



DIBRUGARH

UNIVERSITY

DEPARTMENT OF LIFE SCIENCES; DIBRUGARH-04 ASSAM, INDIA

OUTLINE OF POST GRADUATE SYLLABUS (CBCS MODE) passed in BOS held 08.04.2019

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

Course	Course code	Course Name	C	M
Core course- I	LSC101	Biological Chemistry & Molecular Biology	4	100
Core course- II	LSC102	Cell Biology & Genetics	4	100
Core course- III	LSC103	Techniques in Biology, Biostatistics & Bioinformatics	4	100
Core course- IV	LSC104	Lab. Course: Biological Chemistry, Molecular Biology and Techniques in Biology	2	50
Core course- V	LSC105	Lab. Course: Cell Biology, Genetics, Biostatistics & Bioinformatics	2	50
Discipline Specific Elective- I <i>Zoology Students may choose any one option from A, B and C. Botany Students may choose any one option from D, E and F. Option once selected, will not be allowed to change in subsequent semesters.</i>	LSD106	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		
	LSD107 Lab course:	A. Lab course based on DSE106 A	2	50
		B. Lab course based on DSE106 B		
		C. Lab course based on DSE106 C		
		D. Lab course based on DSE106 D		
		E. Lab course based on DSE106 E		
		F. Lab course based on DSE106 F		
Ability Enhancement Course	LSA108	Biodiversity Conservation/ Public Health Entomology	2	50

Total Credits =24

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

Course	Course code	Course Name	C	M	
Core course- VI	LSC201	Environmental Biology & Microbiology	4	100	
Core course- VII	LSC202	Toxicology, Pest Management and Bioethics & IPR	4	100	
Core course- VIII	LSC203	Taxonomy, Evolution & Biodiversity	4	100	
Core course- IX	LSC204	Lab. Course: Environmental Biology, Microbiology	2	50	
Core course- X	LSC205	Lab. Course: Toxicology, Pest Management and Taxonomy & Evolution	2	50	
Option selected in first semester will be continued in second semester.	LSD206	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: Applied Microbiology		
	LSD207 Lab course:	A.	Lab course based on LSD-206 A	2	50
		B.	Lab course based on LSD-206 B		
		C.	Lab course based on LSD-206 C		
		D.	Lab course based on LSD-206 D		
		E.	Lab course based on LSD-206 E		
		F.	Lab course based on LSD-206 F		
Generic Elective- I	GE208	GE-I	4	100	

Total Credits = 26

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

Course	Course code	Course Name		C	M
Core course- XI	LSC301Z	Animal Physiology		3	75
Core course- XII	LSC302Z	Immunology		3	75
Core course- XIII	LSC303Z	Developmental Biology		3	75
Core course- XIV	LSC304Z	Lab. Course: Animal Physiology & Immunology		1.5	37.5
Core course- XV	LSC305Z	Lab. Course: Developmental Biology		1.5	37.5
Discipline Specific Elective- III Option selected in first semester will be continued in third semester.	LSD306Z	A.	Biochemistry-III: Molecular Biology	4	100
		B.	Fish & Fisheries-III: Fish technology, Economics and Extension		
		C.	Entomology-III: Insect Ecology and Applied Entomology		
	LSD307Z Lab course:	A.	Lab course based on LSD306Z A	2	50
		B.	Lab course based on LSD306Z B		
		C.	Lab course based on LSD306Z C		
Generic Elective- II	GE308	GE-II		4	100
Ability Enhancement Course- II	LSA309Z	Field Study		2	50

Total Credits = 24

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

Course	Course code	Course Name	C	M	
Core course- XI	LSC301B	Mycology & Plant Pathology	3	75	
Core course- XII	LSC302B	Algae & Bryophytes	3	75	
Core course- XIII	LSC303B	Pteridophyte & Gymnosperm	3	75	
Core course- XIV	LSC304B	Lab. Course: Mycology, Plant Pathology and Algae	1.5	37.5	
Core course- XV	LSC305B	Lab. Course: Bryophyte, Pteridophyte & Gymnosperm	1.5	37.5	
Discipline Specific Elective- III Option selected in first semester will be continued in third semester.	LS306B	D.	Plant Ecology-III: Applied Plant Ecology	4	100
		E.	Genetics & Crop improvement – III: Advanced Cytogenetics		
		F.	Microbiology-III: Molecular Microbiology		
	LSD307B Lab course:	D.	Lab course based on LSD306B D	2	50
		E.	Lab course based on LSD306 E		
		F.	Lab course based on LSD306B F		
Generic Elective- II	GE308	GE-II	4	100	
Ability Enhancement Course- II	LSA309B	Field Study	2	50	

Total Credits = 24

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

Course	Course code	Course Name	C	M
Core course- XVI	LSC401Z	Reproductive Physiology	3	75
Core course- XVII	LSC402Z	Molecular Endocrinology	3	75
Core course- XVIII	LSC403Z	Animal Behaviour	3	75
Core course- XIX	LSC404Z	Lab. Course: Molecular Endocrinology	1.5	37.5
Core course- XX	LSC405Z	Lab. Course: Reproductive Physiology & Animal Behaviour	1.5	37.5
DSE IV: Project Work	LSD406Z	A. Biochemistry-IV	4	100
Option selected in first semester will be continued in fourth semester.	LSD406Z	B. Fish & Fisheries- IV	4	100
		C. Entomology- IV	4	100

Total Credits=16

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

Course	Course code	Course Name	C	M
Core course- XVI	LSC401B	Taxonomy of Angiosperm and plant improvement	3	75
Core course- XVII	LSC402B	Development and Reproduction In Angiosperms	3	75
Core course- XVIII	LSC403B	Plant Physiology	3	75
Core course- XIX	LSC404B	Lab. Course: Taxonomy of Angiosperm and plant improvement	1.5	37.5
Core course- XX	LSC405B	Lab. Course: Plant Physiology , Development and Reproduction In Angiosperms	1.5	37.5
DSE IV: Project Work	LSD406B	D. Plant Ecology- IV	4	100
Option selected in first semester will be continued in fourth semester.	LSD406B	E. Cytogenetics & Plant Breeding-IV	4	100
		F. Microbiology- IV	4	100

Total Credits=16

Generic Elective Courses (To be opted by students of other departments)

LSG-1: Health and Nutrition

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

FIRST SEMESTER

LSC101: BIOLOGICAL CHEMISTRY & MOLECULAR BIOLOGY

L	T	Credit: 4
48	16	Marks: 100

Section-A

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.

Unit 2: 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); photochemical reaction in chloroplast and carbon fixation reaction.

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

Section-B

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; Structural and regulatory genes, 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).

LSC102: CELL BIOLOGY & GENETICS

L **T** **Credit: 4**
48 **16** **Marks: 100**

Section-A

Unit 1: Molecular organization of plasma membrane; Membrane lipids & Membrane fluidity, Membrane transport: diffusion, facilitated diffusion, active transport; Carriers & Channel Proteins; Electrical properties of plasma membrane; Dynamics of microfilaments, Role of actin & microtubule cytoskeleton in cell shape, intracellular motility, mitosis & locomotion, Functions of intermediate filaments.

Unit 2: Cellular communication: cell adhesion and roles of different adhesion molecules; Cell signalling; signalling molecules, receptors, second messengers, mechanism of signal transduction, Cell-cycle: phases of cell cycle, checkpoints and regulators of cell cycle progression, Programmed cell death

Unit 3: Protein sorting and transport to the endoplasmic reticulum, Golgi body and lysosomes; Protein glycosylation within Golgi body and protein secretion; Carcinogens and mechanisms of carcinogenesis, Properties of cancer cells, tumor viruses, oncogenes and suppressor genes

Section-B

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, autopolyploidy and allopolyploidy, 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, eugenics, eugenics and euphenics; Genetic counselling; Basic idea on human genome project (HGP), genomic library and gene targeting.

LSC103 : TECHNIQUE IN BIOLOGY, BIOSTATISTICS & BIOINFORMATICS

L T Credit: 4
48 16 Marks: 100

Section-A

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

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 modelling. Basics of Computer Aided Drug Designing, Drug-target interaction: Molecular Docking and QSAR.

LSC104: Lab. Course on BIOLOGICAL CHEMISTRY, MOLECULAR BIOLOGY & TECHNIQUE IN BIOLOGY

Credit: 2

Marks: 50

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 K_m .
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.

LSC104: Lab. Course on CELL BIOLOGY, GENETICS, BIOSTATISTICS & BIOINFORMATICS

Credit: 2

Marks: 50

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

DISCIPLINE SPECIFIC ELECTIVE

LSD106: A. BIOCHEMISTRY-I

INTERMEDIARY METABOLISM

Credit: 4

Marks: 100

- Unit 1: Types and features of biochemical reactions. Bioenergetics: 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, Krebs'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.
- Unit 4: Metabolism of amino acids phenylalanine, histidine, tryptophan and Arginine.
- Unit 5: Metabolism of Purines and Pyrimidines, its regulation.
- Unit 6: Interrelationship of carbohydrate, lipid and protein metabolism, Inborn errors of metabolism.

LSD106: B. FISH & FISHERIES-I

FISH BIOLOGY

Credit: 4

Marks: 100

- 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

LSD106: C. ENTOMOLOGY-I

INSECT DIVERSITY AND EVOLUTION

Credits: 4

Marks: 100

1. Introduction to insects: Morphology, External features.
2. Classification of insect: Basis of insect classification upto orders. Origin and evolution of insects, modern concept of insect identification.
3. Classification of economically important groups upto super family/family
4. Comparative study of head, antennae, mouthparts.
5. Comparative study of legs, wings, abdominal appendages, genitalia
6. Insect societies : Groups of social insects and their societies , honey bees, aphids

LSD106: D. PLANT ECOLOGY-I

PRINCIPLES AND CONCEPTS OF PLANT ECOLOGY

Credit: 4

Marks: 100

- 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 phenological 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 phytogeography; endemism: concept, age and area hypothesis, endemic flora of the world with special reference to India, plant migration and barriers.

LSD106: E. CYTOGENETICS AND CROP IMPROVEMENT-I
GENETICS & CYTOGENETICS

Credit: 4

Marks: 100

Unit1: Cell theory and exceptions, Gross structure and chemistry of eukaryotic 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, CO₂ sensitivity in Drosophila, plastid inheritance and male sterility in plants, organeller genetics - episomes, mitochondria and chloroplast.

LSD106: F. MICROBIOLOGY-I

MICROBIOLOGY

Credit: 4

Marks: 100

- 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 of carbohydrate breakdown (EMP-pathway, HMP shunt, Entner-Doudorff (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.

LSD107: A. Lab Course on BIOCHEMISTRY-I

Credit: 2

Marks: 50

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.

LSD107: B. Lab Course on FISH AND FISHERIES-I

Credit: 2

Marks: 50

1. Identification of locally available fishes.
2. Study of museum specimens.
3. Dissection:
 - (a) Cranial nerves (5th, 7th, 9th & 10th) 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.

LSD107: C. Lab Course on ENTOMOLOGY-I

Credit: 2

Marks: 50

1. Study of mouth part of grasshopper, mosquitoes, house flies, butterflies
2. Mounting of different types of legs and antenna of insects
3. Study of sting apparatus of honey bee
4. Identification of exopterygote insects
5. Identification of endopterygote insects
6. Study of different castes of termites/aphids (social insect)
7. Submission of insects of different orders

LSD107: D. Lab Course on PLANT ECOLOGY-I

Credit: 2

Marks: 50

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.

LSD107: E. Lab Course on GENETICS AND CROP IMPROVEMENT-I

Credit: 2

Marks: 50

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. Study 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).

LSD107: F. Lab Course on Microbiology-I

Credit: 2

Marks: 50

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

ABILITY ENHANCEMENT COURSE (AEC-1)
LSA108: A. BIODIVERSITY CONSERVATION

Credit: 2

Marks: 50

Unit 1: Scope and dimension of biodiversity conservation; the biodiversity concept, megadiversity countries of the world, reduction in biological diversity; the present scenario

Unit 2: Monitoring and documentation of biodiversity; measuring biodiversity: Biodiversity indices (Shannon-Weiner, Margaleff and Simpson biodiversity indices)

Unit 3: Conservation of biological diversity: Environmental education, Environment and law, IUCN status, Biological convention, Protected habitats, Seed Banks, Gene Banks, germplasm repositories, preservation for long duration, restoration of wilderness and green cover, living with biological diversity

Unit 4: Sustainable utilization of biodiversity: value of biodiversity; as natural resources, genetic resources, instrumental resources, means of abiotic resource optimization

LSA108: B. PUBLIC HEALTH ENTOMOLOGY

Credit: 2

Marks: 50

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):
LSC101 (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

LSC102: 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 the gene .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.

LSC103 (Techniques in Biology, Biostatistics & 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. Principles & 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.

LSD106 (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.

LSD106 (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.

LSD106 (C. Entomology-I)

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. Whitfield, J. B. and A. H. Purcell III. 2014. Daly and Doyen's Introduction to Insect Biology and Diversity. 3rd Edition. Oxford University Press, Oxford, UK.

LSD106 (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.

LSD106 (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)

LSD106 (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 by C.B. Power and H.E. Dagainawala ;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 manual of Systematic Bacteriology, 2nd Edition.
10. Bergey's manual of Determinative 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. Prescott 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.

LSA-108 (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

LSA108 AEC (Ability enhancement course)

Public Health Entomology

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

SECOND SEMESTER

LSC201: ENVIRONMENTAL BIOLOGY & MICROBIOLOGY

Credit: 4

Marks: 100

Section-A

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

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;

Section-A

2 credits

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

Unit 4: Bioethics and IKS: Historical perspectives of bioethics; Conflicting issues (GMO, GMP, Cloning, Environmental hazards); Principles and guidelines for research in animals and human; Intellectual Property Rights and their types; Indigenous knowledge system, biopiracy.

Unit 5: Agreement and treaties : GATT & TRIPs Agreement, Madrid Agreement, Hague Agreement , WIPO Treaties, Indian Patent Act 1970 and recent amendment. Patent cooperation treaty, Patent filing procedure.

Unit-6: Overview of Intellectual Property Rights: Introduction and need of IPR; IPR in India and abroad. Role of IPR in modern Biotechnological research. Patents, Copyright, Trademarks and Geographical Indications. Process of patenting.

LSC203: TAXONOMY, EVOLUTION & BIODIVERSITY

Credit: 4

Marks: 100

Section-A

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

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: Lab Course on ENVIRONMENTAL BIOLOGY AND MICROBIOLOGY

Credit: 4

Marks: 100

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, PEST MANAGEMENT, TAXONOMY & EVOLUTION, BIODIVERSITY

Credit: 4

i. Marks: 100

2. Estimation of LD50 and LC 50 using synthetic pesticides
3. Demonstration of essential oil production using Clevenger apparatus
4. Estimation of LC 50 using plant based essential oil
5. Pesticide residue analysis of contaminated soil, vegetable and water using TLC/GLC/HPLC.
6. Submission of brief report on pest management techniques based on survey at farmer/manager's level
7. Plotting of dosage-response curve
8. Determination of LC 50/ LD 50 of insecticide against Mosquitoes/stored grain pest/ cockroach.
9. Study of pesticidal property of plants /essential oil with respect to insect/fish.
10. Toxic action of insecticide on enzymes of honey bees/silkworms
11. Data collection with respect to traditional knowledge (Preparation of questionnaire, interaction with knowledge holder and report submission as assignment).
12. Morphotaxonomy and chemotaxonomy of closely related plants.
13. Numerical Taxonomic classification of plants / fishes.
14. Comparision of hemin crystals of fish and amphibia.
15. Study of important flora (Orchids, aromatic and medicinal plants) of the region.

16. Study of common animal species of the region.
17. Study of terrestrial habitat (Soil type, moisture content, pH, porosity, organic matter).
18. Study of Aquatic habitat (Depth, suspended and dissolved solids, pH, substrate and bank type).
19. Estimation of biodiversity by Shannon, Margaleff and Simpson's biodiversity index.

DISCIPLINE SPECIFIC ELECTIVE –II

LSD206: A. BIOCHEMISTRY –II

PROTEIN CHEMISTRY & ENZYMOLOGY

Credit: 4

Marks: 100

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

LSD206: B. FISH & FISHERIES-II

CAPTURE FISHERIES AND AQUACULTURE

Credit: 4

Marks: 100

- 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

INSECT PHYSIOLOGY

Credit: 4

Marks: 100

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

Unit 2: Insect hormones: chemistry, synthesis, degradation, mechanism of action; Hormonal control of growth, metamorphosis, osmoregulation. Diapause and its regulation.

Unit 3: Digestive and excretory system; Structure and modifications. Salivary and other digestive secretions, physiology of digestion and excretion

Unit4: Respiratory and reproductive system: Tracheal system and gaseous exchanges, aquatic respiration; Male and female reproductive systems, hormonal control of reproduction, special types of reproductions

Unit 5: Insect blood: Cell types and structure, plasma composition, insect immunity: cellular and humoral immunity, signalling in immune response to pathogenesis.

Unit 6: 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

LSD206: D. PLANT ECOLOGY -II

HABITAT ECOLOGY

Credit: 4

Marks: 100

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

Credit: 4

Marks: 100

- 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

Credit: 4

Marks: 100

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, pathogenicity, 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).

LSD207: A. Lab Course on BIOCHEMISTRY-II

Credit: 2

Marks: 50

1. Estimation of protein by Bradford method.
2. Estimation of amino acids
3. Determination of pK and I^{PH} of amino acids.
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. Lab Course on FISH AND FISHERIES-II

Credit: 2

Marks: 50

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.

LSD207: C. Lab Course on ENTOMOLOGY-II

Credit: 2

Marks: 50

1. Dissection of alimentary canal of honey bee, Red cotton bug / Dissection of male and female reproductive system in moths
2. Dissection of stomatogastric nervous system in cockroach, bacterial chamber in termite
3. salivary gland of mosquito, silk worm and hypopharyngeal gland of honey bee
4. Study of haemocytes, hemocyte count
5. Protein extraction and estimation in haemolymph
6. Protein profile in haemolymph by gel electrophoresis
7. Qualitative estimation of uric acid in malpighian tubule
8. Qualitative estimation of chitin in integument

LSD207: D. Lab Course on PLANT ECOLOGY-II

Credit: 2

Marks: 50

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. Lab Course on GENETICS AND CROP IMPROVEMENT-II

Credit: 2

Marks: 50

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. Lab Course on Microbiology-II

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

GENERIC ELECTIVE

GE208

Credit-4

Marks: 100

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

BOOKS RECOMMENDED (Latest editions)

LSC201 (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's Manual of determinative Bacteriology (9th edition)
8. Microbiology by P.D.Sharma .Rastogi Publications.

LSC203 (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

LSC201 (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. Fundamentals of Ecology - by E.P. Odum.
6. General Animal Ecology by Ananthkrishnan, T.K. and T.R. Viswanathan (1978).
7. Climate and Plant Distribution – Woodward
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 Agriculture – 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 Environmental Sciences- by R.K. Trivedy.

LSC203 (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 Woodruffed.
14. Wildlife Management in India – Hosetti

LSC202 (Toxicology, pest management and 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 Kuhr, 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, UK
6. Metabolic pathways of agrochemicals Part II, Roberts, T. R., and Hutson, D. H. The Royal Society of Chemistry, UK

LSD206 C. Entomology-II (Insect Physiology)

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

1. Respiration in vertebrates, respiratory pigments; exchange and transport of gases, mechanism of breathing in mammals. Structure, type and function of nephron; 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

- Unit 1: Types of immunity: innate and acquired immunity, active and passive immunity, primary and secondary 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, haptans, adjuvants, 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

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; *in 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: Lab. Course on ANIMAL PHYSIOLOGY & IMMUNOLOGY

Credit: 1.5

Marks: 37.5

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: Lab. Course on DEVELOPMENTAL BIOLOGY

Credit: 1.5

Marks: 37.5

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 cleavage (S.S.), gastrula(S.S.), neural food (T.S), tadpole(W.M.), embryo 7mm (S.S.), embryo 4mm (W.M.),tadpole 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

- Unit1: Organisation of DNA in chromosomes, Molecular structure, physico chemical properties of DNA, DNA-replication, DNA polymerase in Prokaryotes and Eukaryotes, DNA sequencing, satellite DNA, Palindrome sequences, repetitive DNA.
- Unit2: Organisation of gene in Prokaryotes and Eukaryotes; Split genes, Overlapping 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 Prokaryotes 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

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

Unit 1: Ecology and biodiversity of insects: Insect biodiversity and their functioning in terrestrial ecosystem. Insect population dynamics (growth pattern, dispersal), factors influencing dispersal and succession

Unit 2: Insect –plant interaction: Concept of co-evolution between plant and insects. Plant allelochemicals, host plant selection by insect, chemosensory basis of host plant selection, odour detection, olfactory signalling pathway, molecular basis of odour coding

Unit 3: Tritrophic interactions, host plant response to herbivory :Lipoxygenase, Mevanolate, Shikimic acide pathway. Plant resistance to insect, mechanism and types, non-preference, antibiosis, antixenosis, tolerance.

Unit 4: Pest definition, classification of pest, type of distribution (random, clumping, aggregate), estimation of intensity of pest damage and yield loss; economic injury level, economic threshold level , pest monitoring and sampling , Concepts of integrated pest management, Biological control, Basic concept in Entomopathogens (*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

Unit 5: Importance of microorganism to recombinant DNA technology, DNA replication , Transcription, Restriction enzymes , PCR, 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

Unit 6: 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.

LSD307Z : A. BIOCHEMISTRY-III (MOLECULAR BIOLOGY)

Credit: 2

Marks: 50

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. Immunodiffusion and Immunoelectrophoresis

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

Credit: 2

Marks: 50

1. Induced breeding experiment in fish.
2. Histological study of guts/gonads
3. Preparation of fish feed 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. Lab Course on ENTOMOLOGY-III

Credit: 2

Marks: 50

1. Collection and identification of insects of economic importance
2. Collection and identification of agricultural insect pests
3. Identification of mosquitoes: morphological and molecular
4. Determination of insect population density by random collection method
5. Determination of insect population by line transect method
6. LC50 determination of insecticide by using probit analysis
7. Analysis of protein, fat and carbohydrate in edible insects
8. Development of insecticide/repellent formulation

GENERIC ELECTIVE-II

GE-308:

Credit: 4

Marks: 100

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

ABILITY ENHANCEMENT COURSE-II

LSA309Z: FIELD STUDY

Credit: 2

Marks: 50

BOOKS RECOMMENDED:

LSC301Z (Animal Physiology)

1. Respiratory Physiology of Vertebrates by Goran E. Nilsson. Cambridge University Press.
2. Text book of Medical Physiology, Guyton & Hall .Saunders
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 (4th 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

LSC302Z (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.

LSC303Z (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.

LSD306Z: C. ENTOMOLOGY-III

Insect Ecology and Applied Entomology

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)

LSC301B: MYCOLOGY & PLANT PATHOLOGY

L	T	Credit: 3
24	8	Marks: 75

- Unit 1: Fungi: Cell structure, flagella, cell wall composition, diversity in thallus structure, reproduction, reproductive structures and sexuality, parasexuality, classification; economic importance of fungi: medicine, industry, food, mycorrhiza, fungi as biocontrol agents
- 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. Physiology of parasitism: Role of enzymes, toxins and genetics on disease development
- Unit 4: Plant disease management: Regulatory, cultural, physical, chemical, 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.

LSC302B: ALGAE & BRYOPHYTE

L	T	Credit: 3
24	8	Marks: 75

- Unit 1: Algae: Cell Structure, flagella, pigments and their distribution, pyrenoids and eye spots, diversity in thallus organization; Algal food reserve types.
- 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.

LSC303B: PTERIDOPHYTES AND GYMNOSPERMS

L T Credit: 3
24 8 Marks: 75

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). *Lycopsidea*, *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

LSC304B: Lab Course on Mycology, Plant Pathology and Algae

Credit: 1.5

Marks: 37.5

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*, *Batrachosporium*, *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, semipermanent /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)

LSC305B: Lab Course on Bryophyte, Pteridophyte & Gymnosperm

Credit: 1.5

Marks: 37.5

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*, *Cryptomeria*, *Ephedra*, *Gnetum*.
4. Hybridization technique - Selection and preparation of parents, floral biology study, emasculation, bagging, pollination.
5. Seed testing :Purity, humus content, germination and seed borne diseases.
6. Study of pollen morphology and viability.
7. Test of goodness of fit and working out of few breeding problems.
8. Breeding importance of some common crop plants.
9. Working out the detailed morphology (vegetative and reproductive parts) and the phylogenetic relationship of *Ageratum*, *Cassia*, *Crotolaria*, *Euphorbia*, *Eupatorium*, *Kyllinga*, *Chrysopogon*, *Leotiutrus*, *Leomens*, *Mikania* and *Verbena*.

BOOKS RECOMMENDED: (LSC301-305)

1. Alexopoulos - 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

LSD306B: D. Plant Ecology-III

APPLIED PLANT ECOLOGY

Credit: 4

Marks: 100

- 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 adhoc 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, azadirachtin, reserpine, vasicine etc.) , their antioxidant and antimicrobial activity.

LSD306B: E. Genetics & Crop Improvement

MOLECULAR GENETICS

Credit: 4

Marks: 100

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 (T_m ; DNA- DNA hybridization technique, cot value); Organization of genome (Satellite DNA; repetitive 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 (initiation, 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;

LSD306B: F. Microbiology-III

MOLECULAR MICROBIOLOGY

Credit: 4

Marks: 100

Unit 1: 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 (T_m ; DNA- DNA hybridization technique, cot value); Organization of genome (Satellite DNA; repetitive 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 (initiation, 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.

LSD307B: D. Lab Course on PLANT ECOLOGY-I

Credit: 2

Marks: 50

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.

LSD307B: E. Lab Course on Genetics & Crop Improvement-III

Credit: 2

Marks: 50

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

LSD307B: F. Lab Course on Microbiology-III

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

GENERIC ELECTIVE

GE-308

Credit: 4

Marks: 100

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

ABILITY ENHANCEMENT COURSES

LSA309B: Field Study (Credit-2, Marks: 50)

FOURTH SEMESTER (ZOOLOGY)

LSC401Z: REPRODUCTIVE PHYSIOLOGY

Credit: 3

Marks: 75

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, hypothalamo -hypophysial gonadal axis; Pineal gland –Melatonin and circadian rhythmicity, Role of Pineal gland in regulation of breeding cycles in animals. Eicosanoids, structure of prostaglandin (PGF_{2a} & PGE) and their role in reproduction, Epigenetic of reproduction

LSC402Z: MOLECULAR ENDOCRINOLOGY

Credit: 3

Marks: 75

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

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

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

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

Unit 5: Hormone receptors-physico-chemical properties; membrane receptors: structure, signal transduction and desensitization, Activation and inhibition of adenylatecyclase 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

Unit6. Hormonal regulation of glucose, calcium, electrolyte and water homeostasis in vertebrates. Hormone agonists/antagonists.

LSC403Z: ANIMAL BEHAVIOUR

Credit: 3

Marks: 75

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 relevance 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 communications; 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.

LSC404Z: Lab. Course on MOLECULAR ENDOCRINOLOGY

Credit: 1.5

Marks: 37.5

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. Extraction, purification and detection of JH using HPLC
5. Extraction, purification and detection of ecdysone using HPLC

**LSC405Z: Lab. Course on REPRODUCTIVE PHYSIOLOGY and
ANIMAL BEHAVIOUR**

Credit: 1.5

Marks: 37.5

1. Histological preparation of testes and ovary (fish/toad/rat).
2. Determination of maturity stage in fish.
3. Castration in albino rat.
4. Ovariectomy in albino rat.
5. Study of Estrous cycle in rats.
6. Study of sperm mobility and survivality
7. Study of habituation (learning behaviour) of mosquito/millipede/honey bee.
8. Study of coloration pattern of selected fish in relation to concealment and courtship behaviour.
9. Study of foraging behaviour and feeding rhythm of fish.
10. Study of aggressive behaviour in fish in aquarium.
11. Grooming behaviour in cockroach.
12. Effect of humidity gradient on distribution of invertebrates (woodlouse/snail/earthworm).
13. Taxis in animals:
 - a) Thermotaxis in *Paramecium*.
 - b) Phototaxis in earthworm and *Paramecium*.
 - c) Geotaxis in earthworm.
 - d) Chemotaxis in *Paramecium*.
14. Behaviour project (as per course content).

DISCIPLINE SPECIFIC ELECTIVE-IV

A. BIOCHEMISTRY-IV

LSD-406Z: PROJECT WORK

Credit: 4

Marks: 100

B. FISH AND FISHERIES-IV

LSD-406Z: PROJECT WORK

Credit: 4

Marks: 100

C. ENTOMOLOGY-IV

LSD-406Z: PROJECT WORK

Credit: 4

Marks: 100

BOOKS RECOMMENDED

LSC401Z (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) .Academic press

LSC402Z (Molecular Endocrinology)

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

LSC403Z (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)

LSC401B: TAXONOMY OF ANGIOSPERM AND PLANT IMPROVEMENT

L	T	Credit: 3
24	8	Marks: 75

- 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.

LSC402B: DEVELOPMENT AND REPRODUCTION IN ANGIOSPERM

L	T	Credit: 3
24	8	Marks: 75

- 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 gametophyte: structure of anthers, microsporogenesis, role of tapetum, pollen embryo; female gametophyte, megasporogenesis & organization of the embryo sac.
- Unit 4: Apomixis, polyembryony, fruit development and parthenocarpy, embryo development.

LSC403B: PLANT PHYSIOLOGY**L T****Credit: 3****24 8****Marks: 75**

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 partitioning 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.

LSC404B: Lab Course on Taxonomy of Angiosperms & Plant Improvement**Credit: 1.5****Marks: 37.5**

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.

LS405B: Lab Course on Plant Physiology, Development and Reproduction in Angiosperms

Credit: 1.5

Marks: 37.5

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 carotenoids.
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 inhibition on seeds.
10. Nature of inhibition 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 C₃ and C₄ 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 organisation 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.

BOOKS RECOMMENDED: (LSC401-405)

28. Alexopoulos - Introductory mycology, Willey.
29. Anatomy of Dicotyledons Vol. I & II. - C.R. Metcalf.
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 land plants, Stanford 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. Gwynne vaughan & 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 & sinha

54. An Introduction to Plant Physiology – R. Sharma

DISCIPLINE SPECIFIC ELECTIVE

LSD406B: D. Plant Ecology-IV

Project Work **Credit: 4, Marks: 100**

LSD406B: E. Cytogenetics & Crop Improvement-IV

Project Work **Credit: 4, Marks: 100**

LSD406B: F. Microbiology-IV

Project Work **Credit: 4, Marks: 100**

GENERIC ELECTIVE

(To be opted by students of other departments)

NUTRITION AND HEALTH

(To be offered in even semesters)

Credit: 3+1=4

Marks: 75+25=100

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

Lab Course on NUTRITION AND HEALTH

1. Project- Undertake computer aided diet analysis and nutrition counseling for different age groups.

OR

Identify nutrient rich sources of foods (fruits and vegetables), their seasonal availability

OR

Study of nutrition labeling on selected foods

2. Study of the stored grain pests from slides/ photograph (*Sitophilus oryzae*, *Trogoderma granarium*, *Callosobruchus chinensis* and *Tribolium castaneum*): their identification, habitat and food sources, damage caused and control.

Suggested Readings

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

PLANT TISSUE CULTURE

(To be offered in even semesters)

Credit: 3+1=4

Total: 75+25=100

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

Unit 2: Aseptic 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

Lab course on Plant Tissue Culture

1. Sterilization of tools to be used in tissue culture lab
2. Media preparation: various media used in *in vitro* culture techniques, sterilization, use of plant growth hormone
3. Micropropagation of endemic plants of Northeast India, embryo culture, pollen culture

COMPUTATIONAL BIOLOGY

(To be offered in Odd semester)

Total Credit: 3+1=4

Marks: 75+25=100

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 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

Lab 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 Ouellette, 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