. I & II. Cambridge University Press.
15. Gwynee vaughan & Barnes - The structure and development of fungi, Cambridge University.
16. Jaiswal (Edited) - Hand book of agriculture, ICAR, New Delhi.
17. Kakkan & Kakkan - The Gymnosperms (Fossils & Living), Central Pub.House.
18. Mukherjee, Das, Ganguly - College Botany Vol. II, Central Book Depot.

19. Principles of Angiosperm Taxonomy - by P.H. Devid & V.H. Heywood, Oliver & Beyd, London, Scott - Fossil Botany, Vol. I & II.
20. Singh - Plant diseases, Oxford & IBH.
21. Smith - Cryptogamic Botany Vol. I & II. Mc Graw Hill.
22. Taxonomy of vascular plants - by H.M.G. Lawrence, Mc Millan, N.Y., 1964.
23. Walker - Plant pathology, Hill.
24. Watson - Bryophyta, Hutchinson Univ. Library.
25. Transport in Plants – Vol. 1-3 – Simmerman
26. Plant Physiology – Pandeya & sinha
27. An Introduction to Plant Physiology – R. Sharma

DISCIPLINE SPECIFIC ELECTIVE

LS-D-306B: D. Plant Ecology-III

APPLIED PLANT ECOLOGY **Credit: 4**

Marks: 100 (In=40, End=60)

Unit 1: Environmental pollution and plant ecology: vegetation responses to environmental pollution, deforestation and environmental pollution, air and water pollution and the productivity of economic crops of N. E. India; phytoremediation of environmental pollution.

Unit 2: Environment Impact Assessment (EIA): the concept of EIA, importance of EIA, methods of EIA evaluation with special reference to adhock method and check list method, role of various agencies in operation of an EIA programme.

Unit 3: Weed ecology: definition, classification, origin and evolution, ecological significance, weeds in natural and agro ecosystems, weeds as human hazards, weeds associated with major crops of India, chemical and biological control of weed.

Unit 4: Conservation and management: state of affairs of the prevailing environmental stress upon various productive ecosystems, range management, forest management, soil conservation, conservation of endangered genetic resources.

Unit 5: Agroecosystem management and sustainable agriculture: system approach in agriculture, mutually antagonistic nature of ecology and efficient agriculture; sustainable agriculture: complex agroecosystems- shifting agriculture, rotational fallow, home gardens, mixed arable live-stock farming, agri-silviculture, specialized cash crop systems, intercropping and crop rotation, integrated landscape management for cropping with ‘Global Change’, agriculture and globalization.

Unit 6: Chemical ecology: Secondary metabolites, allelopathy and Kairopathy, biomagnifications and bioaccumulation of hazardous chemicals in food chains; Structural and functional aspects of certain bioactive compounds (curcumin, andrographoloids, azadirechtin, reserpine,vasicine etc.) , their antioxidant and antimicrobial activity.

LS-D-306B: E. Genetics & Crop Improvement

MOLECULAR GENETICS **Credit: 4**

Marks: 100 (In=40, End=60)

Unit1: Molecular genetics; Basic concepts of molecular genetic markers: viz. microsatellite, SNP, RFLP, RAPD, AFLP, ISSR.

Unit 2: DNA: Structure and function; DNA as the genetic material; Nucleosome; DNA sequence (DNA sequencing methods :Sanger as well as Maxam and Gilbert); repetitive and unique sequence); DNA homology (Tm ; DNA- DNA hybridization technique, cot value); Organization of genome (Satellite DNA; repititive DNA, palindromic sequence); fine structure of gene; Organization of genes (continuous gene, split or interrupted gene; overlapping gene, pseudogene).

Unit 3: Replication of DNA: Unit of replication, enzymes involved, replication of linear DNA (leading and lagging strand replication), circular DNA, and mitochondrial DNA; telomere replication (end replication problem, telomerase); PCR and its application. Reverse transcriptase and its significance.

Unit 4: RNA synthesis and processing: Sense and Antisense strands, Types and functions of RNA (mRNA, rRNA, tRNA, micro-RNA, siRNA, Ribozymes); Transcription process (initition, elongation, termination), RNA polymerases, Transcription factors: Activators and repressor; RNA processing - capping, polyadenylations, splicing, editing; Regulation of prokaryotic gene expression; Operon, inducible and repressible systems, structure and function of lactose and tryptophan operon; Regulation of eukaryotic gene expression; Riboswitch, RISC.

Unit 5: Microbial genetics: Mutation, Auxotrophs; polytrophs; Replica plating technique; plasmids; Transposons; Transformation; Conjugation, Transduction;

Unit 6 : Recombinant DNA technology: Importance of microorganisms in recombinant DNA technology; Basic steps in r DNA technology; uses of genetic engineering for human welfare;

LS-D-306B: F. Microbiology-III

MOLECULAR MICROBIOLOGY **Credit: 4**

Marks: 100 (In=40, End=60)

Unit 1: DNA: Structure and function; DNA as the genetic material; Nucleosome; DNA sequence (DNA sequencing methods: Sanger as well as Maxam and Gilbert); repitive and unique sequence); DNA homology (Tm; DNA- DNA hybridization technique, cot value); Organization of genome (Satellite DNA; repititive DNA, palindromic sequence); fine structure of gene; Organization of genes (continuous gene, split or interrupted gene; overlapping gene, pseudogene).

Unit 2: Replication of DNA: Unit of replication, enzymes involved: replication of linear DNA (leading and lagging strand replication), circular DNA, and mitochondrial DNA; telomere replication (end replication problem, telomerase); PCR and its application.Reverse transcriptase and its significance.

Unit 3: RNA synthesis and processing: Sense and Antisense strands, Types and functions of RNA (mRNA, rRNA, tRNA, micro-RNA, siRNA, Ribozymes) :Transcription process (initition, elongation, termination), RNA polymerases, Transcription factors: Activators and repressor; RNA processing-capping, polyadenylations, splicing, editing; Regulation of prokaryotic gene expression: Operon, inducible and repressible systems,structure and function of lactose and tryptophan operon; Regulation of eukaryotic gene expression ;Riboswitch, RNA induced silencing complex (RISC)

Unit 4: Microbial genetics:Mutation,Auxotrophs; polytrophs; Replica plating technique; Molecular basis of bacterial mutation (Frame shift, substitution; spontaneous and induced mutation; mutagens and their mode of action); plasmids; Transposons; Transformation; Conjugation, Transduction;

Unit 5 :Recombinant DNA technology : Importance of microorganisms in recombinant DNA technology; Steps in r DNA technology; uses of genetic engineering for human welfare; Microbial production of molecules using genetic engineering (insulin , interferon).

Unit 6: Immunology: Milestones in immunology; immunity, Humoral and cell mediated immunity; Immunoglobins (uses, structure and function); antigens; Detection and application of antigen-antibody reactions; hybridoma Monoclonal antibody.

LS-D-306B.G: Diversity and Conservation of Angiosperms

Credit: 4

Marks: 100 (In=40, End=60)

Unit-1

Phytogeography: Concept of Phytogeography, Static and Dynamic Phytogeography, Phytochoria and botanical provinces of India; IUCN: Categories and criteria

Unit-2

Origin of Angiosperms: Theories, evidences, Migration of plants and Barriers, Centre of Origin, Primitive and advanced angiosperms, Evolutionary trends Vicariance, Endemism, Hotspots

Unit-3

Botanical Survey of India (BSI): History, Organisation, Activities, Publications. Role of BSI in studying the floristic diversity of India

Unit-4

Plant Diversity of India, Flora of North East India; Endemic, Exotic and RET Plants with respect to India and specifically North East India

Unit-5

Herbaria and Botanic Gardens: Role and importance of herbaria and gardens in taxonomic studies, major Herbaria and Botanic Gardens of the world and India.

Unit-6

Conservation of RET plants: *in situ* and *ex situ* conservation; Biosphere reserves, national parks, wildlife sanctuaries, botanical gardens, cryopreservation, Gene banks, seed banks

LS-D-307B: D. PracticlaCourse on PLANT ECOLOGY-I **Credit: 2**

Marks: 50 (In=20, End=30)

1. To study the anatomical adaptative characters of hydrophytes, mesophytes and xerophytes.
2. To study the phenology and reproductive capacity of plants.
3. Determination of total solids (TS), Total Dissolved Solids (TDS), and Total Suspended Solids (TSS) of water by heat and weight method.
4. To study the total microbial population in rhizosphere soil.
5. To study the allelopathic / kairopathic action of plants on associated plants.
6. Phytochemical extraction of certain MAPs and their antimicrobial and antioxidant activity study.
7. To study the PH, turbidity, temperature and light intensity in a fresh water system.

LS-D-307B: E. Practical Course on Genetics & Crop Improvement-III

Credit: 2

Marks: 50 (In=20, End=30)

1. Study of purity of seeds from commercial seed samplesStudy of 'goodness of fit' by chi-square test with the help of mendelian ratios
2. Demonstration of tissue culture techniques.
3. Media preparation for tissue culture.
4. Study of the extent of genetic variability on different characters of crops by different genetic parameters like environmental etc.
5. Preparation of 20 permanent slides representing various stages of somatic and meiotic division and special type of chromosomes for submission during practical examination.

LS-D-307B: F. Practical Course on Microbiology-III

Credit: 2

Marks: 50 (In=20, End=30)

1. Estimation of DNA of bacteria
2. Isolation and estimation of RNA of bacteria
3. Estimation of protein from microbes
4. Isolation of DNA from microbes
5. Antigen-antibody reaction
6. Replica plating technique

LS-D-307B.G: Practical Course based on Angiosperm Systematics-III

Credit: 2

Marks: 50 (In=20, End=30)

1. Field trips within and around the University Campus, compilation of field notes and preparation of herbarium sheets of such plants, preparation of identification keys.
2. Molecular phylogenetic analysis.
3. BLAST and FASTA in molecular taxonomy.

GENERIC ELECTIVE

LIF-GE-308

Credit: 4

Marks: 100 (In=40, End=60)

Students of M.Sc. Life Sciences will choose this course from other departments.

ABILITY ENHANCEMENT COURSES

LS-A- 309B: Biodiversity Management: II Conservation of Biological Diversity

Credit: 2
Marks: 50 (In=20, End=30)

B: Conservation of biological diversity:

Unit 1: Environmental education: Creation of general awareness concerning environment problems, motivation to conserve resources and avoidance of extra-vagence, understanding and co-operation among people to face ecological issues, conservation of indigenous knowledge, traditions and culture friendly to the environment.

Unit 2: Environmental legislation:

Phase-I: Protective Legislation for specific Animals or Group of Animals.
Phase-II: Protective Legislation for wildlife including preservation of their natural habitats.
Phase-III: Legislation recognizing the rights of people to a healthy environment and provision of compensation to the people affected thereof.

Unit 3: Conservation of biodiversity in protected habitats, seed banks, gene banks, germ plasma repositories, preservation for long duration.

Unit 4: Habitat restoration: restoration of wilderness and green cover, living with biological diversity.

LS-A-309Z: Field Study/Survey

Credit: 2
Marks: 50 (In=20, End=30)

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FOURTH SEMESTER (ZOOLOGY)

LS-C-401Z: PHYSIOLOGY OF REPRODUCTION

L	T	Credit: 3
24	8	Marks: 75 (In=30, End=45)

Unit 1: Gonadal steroids: Chemistry, Sexual dimorphism of brain and role of gonadal steroid. Onset of puberty-pubertal activation of hypothalamic-pituitary-testicular axis, Reproductive cycles in mammals- Estrus cycle, Major events in the menstrual cycle, Endocrine regulation of menstrual cycle, Menstrual disorders – Precocious, delayed or absent puberty; Amenorrhea, Reproductive aging

Unit 2: Physiology of implantation: Placental hormones, Hormonal profile during pre and post implantation period, hormonal control of pregnancy, parturition and lactation. Corpus luteum in pregnancy-structure and function, luteolysis. Growth factor in implantation, Reproductive health

Unit 3: Fertility and its control: Methods of fertility regulation in male and female; contraceptive devices - oral, IUD; collection and cryopreservation of gametes and embryos; superovulation, in vitro fertilization (IVF) and embryo transfer, Birth defects and prenatal diagnosis

Unit 4: Hormones and reproduction: Seasonal and continuous breeder, regulation of gonadal activity, hypothalomo -hypophysical gonadal axis; Pineal gland – Melatonin and circadian rhythmicity, Role of Pineal gland in regulation of breeding cycles in animals. Eicosanoids, structure of prostaglandin (PGF2a & PGE) and their role in reproduction, Epigenetic of reproduction

LS-C-402Z: MOLECULAR ENDOCRINOLOGY

The course on molecular endocrinology will expose the students to an understanding of relationship between neural system with peripheral endocrine system and the molecular basis of functioning of the endocrine system.

L	T	Credit: 3
24	8	Marks: 75 (In=30, End=45)

Unit 1: The information flow in the brain: Connections and synapses, the transmitter systems" Amine neurotransmitters, Amino acid neurotransmitters, Peptide neurotransmitters. 6

Unit 2: Neuroendocrine system in vertebrates: Neurosecretory centres, chemistry and physiology of hypothalamic releasing and inhibiting hormones. Regulation of secretion of hypothalamic hormones. 8

Unit 3: Neuroendocrine system in invertebrstes(insects): hormones of insect neurosecretory cells, their sources, chemistry and function. 7

Unit 4: Hormone biosynthesis: Chemistry and biosynthesis of steroid, amino acid derived and peptide hormones. 7

Unit 5: Hormone receptors-physico-chemical properties; membrance receptors: structure, signal transduction and desensitization, Activation and inhibition of adenyl cyclase mechanism of tyrosine kinase receptor action, Insulin receptor signaling and EGF receptor signaling. Structural domains, receptor binding proteins, SH2/SH3 domains. Steroid hormone receptor structure, receptor protein complexes involved in gene transcription, Positive and negative regulation of gene expression by steroid receptor/transcription factor interactions. 13

Unit 6 : Hormonal regulation of glucose, calcium, electrolyte and water homeostasis in vertebrates. Hormone agonista/antagonists. 7

LS-C-403Z: ANIMAL BEHAVIOUR

L	**T**	**Credit: 3**
24	**8**	**Marks: 75 (In=30, End=45)**

Unit 1: Evolutionary, comparative, descriptive and field oriented approach, classical ethological concepts, types of behaviour; stereotyped and instinct behavior; genetical, hormonal, nervous and environmental control of behaviour; variation: sources and factors that preserve genetic variation; natural selection and adaptation, rhythmic behaviour; biological and circadian clocks; development of behaviour; concepts of critical periods; Chronobiology and its releveance in animal survival and reproduction.

Unit 2: Orientation, communication and learning behaviour: types and mechanism of orientation, multiplicity of orientation cues. Visual, magnetic, chemical, sound and electrolocation; communication: definition and functions, channels for communicatons; learning and memory; habituation, associative learning - imprinting releasers, fixed action patterns; latent, insight and social learning.

Unit 3: Antipredatory behaviour: Crypsis, avoidance of detection through camouflage, diverting coloration, structure and behaviour, warning coloration; Aggression, intimidation and group defense.

Unit 4: Social behaviour: Evolution of social behaviour, costs and benefits of sociality;

Cooperation and altruism; Sexual behavior, mate choice and sexual conflict. Courtship behavior, parental care, offspring rearing, polygamy, polyandry and harem maintenance.

LS-C-404Z: Lab. Course on MOLECULAR ENDOCRINOLOGY & PHYSIOLOGY OF REPRODUCTION

Credit: 1.5
Marks: 37 (In=15, End=22)

1. Dissection of neuroendocrine system of cockroach, Dysdercus
2. Study of Histological preparations of endocrine gland of vertebrates
3. Standardization of solvent combination for invertebrate/vertebrate hormone detection using TLC
4. Histological preparation of testes and ovary (fish/toad/rat).
5. Determination of maturity stage in fish.
6. Study of Estrous cycle in rats.
7. Study of sperm mobility and survivality
8. Effect of hormone/ hormone analogue on Biochemical parameters in invertebrates
9. Castration and Ovariectomy in albino rat through video learning
10. Effect of certain hormones/hormone analogues on biochemical parameters in invertebrate (insects).
11. Effect of hormone on glucose/glycogen/protein in vertebrates
12. Effect of hormone on enzyme activity (phosphatase/LDH) in vertebrates.
13. Chromatographic separation of steroids/ peptides using TLC

LSC405Z: Lab. Course on ANIMAL BEHAVIOUR **Credit: 1.5**

Marks: 38 (In=15, End=23)

1. Study of habituation (learning behaviour) of mosquito/millipede/honey bee.
2. Study of coloration pattern of selected fish in relation to concealment and courtship behaviour.
3. Study of foraging behaviour and feeding rhythm of fish.
4. Study of aggressive behaviour in fish in aquarium.
5. Grooming behaviour in cockroach.
6. Effect of humidity gradient on distribution of invertebrates (woodlouse/snail/earthworm).
7. Taxis in animals:
   a) Thermotaxis in *Paramaecium.*
   b) Phototaxis in earthworm and *Paramaecium.*
   c) Geotaxis in earthworm.
   d) Chemotaxis in *Paramaecium*.
8. Behaviour project (as per course content).

DISCIPLINE SPECIFIC ELECTIVE-IV

A. BIOCHEMISTRY-IV

LS-D-406Z: PROJECT WORK **Credit: 4**

Marks: 100 (In=40, End=60)

B. FISH AND FISHERIES-IV

LS-D-406Z: PROJECT WORK **Credit: 4**

Marks: 100 (In=40, End=60)

C. ENTOMOLOGY-IV

LS-D-406Z: PROJECT WORK **Credit: 4**

Marks: 100 (In=40, End=60)

BOOKS RECOMMENDED

LS-C-401Z (Reproductive Physiology)

1. Review of Medical Physiology, Ganong . Lang.
2. Textbook of Medical Physiology, Guyton . W.B. Saunders.
3. Samson Wrights' Applied Physiology, Keele *et al* .Oxford Press.
4. Harpers' Biochemistry, Murray *et al* Appleton & Lange
5. Best & Taylor's Physiological Basis of Medical Practice, West .William & Wilkins.
6. Physiology of Reproduction Vol I & II. Knobil & Neil (ed) .Acadimic press

LS-C-402Z (Molecular Endocrinology)

1. An introduction to Neuroendocrinoloyg: Michael Wilkinson and Richard E Brown (2015), Cambridge University Press, UK
2. Introduction to Behavioral Neuroendocrinology (5^{th} edition), Randy J. Nelson and Lance J. kriegsfeld (2016) Oxford University press.
3. Progress in Molecular Biology and translational science, Vol.143 gonadotropins from benside to bedside, edited by T. Rajendra Kumar, 2016 ISBN:978-0-12-801058-7, Elsevier Inc. 2018
4. Signal transduction 3red edition, Author: Ijsbrand Kramer, ISBN: 9780123948038 Academic press, 2015

LS-C-403Z (Animal Behaviour)

1. Perspectives on Animal Behaviour: J. Goodewough, B. McGuire and R. A.Wallace, John Wiley & Sons, Inc.

2. Principles of Animal Communication: J.W. Bradburry and S.L. Veherncamp, Sunderland, MA.
3. Behavioural Ecology: An Evolutionary Approach: J.R. Kerbs and N.B. Devis, Blackwell Science.
4. Cognitive Ethology: the Minds of Other Animals – N.J. Ristau- Hillsdale, Erlbaum, NJ.
5. Animal Behaviour: Alcock, John, Sinauer Associates, Inc.: Sunderland.
6. Perspectives on Animal Behaviour: Goodenough, Judith, Hoboken, NJ: Wiley.
7. Animal Behaviour: David Mc Facfarland, English Language book Society, England
8. Animal Behaviour: R.A.Hinde, McGraw Hill, London.
9. Comparative Animal Behaviour: Dewsbury, Mc. Graw Hill N.Y.
10. Social behaviour of Vertebrates: A. Paune , Heinemann , Educational Books , London .
11. An Introduction to Animal Behaviour: T.E. Mc. Gill, Rinehart & Winston Inc. N.Y.
12. Mechanism of Animal Behaviour: E. P. Marler , John Willey & Sons

FOURTH SEMESTER (BOTANY)

LS-C-401B: TAXONOMY OF ANGIOSPERM AND PLANT IMPROVEMENT

L	T	Credit: 3
24	8	Marks: 75 (In=30, End=45)

Unit 1: Basics of Taxonomy: Concept, Aims and Principles. Systems of plant classifications: Pre and Post Darwinian systems of classifications. Taxonomic tools and museum, histological and molecular techniques. Botanical Nomenclature: ICN (formerly ICBN). Names according to rank, Author's citation, Priority, Type method.

Unit 2: A general survey of the following taxa of Angiosperms with special reference to their characteristics, interrelationships, evolutionary trends

Magnoliaceae, Tiliaceae, Meliaceae, Fabaceae, Rubiaceae, Asteraceae, Lamiaceae, Verbenaceae, Euphorbiaceae, Orchidaceae, Arecaceae, Musaceae, Cyperaceae and *Poaceae.*

Unit 3: Conventional methods of crop improvement in autogamous, allogamous and vegetatively propagated crops: selection, introduction ,acclimatization and hybridisation.

Unit 4: Non-conventional methods of crop improvement : mutation, *in vitro* culture and their application in crop improvement; concept of breeding for disease resistance; dwarfing genes and golden rice.

LS-C-402B: DEVELOPMENT AND REPRODUCTION IN ANGIOSPERM

L	T	Credit: 3
24	8	Marks: 75 (In=30, End=45)

Unit 1: Root development: organization of root apical meristem (RAM), lateral roots, root-microbe interactions.

Unit 2: Shoot development: organization of shoot apical meristem (SAM), cytological and molecular analysis of SAM, Molecular mechanism of control of vascular tissue differentiation, secondary growth, wood development in relation to environmental factors; Leaf growth and determination of phyllotaxy, Molecular mechanism of differentiation of stomata & trichomes.

Unit 3: Male gemetophyte: structure of anthers, microsporogenesis, role of tapetum, pollen embryo; female gametophyte, megasporogenesis &organization of the embryosac.

Unit 4: Apomixis, polyembryony, fruit development and parthenocarpy, embryo development.

LS-C-403B: PLANT PHYSIOLOGY

L	T	
24	**8**	**Credit: 3** **Marks: 75 (In=30, End=45)**

Unit 1: Plant Water relation : Structure and properties; Diffusion of water; Osmosis and imbibitions; Plasmolysis; Water potential, determination of water potential, determination of osmotic potential; Absorption and translocation of water, Active and passive absorption, factors affecting absorption of water, Apoplast and Symplast, Ascent of sap, Root pressure,Vital theory, Cohesion-tension theory

Unit 2: Essential elements and beneficial elements, criteria of essentiality; Physiological role of essential elements, Deficiency and toxicity symptom, Passive and active ion transport; Hydroponics and its physiological significance.

Unit 3: Photosynthesis: A brief introduction of photosynthesis and its history, pigments and structure of photosynthetic apparatus, electron transport and phosphorylation reaction, Hill reaction, photosystem I and II, red drop and Emerson enhancement effect. Photosynthetic systems: C3 , C4 , and CAM photosynthesis ,calvin cycle, Hatch and Slack pathway, CAMcycle,factors affecting photosynthesis, Source- sink relationship, concept of dry matter portioning and harvest index; Photorespiration and its relationship with photosynthesis.

Unit 4: Growth and development: Introduction, definition of growth, development and differentiation, growth phases; Physiology of flowering; Photoperiodism and vernalization; Phytochrome concept and role in flowering; Plant growth hormones: auxins, gibberellins, cytokinins, ethylene and abscissic acid, their physiological role; Seed germination and dormancy; Senescence and abscission.

LS-C-404B: Lab Course on Taxonomy of Angiosperms & Plant Improvement

Credit: 1.5

Marks: 37 (In=15, End=22)

1. Hybridization technique - Selection and preparation of parents, floral biology study, emasculation, bagging, pollination.
2. Seed testing :Purity, humus content, germination and seed borne diseases.

3. Study of pollen morphology and viability.
4. Test of goodness of fit and working out of few breeding problems.
5. Breeding importance of some common crop plants.
6. Drawing, description and identification of plant specimens from selected group of families.
7. Identification of unknown plants with the help of keys from different floras and manuals.
8. Preparation of taxonomic keys at family, generic and species level based on locally available plants.
9. Chemotaxonomic variation in plant families.
10. Molecular tools in solving taxonomic problems: RFLP/RAPD/AFLP.
11. Classification of plants based on numerical taxonomic characters.

LS-C-405B: Lab Course on Plant Physiology, Development and Reproduction in Angiosperms

Credit: 1.5

Marks: 38 (In=15, End=23)

1. Determination of water potential of plant cells.
2. Extraction of chlorophyll pigments.
3. Separation of chlorophyll a and Chlorophyll b and absorption spectrum of chlorophylls and carbotenoids.
4. Effect of different wavelength of light on photosynthesis.
5. Assay of auxins by coleoptile test/gibberlin amyrase test.
6. Effect of red and far red light on expansion of plumule/coleoptile test.
7. Respiratory Quotient (R.Q.) of different seeds.
8. Study of living shoot alpices by dissections using aquatic plants such as *Hydrilla/Ceratophyllum.*
9. Ionic inbibition on seeds.
10. Nature of inbibition of different types of seeds.
11. Study of cytological zonation in SAM in sectioned and double stained permanent slides of a suitable plant like *Coleus*/tobacco.
12. Microscopic examination of vertical sections of leaves of C_3 and C_4 plants.
13. To study the secondary growth in T.S. and double stained permanent slides of the stems of *Amaranthus* & *Mirabilis*.
14. To study the 77inha77n77tion of RAM in L.S. of root in suitable plants like *Pistia/Jussaea* etc.

15. Study of microsporogenesis and gametogenesis in sections of anthers.
16. Study of ovules and placentation in cleared preparations; study of embryo sacs through permanent slides.
17. Field study of several types of flower with different pollination mechanism.

DISCIPLINE SPECIFIC ELECTIVE

LS-D-406B: D. Plant Ecology-IV
Project Work **Credit:4, Marks: 100 (In=40, End=60)**

LS-D-406B: E. Cytogenetics & Crop Improvement-IV
Project Work **Credit:4, Marks: 100 (In=40, End=60)**

LS-D-406B: F. Microbiology-IV
Project Work **Credit:4, Marks: 100 (In=40, End=60)**

LS-D-406B.G: Angiosperm Systematics – IV
Project Work **Credit-4, Marks: 100 (In=40, End=60)**

The students will choose a topic in consultation with the course teacher and will complete the project work. He/she will have to prepare and submit a project work and will have to present it during submission.

BOOKS RECOMMENDED: (LSC401-405)

28. Alexopoulus – Introductory mycology, Willey.
29. Anatomy of Dicolyledons Vol. I & II. – C.R. Metcaff.
30. Arnold – An Introduction to Paleobotany, McGraw Hill.
31. Bessey – Morphology and taxonomy of fungi, Hafner. Pub. Company.
32. Bower – Primitive land plants, Macmillan.
33. Butler & Jones – Plant pathology, Macmillan.
34. Campbell – Evolution of lands plants, Standford Univ. Press.
35. Chapman – Introduction to study of Algae, Macmillan.
36. Cochrane – Physiology of fungi, Willey.
37. Coulter & Chamberlain – Morphology of Gymnosperms, Chicago Uni. Press.
38. Eames – Morphology of vascular plants, McGraw Hill.
39. Experimental embryology: Embryogenesis in vascular plants – V. Raghavan.
40. Families of flowering plants Vol. I & II, by J.Hutchinsons, Mc Millan,London, 1967.
41. Fritsch: Structure and reproduction in Algae, Vol. I & II. Cambridge University Press.
42. Gwynee 78inha78n & Barnes – The structure and development of fungi, Cambridge University.
43. Jaiswal (Edited) – Hand book of agriculture, ICAR, New Delhi.

44. Kakkan & Kakkan – The Gymnosperms (Fossils & Living), Central Pub.House.

45. Mukherjee, Das, Ganguly – College Botany Vol. II, Central Book Depot.
46. Principles of Angiosperm Taxonomy – by P.H. Devid & V.H. Heywood, Oliver & Beyd, London, Scott – Fossil Botany, Vol. I & II.
47. Singh – Plant diseases, Oxford & IBH.
48. Smith – Cryptogamic Botany Vol. I & II. Mc Graw Hill.
49. Taxonomy of vascular plants – by H.M.G. Lawrence, Mc Millan, N.Y., 1964.
50. Walker – Plant pathology, Hill.
51. Watson – Bryophyta, Hutchinson Univ. Library.
52. Transport in Plants – Vol. 1-3 – Simmerman
53. Plant Physiology – Pandeya & 79inha
54. An Introduction to Plant Physiology – R. Sharma

GENERIC ELECTIVE

(To be opted by students of other departments)

LIF-GE-208.A: NUTRITION AND HEALTH

(To be offered in even semesters)

Credit: 4

Marks: 100 (In=40, End=60)

Unit 1: Basic concept of nutrition and health

Concept of a balanced diet, nutrient needs and dietary pattern for various groups-adults, pregnant and nursing mothers, infants, school children, adolescents and elderly & Introduction to health

Unit 2: Health

Concept of health, Major nutritional Deficiency diseases- Protein Energy Malnutrition, Vitamins deficiency disorders, Iron deficiency disorders, Iodine deficiency disorders- their causes, symptoms, treatment, prevention and government programmes, if any.

Unit-3: Common ailments- cold, cough, and fevers, their causes and treatment

Life style related diseases- obesity, hypertension, anxiety & diabetes mellitus- causes and prevention through dietary and lifestyle modifications

Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS) - their causes, treatment and prevention

Unit 4: Hygiene

Potable water- sources and methods of purification at domestic level

Food and Water borne infections: Bacterial disease: Cholera, typhoid fever, dysentery; Viral: Hepatitis, Protozoan: amoebiasis, Parasitic: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention

PRACTICLA Course on NUTRITION AND HEALTH

1. Identify nutrient rich sources of foods (fruits and vegetables), their seasonal availability
2. Calculation of BMI and blood pressure
3. Estimation of ascorbic acid
4. Calculation of calories in different food items.

SUGGESTED BOOKS

- Mudambi, SR and Rajagopal, MV. Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; 2007; New Age International Publishers
- Srilakshmi B. Nutrition Science; 2002; New Age International (P) Ltd.
- Srilakshmi B. Food Science; Fourth Ed; 2007; New Age International (P) Ltd.
- Swaminathan M. Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.
- Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; 2009; Oxford & IBH Publishing Co. Pvt Ltd.
- Wardlaw GM, Hampl JS. Perspectives in Nutrition; Seventh Ed; 2007; McGraw Hill.
- Lakra P, Singh MD. Textbook of Nutrition and Health; First Ed; 2008; Academic Excellence.
- Manay MS, Shadaksharaswamy. Food-Facts and Principles; 1998; New Age International (P) Ltd.

Generic Elective Course LIF-GE-208.B: PLANT TISSUE CULTURE

(To be offered in even semesters)

Credit: 4

Total: 100 (In=40, End=60)

Unit 1: *In vitro* culture technique in plants: principles explant selection, various types of media, macro & micronutriteints, culture conditions

Unit 2: Aspetic manipulation of *in vitro* culture technique: principles, sterilisation of explants, glassware, media, sterilisation of culture area

Unit 3; Applied aspects of tissue culture technique: artificial seeds, transgenic plants, mass cultivation, somaclonal variation, somatic embryogenic, haploidy, protoplast fusion

Unit 4: advantages of in vitro culture techniques, application of plant tissue culture in crop improvement and economy of the country. *In vitro culture* technique & rDNA technology

Practicalcourse on Plant Tissue Culture

Sterilization of tools to be used in tissue culture lab

Media preparation: various media used in invitro culture techniques, sterilization, use of plant growth hormone

Micropropagation of endemic plants of Northeast India, embryo culture, pollen culture

Generic Elective Course
LIF-GE-308: COMPUTATIONAL BIOLOGY

(To be offered in Odd semester)

Total Credit: 4

Marks: 100 (In=40, End=60)

Unit-1

Introduction to Biological Macromolecules: DNA, RNA, Protein, their structures and functions; DNA Replication, Central Dogma of Molecular Biology

Unit-2

Definition and scope of Computational Biology and Bioinformatics; Major Biological Databases and Information Retrieval

Unit-3

Mutation and mutation patterns, Homology Concept and Alignment of of sequences. Phylogenetic analysis: Definition and description of phylogenetic trees, Basics of computational phylogenetic analysis. Computational gene prediction methods

Unit-4

Properties of amino acids and peptide bonds, Ramachandran Plot. Motifs and Folds; Protein structure related databases, Protein. Protein structure prediction methods, Homology modeling. Basics of Computer Aided Drug Designing, Principles of Pharmacokinetics and Pharmacodynamics: ADME, Bioavailability of drugs - Lipinski's rule; Molecular Docking and QSAR

Practical Course on COMPUTATIONAL BIOLOGY

1. Searching for similar sequences using BLAST/ FASTA.
2. Multiple Sequence Alignment using Clustal-w, Clustal-x
3. Construction of Phylogenetic Tree using PHYLIP / MEGA
4. ADME/Tox screening of Ligands
5. Study of protein-ligand interaction using Molecular Docking tools
6. Prediction of Bioactivity using QSAR

Suggested Readings

1. Bioinformatics: Sequence and Genome Analysis by Mount D.
2. Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F.
3. Bioinformatics: A Students Companion by Borah, P. *et al.*
4. Fundamentals of Molecular Evolution by Graur, D. and Li, W-H.
5. Molecular Modelling: Principles and applications by Leech Andrew
6. Molecular Modelling for Beginners by Hinchliffe Alan

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