

UNIVERSITY OF NORTH BENGAL
ACCREDITED BY NAAC WITH GRADE "A"



ENLIGHTENMENT TO PERFECTION

Truncated Syllabus for B.Sc. (Honours) in Tea Science

**Six Semester Course Under Choice
Based Credit System**

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HEAD
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Scheme for CBCS Curriculum

Credit Distribution across Courses

Course Type	Number of Courses	Credits		
		Theory	Practical	Theory + Practical
Core Courses	14	$14 \times 4 = 56$	$14 \times 2 = 28$	84
Discipline Specific Electives	4	$4 \times 4 = 16$	$4 \times 2 = 8$	24
Generic Electives	4	$4 \times 4 = 16$	$4 \times 2 = 8$	24
Ability Enhancement Language Courses	2	$2 \times 2 = 4$		4
Skill Enhancement Courses	2	$2 \times 2 = 4$		4
Totals	26	96	44	140

B.Sc. TEA SCIENCE (HONS CBCS)

Year	SEMESTER	Discipline Specific CORE COURSE (DSC) (14T+14P) (Credit 14x4+ 14x2)	ABILITY ENHANSMENT COMPULSORY COURSE (AECC) (2) (Credit 2x2)	SKILL ENHANSMENT COMPULSORY COURSE (SEC) (2) (Credit 2x2)	DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE) (4T+4L) (Credit 4x4+ 4x2)	GENERIC ELECTIVE COURSES (GE) (4T+4L) (Credit 4x4+ 4x2) (For other Disciplines)	TOTAL CREDITS
1	I	DSC Paper-1 PLANT DIVERSITY	AECC-1			GE-1 Paper 1- Microbiology 1.1: INTRODUCTION AND SCOPE OF MICROBIOLOGY 1.2: MICROBIAL METABOLISM	20
		DSC Paper-2 ANIMAL DIVERSITY	ENVIRONMENTAL SCIENCE				
	II	DSC Paper-3 TEA CULTURE, BOTANY, MICROBIOLOGY	AECC-2			GE-1 Paper 2-Microbiology 2.1. BACTERIOLOGY AND VIROLOGY 2.2.MEDICAL MICROBIOLOGY AND IMMUNOLOGY	20
		DSC Paper-4 BASIC COMPUTER APPLICATION AND BIostatISTICS	Comm. English/ MIL				
2	III	DSC Paper-5 MORPHOLOGY AND ANATOMY		SEC Paper-1 1. Biofertilizers and organic farming 2. Tissue culture 3. Medicinal Plants and Ethnobotany 4. Sensory Evaluation and quality control 5. Geographical Management System		GE-2 Paper 1-Food Technology	26
		DSC Paper-6 CELL BIOLOGY AND PLANT BREEDING					
	IV	DSC Paper-7 PLANT SYSTEMATICS AND ECONOMIC BOTANY					26
		DSC Paper-8 FUNDAMENTALS OF BIOCHEMISTRY		SEC Paper-2 1. Plant diversity and Human Welfare 2. Fresh Water fish culture 3. Nursery and Gardening 4. Intellectual Property Rights 5. Disaster		GE-2 Paper 2- Food Technology	

3	V	DSC Paper-9 GENETICS AND MOLECULAR BIOLOGY	Management	24	24	
		DSC Paper-10 BASIC PRINCIPLES OF INSTRUMENTATION				
3	V	DSC Paper-11 PLANT PHYSIOLOGY AND METABOLISM	Management	DSE Paper-1 ANALYTICAL TECHNIQUES IN PLANT SCIENCES / PLANT BIOTECHNOLOGY	24	
		DSC Paper-12 PLANT ECOLOGY AND PHYTOGEOGRAPHY		DSE Paper-2 TEA PHARMACOLOGY / NATURAL RESOURCE MANAGEMENT		
		DSC Paper-13 LAWS OF ENVIRONMENT, PUBLIC HEALTH AND LABOUR		DSE Paper-3 TEA GARDEN MANAGEMENT / TEA ENTOMOLOGY		
3	VI	DSC Paper-14 SOIL AND INTEGRATED NUTRIENT MANAGEMENT	Management	DSE Paper-4 BIOINFORMATICS /STRESS BIOLOGY	24	
TOTAL		56+28=84	4	4	16+8=24	140

STRUCTURE OF B.SC. HONOURS IN TEA SCIENCE UNDER CBCS

CORE COURSE (DSC):

- DSC Paper-1 PLANT DIVERSITY
- DSC Paper-2 ANIMAL DIVERSITY
- DSC Paper-3 TEA CULTURE, BOTANY, MICROBIOLOGY
- DSC Paper-4 BASIC COMPUTER APPLICATION AND BIOSTATISTICS
- DSC Paper-5 MORPHOLOGY AND ANATOMY
- DSC Paper-6 CELL BIOLOGY AND PLANT BREEDING
- DSC Paper-7 PLANT SYSTEMATICS AND ECONOMIC BOTANY
- DSC Paper-8 FUNDAMENTALS OF BIOCHEMISTRY
- DSC Paper-9 GENETICS AND MOLECULAR BIOLOGY
- DSC Paper-10 BASIC PRINCIPLES OF INSTRUMENTATION
- DSC Paper-11 PLANT PHYSIOLOGY AND METABOLISM
- DSC Paper-12 PLANT ECOLOGY AND PHYTOGEOGRAPHY
- DSC Paper-13 LAWS OF ENVIRONMENT, PUBLIC HEALTH AND LABOUR
- DSC Paper-14 SOIL AND INTEGRATED NUTRIENT MANAGEMENT

ABILITY ENHANCEMENT COMPULSORY COURSE (AECC):

- AECC-1. Environmental Science
- AECC-2. English/MIL Communication

SKILL ENHANSMENT COMPULSORY COURSE (SEC):

SEC Paper-1

1. Biofertilizers and organic farming
2. Tissue culture
3. Medicinal Plants and Ethnobotany
4. Sensory Evaluation and quality control
5. Geographical Management System

SEC Paper-2

1. Plant diversity and Human Welfare
2. Fresh Water fish culture
3. Nursery and Gardening
4. Intellectual Property Rights
5. Disaster Management

DISCIPLINE SPECIFIC ELECTIVES COURSE (DSE):

DSE Paper-1

ANALYTICAL TECHNIQUES IN PLANT SCIENCES / PLANT BIOTECHNOLOGY

DSE Paper-2

TEA PHARMACOLOGY / NATURAL RESOURCE MANAGEMENT

DSE Paper-3

TEA GARDEN MANAGEMENT / TEA ENTOMOLOGY

DSE Paper-4

BIOINFORMATICS / STRESS BIOLOGY

GENERIC ELECTIVES COURSES (GE):

GE-1 Paper 1- Microbiology

GE-1 Paper 2-Microbiology

GE-2 Paper 1-Food Technology

GE-2 Paper 2- Food Technology

CORE COURSE (DSC):

Core Course I: PLANT DIVERSITY (Credits: Theory-4, Practical-2)

THEORY **Lectures: 60**

Unit 1: Microbes

(12 lectures)

Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction)

Unit 2: Algae

(12 lectures)

General characteristics; Classification of algae; General Characters of the following: *Nostoc*, *Chlamydomonas*, *Oedogonium*, *Fucus*, *Polysiphonia*..

Unit 3: Fungi

(12 lectures)

Introduction- General characteristics, ecology and significance, classification; True Fungi- General characteristics of *Rhizopus* (Zygomycota) *Penicillium*, (Ascomycota), *Agaricus* (Basidiomycota); Symbiotic Associations-Lichens: General account, Mycorrhiza.

Unit 4: Bryophytes (8 lectures)

General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), General Characters of *Marchantia* and *Funaria*.

Unit 5: Pteridophytes (8 lectures)

General characteristics, classification, Classification (up to family), General Characters of *Selaginella*, *Equisetum* and *Pteris*. Heterospory and seed habit.

Unit 6: Gymnosperms (8 lectures)

General characteristics; Classification (up to family), General Characters of *Cycas* and *Pinus* Ecological and economical importance.

Practical

1. EMs/Models of viruses – T-Phage and TMV. Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs.
3. Gram staining & simple staining process.
- 3 Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas*, *Fucus* and *Polysiphonia* through temporary preparations and permanent slides.
- 4 *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
- 5 *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
- 6 Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
- 7 *Marchantia*- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore (all permanent slides).
- 8 *Funaria*- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule.
- 9 *Selaginella*- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).
- 10 *Equisetum*- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry) (temporary slides).

11. *Pteris*- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
12. *Cycas*- morphology (coralloid roots, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).
13. *Pinus*- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarf shoot, t.s. needle, t.s. stem, l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone.

Suggested Readings

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

Core Course II: ANIMAL DIVERSITY (Credits: Theory-4, Practical-2)

THEORY Lectures: 60

Unit 1: Protista	(04 lectures)
General characters of Protozoa	
Unit 2: Porifera	(04 lectures)
General characters and canal system in Porifera	
Unit 3: Radiata	(04 lectures)
General characters of Cnidarians and polymorphism	
Unit 4: Aceolomates	(04 lectures)
General characters of Platyhelminthes	
Unit 5: Pseudocoelomates	(04 lectures)
General characters of Nematoda	
Unit 6: Annelida	(04 lectures)
General characters of Annelida	
Unit 7: Arthropoda	(04 lectures)
General characters	
Unit 8: Mollusca	(04 lectures)
General characters of mollusca	
Unit 9: Echinodermata	(04 lectures)
General characters of Echinodermata	
Unit 10: Protochordata	(04 lectures)
Salient features	
Unit 11: Pisces	(04 lectures)
General Characters	
Unit 12: Amphibia	(04 lectures)
General characters	
Unit 13: Reptilia	(04 lectures)
General Characters	
Unit 14: Aves	(04 lectures)
General Characters	
Unit 15: Mammalia	(04 lectures)
General Characters	

List of Practical

Spot identification (specimen/ photographs/ permanent slides):

- a. Non Chordates: *Euglena, Paramecium, Sycon, Physalia, Metridium, Taenia, Ascaris, Nereis, Leech, Peripatus, Limulus, Hermitcrab, Daphnia, Millipede, Centipede, Beetle, Chiton, Octopus, Asterias, Antedon* and *Balanoglossus*.
- b. Chordates: *Amphioxus, Petromyzon, Scoliodon, Hippocampus, Labeo, Ichthyophis / Uraeotyphlus, Salamander, Draco, Naja, Viper, Archaeopteryx*, any three common birds - (Crow, Duck, Owl), Squirrel and Bat.

Suggested Readings

1. Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.
2. Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole
3. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd
4. Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.
5. Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi.
6. Modern text book of zoology: Invertebrates, Kotpal, R. L., Rastogi Publication
7. Modern text book of zoology: Vertebrates, Kotpal, R. L., Rastogi Publication
8. Biology of Animals (Volume I & II), Sinha, Adhikari, Ganguly, New Central Book Agency.
9. Invertebrate Zoology, Jordan and Verma, S Chand Publication.

**Core Course III: TEA CULTURE, BOTANY, MICROBIOLOGY
(Credits: Theory-4, Practical-2)**

**THEORY
Lectures: 60**

Tea Culture, Botany & Microbiology

- History of tea; Climate for tea cultivation; Geographical distribution of tea plantations; Morphology and anatomy of Tea plants 12
- Physiology of tea plants; Cytogenetics of tea plant; Genetic diversity of tea plants; Quantitative and qualitative traits of tea plants; Varieties of tea; Tea clones of different tea growing areas; Selection of vegetative clones. 12
- Preliminary idea about planting; Maintenance and management of tea plants and plucking; Growth patterns in unpruned and pruned tea 10
- Tissues and tissue systems 8
- Absorption of water and ascent of sap; Translocation of solutes; Transpiration; Photosynthesis; Photorespiration and dark respiration; Photoperiodism; Dormancy of seeds and buds; Winter and inter-flush dormancy 10
- Diversity of microorganisms; Biological nitrogen fixation. 8

Practical

- Morphology and anatomy of Tea plants.
- Transpiration, respiration.
- Stomatal frequency and index.
- Varieties of tea.
- Plucking.
- Study of leaf, stem and root apical meristem.
- Absorption of water and ascent of sap.
- Photosynthesis; Photorespiration and dark respiration.
- Gram staining. Study of growth pattern in bacteria.

Suggested Readings

- Plant physiology- BP Pandey
- Basic biophysics for Biologists – M. Daniel, Agro Botanica Publishers
- Biochemistry and Physiology of Plant Hormones – T.C Moore, Springer-Verlag, New York, USA
- Class experiments in Plant Physiology – H. Meidner, George Allen and Unwin
- Concepts of Photobiology: Photosynthesis and Photomorphogenesis – G.S Singhal, G Renger, S.K Sopory, K.D Irrgang and Govindjee, Narosa Publishing House, New Delhi
- Bacterial Metabolism - G. Gottschalk, Springer
- Fundamentals of Microbiology and Immunology – A.K. Banerjee and N. Banerjee, New Central Book Agency
- Brock Biology of Microorganisms - M.T. Madigan, J.M. Martinko & J. Parker, Prentice-Hall
- Food Microbiology - M.R. Adams & M.O. Moss, RSC
- Foundations in Microbiology - K.P. Talaro & A. Talaro, WCB/McGraw-Hill
- Fundamentals of Microbiology - Alcamo, Benjamin/Cummings
- General Microbiology - H.G. Schlegel, Cambridge University Press
- General Microbiology - R.Y. Stanier, E.A. Adelberg & J.L. Ingraham, McMillan

Core Course IV: BASIC COMPUTER APPLICATION AND BIOSTATISTICS (Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Computer Applications Basics concepts of computers: Architecture- input, output, CPU, ALU etc.; Generations of hardware and software; A brief introduction on input-output devices- disks, printers, CDROMS and other storage media etc. **(12 lectures)**

Unit 2: Operating systems- WINDOWS and LINUX. System and application software; Basics of internet- LAN, MAN and WAN; Concept of websites Electronic spread sheet: Creating, opening and saving files; Working with worksheets and work books; Entering data and selecting cells; Editing worksheets; Creating formulae; Working with charts; Summarizing data in lists and tables; Analyzing data, Analyzing sample statistical data. **(12 lectures)**

Unit 3: Measures of central tendency mean, median, mode, geometric mean. Measures of dispersion - range, standard deviation, mean deviation. **(12 lectures)**

Unit 4: Correlation types and methods of correlation, regression, simple regression equation, similarities and dissimilarities of correlation and regression **(12 lectures)**

Unit 5: Statistical inference Hypothesis - simple hypothesis-student 't' test - chi square test. **(12 lectures)**

Practical

1) Basics of computers: Basic commands– file creation, copying, moving and deleting in Linux and Windows; Creating spread sheets; Usage of spread sheet to biological applications.

- 2) Using email; Using browsers; Search engines; Pubmed; Using biological databases
- 3) Calculation of mean, standard deviation and standard error
- 4) Calculation of correlation coefficient values and finding out the probability
- 5) Calculation of 'F' value and finding out the probability value for the F value.

Suggested Readings

1. Biostatistic, Danniell, W.W., 1987. New York, John Wiley Sons.
2. An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S and Richards, J. Christian Medical College, Vellore
3. Statistical Analysis of epidemiological data, Selvin, S., 1991. New York University Press.
4. Statistics for Biology, Boston, Bishop, O.N. Houghton, Mifflin.
5. The Principles of scientific research, Freedman, P. New York, Pergamon Press.
6. Statistics for Biologists, Campbell, R.C., 1998. Cambridge University Press.

Core Course V: MORPHOLOGY AND ANATOMY (Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Leaves (3 Lectures)

Types, phyllotaxy.

Unit 2: Flower (6 Lectures)

The flower as a modified shoot; aestivation; Inflorescence: Types and evolution. Placentation and its evolution; floral formulae, floral diagram;

Unit 3: Fruits and Seeds (3 Lectures)

Definition and types

Unit 4: Organs (3 Lectures)

Structure of dicot and monocot root stem and leaf.

Unit 5: Structure and Development of Plant Body (5 Lectures)

Internal organization of plant body: Types of cells and tissues, the three tissue systems, Classification of tissues; Simple and complex tissues.

Unit 6: Apical meristems (12 Lectures)

Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cytohistological zonation); Types of vascular bundles; Structure of dicot and monocot stem. Structure of dicot and monocot leaf, Kranz anatomy. Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.

Unit 7: Secondary Growth (8 lectures)

Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood)

Unit 8: Adaptive and Protective Systems (7 Lectures)

Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification)

Unit 9: Structural organization of flower (8 lectures)

Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.

Unit 10: Pollination and fertilization (5 Lectures)

Pollination mechanisms and adaptations; Double fertilization.

Practical

1. Identification with reasons: Types of leaves, stipules, tendrils, inflorescence, fruits, calyx, corolla, androecium, gynoecium.

2. Study of meristems through permanent slides and photographs.
3. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
4. Root: monocot, dicot, secondary growth.
5. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels. Secondary structures
6. Leaf: Dicot and Monocot leaf
7. Adaptive anatomy: Xerophyte, Hydrophyte.

Suggested Readings

1. Sachdeva, S. K. 1990. Angiosperms, Morphology, Anatomy, Taxonomy, Evolution. Kalyani Publishers, New Delhi.
2. Naik, V. N. Taxonomy of Angiosperms. Tata Mc. Graw Hill Publishers Co. 1981. New Delhi
3. Plant Systematics. Gurucharan Singh. 2005 (2nd Edition). Oxford & IBH.
4. Plant Taxonomy- Nair. Tata Mc. Graw Hill Publisher Company Limited.
5. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
6. Fahh, A. (1974). Plant Anatomy. Pergmon Press, USA.
7. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

Core Course VI: CELL BIOLOGY AND PLANT BREEDING (Credits: Theory-4, Practical-2)

THEORY Lectures: 60

Unit 1

(8 lectures)

Plasma membrane :structure and functions; association of protein and lipids in biological membranes.

Unit2

(10 lectures)

Cell cycle: - An overview of cell cycle; Components of cell cycle control system; Intracellular and Extra-cellular control of cell division, Programmed cell death (Apoptosis).

Unit 3

(12 lectures)

Nucleus: Structure and function, Nuclear envelope. Mitochondria-Structure, organization of respiratory chain complexes, ATP synthase, Chloroplast-organization of photosynthetic complexes, srstructural organization of ribosomal assembly.

Unit-4

(10 Lectures)

Chromosome aberrations in plants, Breeding behavior of interchange heterozygotes and permanent hybrid, Euploidy and aneuploidy.

Unit-5

(12Lectures)

Origin and meiotic & breeding behaviours of haploids, autopolyploids and allopolyploids, chromosome fragment transfers and crop improvement, Giemsa banding of chromosomes, FISH.

Unit-6

(8 Lectures)

Phenotypic variance and its components, Heritability of traits and its estimation, Gene frequency in a population, genetic equilibrium and Hardy-Weinberg law.

Practical

1. Microscopy-Bright field, dark field, phase contrast.
2. Study of the effect of organic compounds on membrane permeability.
3. study of somatic chromosomes of some common plant.
4. study of meiosis of some aberrant plants.
5. camera lucida drawing of cytological preparations.

6. Numerical exercises on linkage and crossing over.
7. Numerical exercises on X^2 for independence of attributes and goodness of fit.

Suggested Readings

The Cell: A molecular approach by Geoffrey M. Cooper
Watson J. D. et al. (2004). Molecular Biology of the gene.
Alberts B. et al. (2002) Molecular Biology of the cell. Garland.
Fukui K. and Nakayam S. (1996). Plant Chromosomes: Laboratory methods. CRC Press.
Sharma A. K. and Sharma A. (1999). Plant Chromosomes: Analysis, Manipulation and Engineering. Harwood Academic Publishers.

Core Course VII: PLANT SYSTEMATICS AND ECONOMIC BOTANY (Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Significance of Plant systematics (8 lectures)

Introduction to systematics; Plant identification, Classification, Nomenclature. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India.

Unit 2: Taxonomic hierarchy (4 lectures)

Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).

Unit 3: Systematics - an interdisciplinary science (4 lectures)

Evidence from palynology, cytology, phytochemistry and molecular data.

Unit 4: Botanical nomenclature (5 lectures)

Principles and rules (ICN); Ranks and names; binominal system, Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.

Unit 5: Systems of classification (5 lectures)

Types of classification-artificial, natural and phylogenetic. Classification systems of Bentham and Hooker (upto series), Engler and Prantl (upto series). Brief reference of Angiosperm Phylogeny Group (APG III) classification.

Unit 6: Study of Diagnostic features of some dominant families: (6 lectures)

Asteraceae, Leguminosae, Gramineae, Cyperaceae, Lamiaceae, Rubiaceae, Theaceae

Unit 7: Tea Taxonomy (6 lectures)

Systematic position of tea plant; Morphological, anatomical and chemical basis of classification, Flowering, fruit and Seed setting; Tea varieties and clones of different tea growing areas.

Unit 8: Origin of Cultivated Plants (6 lectures)

Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

Unit 9: Cereals and Legumes (4 Lectures)

General account with special reference to Rice, Wheat and Gram (Botanical name, family, origin, morphology & uses)

Unit 10: Beverages and Spices (4 Lectures)

General account with special reference to Tea, Coffee and clove (Botanical name, family, part used, morphology and uses)

Unit 11: Fibre and Oil Yielding Plants (4 Lectures)

General description with special reference to Cotton, Jute and mustard (Botanical name, family, part used, morphology and uses)

Unit 12: Drug-yielding plants (4 Lectures)

Therapeutic and habit-forming drugs with special reference to *Cinchona*, *Digitalis* (Botanical name, family, morphology, processing, uses and health hazards)

Practical

1. Study of vegetative and floral characters of the following families (Habit sketch, Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Asteraceae, Leguminosae, Gramineae, Cyperaceae, Lamiaceae, Rubiaceae, Solanaceae, Theaceae
2. Mounting of a properly dried and pressed specimen of any Tea Varieties, Weeds, Shade trees and any other plants from tea garden areas with herbarium label (to be submitted in the record book).
3. Field visit – Subject to grant of funds from the university.
4. Study of economically important plants : Rice, Wheat, Gram, Tea, Coffee, *Cinchona* through specimens /photographs, habit sketch, sections and microchemical tests.

Suggested Readings

1. Radford, A.E. (1986). *Fundamentals of Plant Systematics*. Harper and Row, New York.
2. Simpson, M.G. (2006). *Plant Systematics*. Elsevier Academic Press, San Diego, CA, U.S.A.
3. Singh, G. (2012). *Plant Systematics: Theory and Practice*. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
4. Jeffrey, C. (1982). *An Introduction to Plant Taxonomy*. Cambridge University Press, Cambridge.
5. Kochhar, S.L. (2011). *Economic Botany in the Tropics*, MacMillan Publishers India Ltd., New Delhi. 4th edition.
6. Wickens, G.E. (2001). *Economic Botany: Principles & Practices*. Kluwer Academic Publishers, Netherlands.

Core Course VIII: FUNDAMENTALS OF BIOCHEMISTRY (Credits: Theory-4, Practical-2)

THEORY Lectures: 60

Unit-1

1. Carbohydrates : Structural aspects – Introduction & Occurrence, Classification of Mono-, Di- and Polysaccharides, Reducing & Non-reducing Sugars, Inter-conversion of monosaccharides. **(10 Lectures)**

Unit 2

Lipids : Structural aspects – General introduction, Classification & Structure of Simple & Compound lipids, Biological membrane, Lipoproteins (elementary idea). **(10 Lectures)**

Unit 3

Proteins : Structural aspects – General introduction, Classification & General characteristics, Structure of Primary, Secondary, Tertiary & - α Quaternary proteins (elementary idea), Classification of Amino acids. **(10 Lectures)**

Unit 4

Nucleic acid : Structural aspects – Components of DNA and RNA, Nucleosides & Nucleotides (introduction, structure & bonding), Double helical structure of DNA (Watson-Crick model), various forms of DNA. **(10 Lectures)**

Unit 5

Chemical & Enzymatic Kinetics - An introduction to enzyme; How enzyme works. **(10 Lectures)**

Unit 6

Genes are DNA – DNA is the genetic material, DNA is a double helix, DNA replication is semiconservative, mutations change the sequence of DNA, a gene codes for a single polypeptide, recombination occurs by physical exchange of DNA, genetic code is triplet. **(10 Lectures)**

Practical

1. Estimation of protein by Folin Lowry method .
2. Determination of K_m and V_{max} of enzyme.
3. TLC separation of Amino acids /sugars .
4. Determination of Iodine number of a fat.
5. Verification of Beer's Law Spectrophotometrically .

Suggested Readings

- Lehninger A. L. (1993). Principle of Biochemistry
- Stryer L. (1993). Biochemistry. W. H. Freeman.
- Nelson D. L. and Cox M. M. (2000). Lehninger Principles of Biochemistry
- Plumer D.T. (1993). An Introduction to Practicals in Biochemistry. Tata McGraw Hill.

Core Course IX: GENETICS AND AND MOLECULAR BIOLOGY

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Genetics and Molecular Biology

- Mendelism; Allelic and nonallelic interactions; Chromosomal theory of inheritance; Extrachromosomal inheritance; Linkage and crossing over; Three point cross; Autosomal and sex chromosomal inheritance • 12
- Mutation; DNA repair • 10
- Theories of speciation; population genetics • 10
- Fine structure of gene; Split gene concept; Genetic code; Transposon; Replication; Transcription and translocation; Post transcriptional modifications • 12
- Techniques of molecular biology like RFLP; PCR; RAPD; AFLP. • 16

Practical

- Study of Mendelian and non Mendelian ratios.
- DNA isolation and purification.
- Techniques like RFLP; PCR; RAPD; AFLP.

Suggested Readings

- Genes VIII - B. Lewin, Oxford University Press
- Genetics : PJ Russell. Benjamin Cummings Pub. Inc. USA.
- Principles of Genetics: Snustad and Simmons, John Wiley and Sons, USA
- Concepts of Genetics: Klug and Cummings, Pearson Education, USA 4.
- Genome 3: T.A. Brown, Pearson Education, USA
- Principles of Gene Manipulation and Genomics: Primrose and Twyman, Blackwell Scientific, Oxford.
- Plant chromosome: Analysis; Manipulation and Engineering: Sharma & Sharma, Harwort Academic Pub. Austral
- The Science of Genetics: Sauders College Publishing, Fort Worth, USA
- Genetics: Principles and Analysis, Hartl and Jones, EW Jones & Bartlett Pub, USA.
- Gene IX: Lewin, B. Oxford University Press, USA.
- Essential Genes, Lewin, B. Pearson Education.
- Functional Genomics: A practical Approach. Hunt And Rick, Oxford University Press.
- Genetic Engineering: An Introduction to Gene Analysis and Exploitation in Eukaryotes: Kingsman & Kingsman, Blackwell Scientific .Pub. Oxford.
- Molecular Biotechnology: Glick & Pasternock, Indian Edition.
- Molecular Cloning: A Laboratory Manual, Sambrook & Russel, CSHL press, N.York.
- DNA Cloning: A Practical Approach, Glover & Hames, IRL press, Oxford.
- Methods in Enzymology, Guide to molecular Technique, Vol. 152. Berger & Kimmel, Academic Press, San Diego.
- DNA Science: A first course in recombinant Technology, Mickloss & Freger, CSHL Press, NY.
- Recombinant DNA Technology: Watson, Academic Press.

Core Course X: BASIC PRINCIPLES OF INSTRUMENTATION

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1

General Biophysical methods – Measurement of pH.

(6 lectures)

Unit 2

Separation & Identification of Materials - concept of Chromatography (Partition Chromatography, Paper Chromatography, Adsorption Chromatography, TLC, GLC, Ion Exchange Chromatography, Gel Chromatography, HPLC, Affinity Chromatography); Electrophoresis (Gel Electrophoresis, Paper Electrophoresis).

(12 lectures)

Unit 3

Centrifugation – Basic Principle of Centrifugation, Instrumentation of Ultracentrifuge, Factors affecting Sedimentation velocity, Standard Sedimentation Coefficient, Centrifugation of associating systems.

(8 lectures)

Unit 4

Microscopy – Light microscopy, Bright & Dark Field microscopy, Phase Contrast microscopy, TEM, SEM.

(10 lectures)

Unit 5

X-Ray Crystallography – X-ray diffraction, Concept of different crystal structure, determination of crystal structure [concept of rotating crystal method, powder method].

(6 lectures)

Unit 6

Spectroscopy: Raman Spectroscopy – What is Raman effect, Quantum mechanical reason of Raman effect, Molecular Polarizability.

(8 lectures)

Unit 7

NMR Spectroscopy – Basic principle of NMR spectroscopy, Experimental technique & instrumentation, Chemical shift, Relaxation process. Absorption Spectroscopy – Simple theory of the absorption of light by molecules, Beer-Lambert law, Instrumentation for measuring the absorbance of visible light, Factors affecting the absorption properties of a Chromophore.

(10 lectures)

Practical

1. Microscopy – Light microscopy : principles, parts & function, Operation.
2. Image analysis of different classes of Microbes.
3. Sterilization: principles & operations – Autoclave, Hot Air Oven, Filtration, Laminar Air Flow
4. Principles & operations of Incubators & Shakers
5. Principle & operation of Centrifuge
6. Principle & operation of pH meter
7. Principle & operation of Spectrophotometer

Suggested Readings

- Physical Biochemistry: Applications to Biochemistry and Molecular Biology by David M Freifelder
- Benson H. J (1990). Microbiological Applications-A Laboratory Manual in General Microbiology. Wm.C. Brown Publishers.

Chandra Ghosh.

HEAD

Department of Tea Science
North Bengal University
Dist Darjeeling Pin - 734013

THEORY

Lectures: 60

Unit1

(5 lectures)

Bioenergetics: Laws of thermodynamics and their significance in free energy changes in biological systems.

Unit2

(10lectures)

Photosynthesis: Organization of the light absorbing pigment systems. Mechanisms of photoexcitation of chlorophyll and electron transport chain. Carbon fixations in photosynthesis.

Unit3

(15 lectures)

Respiration: Glycolysis and its regulation, Fatty acid oxidation, mechanisms of oxidative decarboxylation of pyruvic acid. Mitochondrial electron transport and oxidative phosphorylation. Biological nitrogen fixation and assimilation of ammonia.

Unit4

(12 lectures)

Water relations in plants: Water potential in plants, soil-plant-atmosphere continuum, Movement of water in plants, Passive and active transport, membrane transport proteins.

Unit5

(10lectures)

Plant Growth Regulators: Auxins, gibberellins, cytokinins, abscisic acid, ethylene-physiological effects and mechanism of action.

Unit6

(8 lectures)

Dormancy: Types and mechanism of regulation, Flowering: photoperiodism and vernalization, Biochemical mechanisms involved in flowering.

Practical

1. Study of the effect of organic compounds on membrane permeability
2. Determination of water potential in plant tissues.
3. Estimation of chlorophylla,b and total chlorophyll content on plant tissues.
4. Isolation of plant pigments and determination of their absorption spectra.
5. Measurement of hill reaction activity.

Suggested Readings

- Hopkins W.G. and Hunter N.P. (2003). Introduction to Plant Physiology. John Wiley.
- Mukherjee S. and Ghosh A. K. (1996). Plant Physiology. Tata-McGraw Hill.
- Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

Core Course XII: PLANT ECOLOGY AND PHYTOGEOGRAPHY

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Introduction (8 lectures)

Basic concepts; Levels of organization. Inter-relationships between the living world and the Environment.

Unit 2: Ecological factors (10 lectures)

Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors.

Unit 3: Plant communities (10 lectures)

Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.

Unit 4: Ecosystem (12)

Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous

Unit 5: Population ecology (8 lectures)

Characteristics and Dynamics .Ecological Speciation

Unit 6: Phytogeography (12 lectures)

Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India.

Practical

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
3. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
4. Determination of minimal quadrat size for the study of herbaceous vegetation in the campus by species area curve method. (species to be listed)
5. Quantitative analysis of herbaceous vegetation in the campus for frequency, density, abundance and comparison with Raunkiaer's frequency distribution law
6. Field visit to familiarise students with ecology of different sites.

Suggested Readings

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
4. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition

Core Course XIII: LAWS OF ENVIRONMENT, PUBLIC HEALTH AND LABOUR
(Credits: Theory-4, Practical-2)

THEORY**Lectures: 60**

- Environment and Law 8
- Origin of Environmental Law
- Sustainable Development and Environmental Governance
- Concept of Law & Policy 12
- Environmental Law and the Indian Constitution
- Environment (IPC, Cr.PC, Torts)
- Environmental Equity and Governance
- Emergence of International Environmental Law
- Application of International Environmental Law
- Introduction to Trade & Environment

- Nature and Origin of International Environmental Organisations (IEOs) 8
- MEAs and Dispute Settlement Mechanisms
- Right to Environment as Human Right
- International Humanitarian Law and Environment
- Environment and Conflict Management
- UNFCCC, 1992 & Kyoto Protocol, 1997 12
- Treaty on Antarctic & Polar Regions – 1961
- UN Convention of Law of the Sea, 1982 and Regional Seas Convention
- International Water Courses
- Environment and IPR 12
- Traditional Knowledge and Environment
- International Convention for the Protection of New Varieties of Plants (UPOV Convention)
- The Environment protection Act. 8
- The Air Act.
- The water Act.
- The wildlife protection Act and Forest Conservation Act.

Practical

Project on environmental law.

Suggested Readings

1. Air Environment and Pollution – S.S. Purohit
2. Water Pollution causes, effects and control – P.K. Goel
3. Biodiversity and Forest genetic resource – D.N. Tiwari
4. Biodiversity : Planning for sustainable Development – J. Singh
5. Text Book of Ecology and Environment – S.C. Joshi
6. Environmental Engineering – G. Kiely
7. Environmental Engineering – B.K. Nanda and T. Biswal

Core Course XIV: SOIL AND INTEGRATED NUTRIENT MANAGEMENT (Credits: Theory-4, Practical-2)

THEORY **Lectures: 60**

Soil and integrated nutrient management

- Soil plant relationship; Physical and chemical properties of soil; Soil structure and types; Soil formation 8
- Soil nutrition; Macro and micronutrients- source; role and deficiency symptoms; Soil moisture and air; Soil nutritional dynamics; Nutrient leaching; Nutrient-shade interactions; Concept of integrated nutrient management 10
- Carbon; Nitrogen; Phosphorus and potassium cycle in soil; Soil enrichment practices- inorganic and organic; Fertilizer types and composition; Method and time of fertilizer application; Effect of fertilizers on tea quality; Impact of low or excessive use of fertilizers 10
- Organic farming; Various organic manures; Bio-fertilizers; Compost and composting; Vermiculture; vermicompost and vermiwash; Mulching; Biofertilizers and organic farming 14

- Biofertilizers- types; importance; Concept of organic farming; its importance and application; Organic manures- types; physical and chemical properties; Microbial activity in organic manures and organic farming
- Soil microflora- importance; classification. Soil microflora management 10
- Soil pollution; Soil erosion; Causes and effects of soil erosion; Methods of soil conservation 8

Practical

- Soil structure and types.
- Physical and chemical properties of soil.
- Deficiency symptoms.
- Soil nutritional dynamics.
- Nutrient leaching.
- Nutrient-shade interactions.
- Fertilizer types and composition.
- Methods of fertilizer application.
- Effect of fertilizers on tea quality.
- Bio-fertilizers; Compost and composting; Vermiculture; vermicompost and vermiwash; Mulching.
- Soil microflora.
- Soil pollution; Soil erosion.

Suggested Readings

- Soil and integrated nutrient management
- Soil Chemical Analysis by Jackson, M.L.
- Baruah, T.C. and Barthakur, H.P. (1997) A Text Book of Soil Analysis. Vikas Publishing House Pvt Ltd., New Delhi.
- Soil Testing & Recommendation by Ranjan Kumar Basak

SKILL ENHANSMENT COMPULSORY COURSE (SEC):

SEC Paper-1 Biofertilizers and organic farming

(Credits 2)

Lectures: 30

- Introduction, concept, relevance in present context;
- Organic production requirements;
- Vermicomposting, green manuring, recycling of organic residues, biofertilizers;
- Biological intensive nutrient management-organic manures
- Soil improvement and amendments;
- Biopesticides
- Quality considerations, certification, labeling and accreditation processors, marketing, exports.

Suggested Readings

1. Organic Farming : Theory and Practice - S.P.Palaniappan and K.Aannadurai
2. A Hand book of Organic Farming - A.K. Sharma
3. Hand book of Organic Farming and Biofertilizers - A.C.Gaur
4. Organic farming for sustainable Horticulture – P. Parvatha Reddy
5. Organic Agriculture – J.C. Tarafdar

SEC Paper-1 Tissue culture

(Credits 2)

Lectures: 30

Tissue culture

- History and development of Tissue culture techniques; Importance of Tissue culture 10
- Tissue culture laboratory and instrumentation; Culture media; media supplements and culture conditions; Selection of explants for culture initiation
- Concepts of totipotency; cytodifferentiation; organogenesis etc. ; 5
- Micropropagation; Callus culture and organogenesis
- Single cell culture (haploid and diploid cells); Protoplast culture; fusion and somatic hybridization; Somatic variations; Artificial seeds 10
- Application of tissue culture techniques in development of transgenic. 5

Suggested Readings

- Introduction to plant Tissue culture by M K Razdan
- Introduction to plant biotechnology by H S Chawla
- Plant tissue culture by K K Dey

SEC Paper-1 Medicinal Plants and Ethnobotany

(Credits 2)

Lectures: 30

Unit 1: History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; (4 Lectures)

Unit 2: Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanic Gardens, Ethnomedicinal plant Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.

(8 Lectures)

Unit 3: Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Ethnobotany as an interdisciplinary science. Applications of Ethnobotany: National interacts, folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. (6 Lectures)

Unit 4: Medico-ethnobotanical sources in India; Role of ethnobotany in modern medicine Role of ethnic groups in conservation of plant genetic resources. (6 lectures)

Unit 5: Ethnobotany and legal aspects. Ethnobotany as a tool to protect interests of ethnic groups. Biopiracy, Intellectual Property Rights and Traditional Knowledge. (6 lectures)

Suggested Readings

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.

3. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
4. S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981
5. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
6. S.K. Jain, 1990. Contributions of Indian ethnobotny. Scientific publishers, Jodhpur.
7. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
8. Faulks, P.J. 1958. An introduction to Ethnobotany, Moredale pub. Ltd.

SEC Paper-1 Sensory Evaluation and quality control

(Credits 2)

Lectures: 30

Unit1

(10 lectures)

Sensory Science: Introduction; Techniques in sensory analysis; Role of sensory analysis, Sensory methods; Analytical/laboratory tests- sensitivity tests (applications of threshold tests, and discriminatory tests), qualitative tests- ranking method.

Unit2

(15 lectures)

Quality and criteria; Sampling schemes- two-class attributes plans, three-class attributes plan, choosing a plan stringency, and variables accepting sampling; Statistical quality control; Reliability; Quality control using microbiological criteria; Control at source- training, facilities and operations, equipment, and cleaning and disinfection

Unit3

(5 lectures)

Ways of describing tea quality: Composition, appearance, kinesthetic and flavour attributes;

Suggested Readings

1. Tea Manufacturing Manual, TRA
2. The Tea testing Manual, TRA
3. World Tea Production and Manufacturing by M. P. Sinha
4. Tea Technology, Assam Review

SEC Paper-1 Geographical Management System

(Credits 2)

Lectures: 30

Unit 1: Geographical Information System (GIS): Definition and Components.
(6 lectures)

Unit 2: Global Positioning System (GPS): Principles and uses; DGPS.
(6 lectures)

Unit 3: GIS Data Structures: Types (spatial and Non-spatial), raster and vector data structure.
(6 lectures)

Unit 4: GIS Data Analysis: Input; geo-referencing; editing, output and query; overlays.
(6 lectures)

Unit 5: Application of GIS: Land use mapping; urban sprawl analysis; forests monitoring.
(6 lectures)

Suggested Readings

1. Bhatta, B. (2010) Analysis of Urban Growth and Sprawl from Remote Sensing, Springer, Berlin Heidelberg.41
2. Burrough, P.A., and McDonnell, R.A. (2000) Principles of Geographical Information System-Spatial Information System and Geo-statistics. Oxford University Press
3. Heywoods, I., Cornelius, S and Carver, S. (2006) An Introduction to Geographical Information system. Prentice Hall.
4. Jha, M.M. and Singh, R.B. (2008) Land Use: Reflection on Spatial Informatics Agriculture and Development, New Delhi: Concept.
5. Nag, P. (2008) Introduction to GIS, Concept India, New Delhi.
6. Sarkar, A. (2015) Practical geography: A systematic approach. Orient Black Swan Private Ltd., New Delhi
7. Singh, R.B. and Murai, S. (1998) Space Informatics for Sustainable Development, Oxford and IBH, New Delhi.

SEC Paper-2 Plant diversity and Human Welfare

(Credits 2)

Lectures: 30

Unit 1: Plant diversity and its scope- Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agrobiodiversity and cultivated plant taxa, wild taxa. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes. (8 lectures)

Unit 2: Loss of Biodiversity: Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss, Management of Plant Biodiversity: Organizations associated with biodiversity management-Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity information management and communication. (8 lectures)

Unit 3: Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, *In situ* and *ex situ* conservation, Social approaches to conservation, Biodiversity awareness programmes, Sustainable development. (8 lectures)

Unit 4: Role of plants in relation to Human Welfare: a) Importance of forestry their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. Fruits and nuts: Important fruit crops their commercial importance. Wood and its uses. (6 lectures)

Suggested Readings

1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi

SEC Paper-2 Fresh Water fish culture

(Credits 2)
Lectures: 30

Unit 1: Introduction

(04 lectures)

Different freshwater aquaculture systems, major species cultured production trends and prospect in different parts of the world, Water quality management. Selection, transportation and acclimatization of candidate species. Monoculture and polyculture of carps, stocking density and ratio.

Unit 2: Culture of Fishes

(03 lectures)

Culture of indian major carps – catla, rohu,
Culture of exotic carps – grass carp, tilapia.
Culture of air breathing fishes – murrels and cat fishes.

Unit 3: Biology of cultivable fresh water fishes

(03 lectures)

Biology of carps, Biology of important air breathing fishes, Biology of important catfishes.

Unit 4: Aquatic environment, weeds, insect and their control

(06 lectures)

Freshwater aquaculture resources-ponds, tanks, lakes, reservoirs etc. Nursery, rearing and grow-out ponds preparation and management-control of aquatic weeds and algal blooms, predatory insects, weed fishes and their control.

Unit 5: Fish feed and fertilization

(04 lectures)

Food and feeding habits, factors influencing feeding, nutritional requirements, varieties of fish feeds, formulated feeds, died feeds, management of feeding, use of fertilizers and manures, supplementary feeding.

Unit 6: Reproduction

(06 lectures)

Hatchery management : Induced breeding; hypophysation of Indian Major carps; types of hatcheries - Hapa, Jar hatchery, circular hatchery (Chinese hatchery), Modern Indian hatchery system.

Unit 7: Fish disease and fish health management

(04 lectures)

Major fish diseases, nutritional diseases, fish disease controls, principles of fish health management.

Suggested Readings

1. Fresh water aquaculture, Rauth, R. K., Scientific Publishers, India
2. Aquaculture Principles and Practices, Pillay, T. V. R. , The Fishing News Books.
3. Fisheries and Aquaculture. Piska, R. S. , Lahari Publications. Hyderabad.
4. Sustainable Indian Fisheries. Pandian, T. J., National Academy of Agricultural Sciences.

SEC Paper-2 Nursery and Gardening

(Credits 2)

Lectures: 30

Unit 1:Nursery: definition, objectives and scope and building up of infrastructure for nursery,planning and seasonal activities - Planting - direct seeding and transplants.

(4 Lectures)

Unit 2: Seed: Structure and types - Seed dormancy; causes and methods of breakingdormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion – Seedproduction technology - seed testing and certification. **(6 Lectures)**

Unit 3:Vegetative propagation: air-layering, cutting, selection of cutting, collecting season,treatment of cutting, rooting medium and planting of cuttings - Hardening of plants – greenhouse - mist chamber, shed root, shade house and glass house. **(6 Lectures)**

- Unit 4:** Gardening: definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping – Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting. **(8 Lectures)**
- Unit 5:** Seed bed: preparation and management. Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures. **(6 Lectures)**

Suggested Readings

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
2. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
3. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
5. Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
6. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

SEC Paper-2 Intellectual Property Rights

(Credits 2)
Lectures: 30

Unit-1

(6 lectures)

Overview of Intellectual property right (IPR)-Introduction, Patent copy right, Trade Mark, Design, Geographical Indication, Plant varieties and Layout Design-Genetic Resources and Traditional Knowledge-Trade Secret-IPR in India.

Unit-2

(6 lectures)

Patents - Elements of Patentability: Novelty , Non Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and licence

Unit-3

(6 lectures)

Nature of Copyright - Subject matter of copyright Registration Procedure, Term of protection, Ownership of copyright, Assignment and licence of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights.

Unit 4

(6 lectures)

Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks.

Unit-5

(6 Lectures)

Design: meaning and concept of novel and original - Procedure for registration, effect of registration and term of protection.

Geographical Indication (GI)

Geographical indication: meaning, and difference between GI and trademarks - Procedure for registration, effect of registration and term of protection.

Plant Variety Protection

Plant variety protection: meaning and benefit sharing and farmers' rights – Procedure for

registration, effect of registration and term of protection.

Suggested readings

1. Nithyananda, K V. (2019). *Intellectual Property Rights: Protection and Management*. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., & Khusdeep, D. (2014). *Intellectual Property Rights*. India, IN: PHI learning Private Limited.

SEC Paper-2 Disaster Management

(Credits 2)

Lectures: 30

- Concepts of Hazard Vulnerability; Risks; Natural Disasters (earthquake, Cyclone, Floods, Volcanoes); and Man Made Disaster (Armed conflicts and civil strip; Technological disasters; Human Settlement; Slow Disasters (famine; draught; epidemics) and Rapid Onset Disasters(Air Crash; tidal waves; Tsunami) 4
- Risks; Difference between Accidents and Disasters; Simple and Complex Disasters; Refugee problems; Political; Social; Economic impacts of Disasters; principles of psychosocial issues and recovery during emergency situations; Models in Disasters 4
- Disaster Risk Reduction Strategies; Disaster Cycle; Phases of Disaster; Preparedness Plans; Action Plans and Procedures; Early warning Systems Models in disaster preparedness; 4
- Components of Disaster Relief-(Water, food, sanitation, shelter, Health and Waste Management)
- Policies for Disaster Preparedness Programs; Preparedness Planning; Roles and Responsibilities; Public Awareness and Warnings; Conducting a participatory capacity and vulnerability analysis 4
- Sustainable Management; Survey of Activities Before Disasters Strike; Survey of Activities During Disasters; DRR Master Planning for the Future; Capacity Building; Sphere Standards 4
- Rehabilitation measures and long term reconstruction; Psychosocial care provision during the different phases of disaster; Introduction to disaster medicine; Disaster preparation; Disaster recovery in relation to disaster medical management; 4
- International Health Regulation; United Nation International Strategy for Disaster Risk Reduction (UNISDR); International Search and Rescue Advisory Group; (INSARAG; Global Facility for Disaster Risk Reduction (GFDRR); Asean Region Forum (ARF); Asian disaster Reduction Centre (ADRC); SAARC 277 Disasters Management Centre (SDMC); USAID); UNDAC;UNOCHA; USAR 4
- Disaster Management Indian scenario; India's vulnerability profile; Disaster Management Act 2005 and Policy guidelines; National Institute of Disaster Management; National Disaster Response Force (NDRF)National Disaster Management Authority. 4

Suggested Readings

- **Disaster management:** a disaster manager's *handbook* by Carter, W. Nick.
- Disaster Management by R B Singh

DISCIPLINE SPECIFIC ELECTIVES COURSE (DSE):

DSE Paper-1 ANALYTICAL TECHNIQUES IN PLANT SCIENCES

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Imaging and related techniques

(15 lectures)

Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy.

Unit 2: Cell fractionation

(8 lectures)

Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl₂ gradient, analytical centrifugation, ultracentrifugation.

Unit 3: Radioisotopes

(4 lectures)

Use in biological research, auto-radiography.

Unit 4: Spectrophotometry Principle and its application in biological research. (4 lectures)

Unit 5: Chromatography

(8 lectures)

Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC.

Unit 6: Characterization of proteins and nucleic acids

(6 lectures)

Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE.

Unit 7: Biostatistics

(15 lectures)

Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

Practical

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate sugars by thin layer chromatography.
4. Isolation of chloroplasts by differential centrifugation.
5. To separate chloroplast pigments by column chromatography.
6. To estimate protein concentration through Lowry's methods.
7. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
8. Preparation of permanent slides (double staining).

Suggested Readings

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition. 29.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

DSE Paper-1 PLANT BIOTECHNOLOGY

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

- Introduction to Structural organization of Plant Genome; Genome organization in higher plants; Biochemical and molecular traits relevant to crop Productivity; Molecular markers. 15
- Agrobacterium and Ti Plasmid and physical DNA delivery methods 8
- Enhancer trap; Promoter tagging; gene tapping gene tagging; Insertional Mutagenesis; Developing herbicide resistance in crops: Target of herbicide action and Detoxification of herbicides; 12
- Genetic engineering of plants for Insect resistance: Bt toxins and use of protease; inhibitors Transgenic plants for disease resistance; Transgenic ornamental and fruit crops; Engineering plants for abiotic stress tolerance; Analysis of transgenics 12
- Approaches to marker-free transgenics; Gene silencing; PTGS; RNai; Antisense technology; Applications; Planti-bodies and plant vaccines 8
- Intellectual property rights; Biosafety; Bioethics and plant biotechnology 5

Practical

- Molecular markers.
- *Agrobacterium* and Ti Plasmid and physical DNA delivery methods
- Developing herbicide and Insect resistance resistance in crops.

Suggested Readings

- A Textbook of Biotechnology by B. P. Singh
- Introduction to Plant Biotechnology by H. S. Chawla

DSE Paper-2 TEA PHARMACOLOGY

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit-1

10 lectures

Chemical composition of tea leaf; Inorganic constituents, Nitrogen, carbohydrate and other associated compounds; Enzymes; Polyphenols; Aromatic compounds; Vitamins; Chlorophyll; Carotenoids; Volatile compounds.

Unit-2

10 lectures

Basic chemistry of polyphenols, alkaloids.

Unit-3

10 lectures

Biochemical changes during withering, rolling, fermentation and drying of tea.

Unit-4

10 lectures

Biochemical basis of quality; Flavour compounds of tea;; Role of volatile flavour components in tea.

Unit-5**10 lectures**

Pharmacology of tea; Focus on international works regarding health values on tea.

Unit-6**10 lectures**

Antioxidants: Natural antioxidants- category, chemistry, potency, sources, practical applications, and functionality during tea processing; Cardiovascular disease and nutritional phenolics; Antioxidants and antitumour properties; Bioavailability of antioxidants in tea.

Practical

1. Estimation of moisture content of food samples by oven (hot air/vacuum) drying method.
2. Estimation of ash content in tea.
3. Estimation of crude fibre content in tea by gravimetric method.
4. Estimation of caffeine and polyphenol content in tea.
5. Estimation of catechin content in tea.
6. Estimation of caretenoids.
7. Organoleptic evaluation of tea (tea tasting).

Suggested Readings

1. Tea, In health and Disease prevention Edited by V. R. Preedy, Elsevier
2. Tea Science and Human Health, TRA

DSE Paper-2 NATURAL RESOURCE MANAGEMENT**(Credits: Theory-4, Practical-2)****THEORY****Lectures: 60****Unit 1: Natural resources (6 lectures)**

Definition and types.

Unit 2: Sustainable utilization (8 lectures)

Concept, approaches (economic, ecological and socio-cultural).

Unit 3: Land (8 lectures)

Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.

Unit 4: Water (8 lectures)

Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.

Unit 5: Biological Resources (10 lectures)

Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan.

Unit 6: Forests (6 lectures)

Definition, Cover and its significance (with special reference to India); Major and minor Forest products; Depletion; Management.

Unit 7: Energy (6 lectures)

Renewable and non-renewable sources of energy

Unit 8: Contemporary practices in resource management (8 lectures)

Ecological Footprint with emphasis on carbon Foot print, Resource Accounting; Waste management.

Practical

1. Estimation of solid waste generated by a domestic system (biodegradable and non biodegradable) and its impact on land degradation.
2. Collection of data on forest cover of specific area.
3. Measurement of dominance of woody species by DBH (diameter at breast height) method.
4. Calculation and analysis of ecological footprint.
5. Ecological modelling

Suggested Readings

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

DSE Paper-3 TEA GARDEN MANAGEMENT **(Credits: Theory-4, Practical-2)**

THEORY **Lectures: 60**

Unit 1: Land preparation; Catchment planning, terracing, uprooting and rehabilitation; Layout and style of planting; Spacing, pits and trenches for tea planting; Planting materials, Planting techniques **(10 lectures)**

Unit 2: Management of Young Tea; Management of Mature Tea; Important shade trees in tea plantations; Different species of shade trees; **(15 lectures)**

Unit 3: Water management in tea; Irrigation and drainage systems in tea; Sprinkler and other methods of irrigation **(10 lectures)**

Unit 4: Integrated tea pest and disease management through different approaches, like cultural practices, chemical pest control, sex pheromones, insect growth regulators, and biological control; Weed management in tea; Integrated weed management techniques **(15 lectures)**

Unit 5: Soil and Integrated Nutrient Management; Organic farming; Various organic manures, Bio-fertilizers; Composting; Vermiculture; Mulching **(10 lectures)**

Practical

1. Special management practices relevant to the prevailing climatic and soil conditions
2. Study of various instruments in an agri-met observatory
3. Study of different style of planting; Techniques of planting
4. Study of mulching materials and mulching of tea, green cropping
5. Study of different types of shade trees and their characteristic features
6. Identification and collection of important pest and diseases of tea; Identification of weeds; alternate hosts
7. Preparation of herbarium specimens of diseased tea plant parts, shade trees and weeds
8. Preparation of dry and wet specimens of pest
9. Spray techniques - spray of pesticides
10. Study of various Irrigation systems and their applications

Suggested Readings

1. Tea- Eden (Longmans, Green and Co.)
2. Tea in India - Bala Subramaniam (Wiley Eastern)
3. Heritage of Indian Tea (IIME)
4. Science and Practice in Tea Culture – D.N. Barua (Tea Research Association)
5. The Planters' Handbook (Tea Research Association)
6. Field Management in Tea (Tocklai Experimental Station)
7. Shade Trees, Green Crops and Cover Crops – Memorandum 30 (Tea Research Association)
8. Drainage in Tea – J. Chakravartee (Tea Research Association)
9. Diseases of Tea and Associated Crops in North East India – K.C. Sarmah (Indian Tea Association – Scientific Department)
10. Pest Management in Tea – N. Muraleedharan (United Planters' Association of Southern India)

DSE Paper-3 TEA ENTOMOLOGY **(Credits: Theory-4, Practical-2)**

THEORY **Lectures: 60**

- Unit 1: Introduction** (05 lectures)
General Features of Insects
- Unit 2: Insect Taxonomy** (05 lectures)
Basis of insect classification; Classification of insects up to orders (according to Brusca and Brusca, 2016)
- Unit 3: General Morphology of Insects** (08 lectures)
External Features; Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits
Thorax: Wings and wing articulation, Types of Legs adapted to diverse habitat Abdominal appendages and genitalia
- Unit 4: Physiology of Insects** (20 lectures)
Structure and physiology of Insect body systems - Integumentary, digestive, excretory, circulatory, respiratory, endocrine, reproductive, and nervous system. Photoreceptors: Types, Structure and Function
- Unit 5: Insect Society** (08 lectures)
Social insects with special reference to termites
Trophallaxis in social insects such as ants, termites and bees
- Unit 6: Insect Plant Interaction** (06 lectures)
Theory of co-evolution, role of allelochemicals in host plant mediation Host-plant selection by phytophagous insects.
- Unit 7: Insects as Vectors** (08 lectures)
Insects as mechanical and biological vectors, Brief discussion on houseflies and mosquitoes as important vectors

Practical

1. Study of life cycle of Tea Mosquito Bag, Moth, Tea Jassids, Aphids, Tea Thrips
2. Study of different kinds of antennae, legs and mouth parts of insects
3. Mounting of insect wings, spiracles and genitalia of any insects
4. Methodology of collection, preservation and identification of insects.
5. Study of major insect pests of tea and their damages

Suggested Readings

1. A general text book of entomology, Imms, A. D., Chapman & Hall, UK
2. The Insects: Structure and function, Chapman, R. F., Cambridge University Press, UK
3. Principles of Insect Morphology, Snodgrass, R. E., Cornell Univ. Press, USA
4. Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F., M Saunders College Publication, USA
5. The Insect Societies, Wilson, E. O., Harvard Univ. Press, UK
6. Host Selection by Phytophagous insects, Bernays, E. A., and Chapman, R. F., Chapman and Hall, New York, USA
7. Physiological system in Insects, Klowden, M. J., Academic Press, USA
8. The Insects, An outline of Entomology, Gullan, P. J., and Cranston, P. S., Wiley Blackwell, UK
9. Insect Physiology and Biochemistry, Nation, J. L., CRC Press, USA
10. Medical Entomology, Hati A. K., Allied Book Agency, 2010
11. Pest Management in Tea, Muraleedharan, N., UPASI-Tea Research Institute
12. Pest of Tea in North-East India and their control, Tea Research Association, Tocklai Experimental Station
13. Science and Practice in Tea Culture, Barua, D. N., Tea Research Association

DSE Paper-4 BIOINFORMATICS **(Credits: Theory-4, Practical-2)**

THEORY

Lectures: 60

Unit 1. Introduction to Bioinformatics (10 Lectures)

Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.

Unit 2. Databases in Bioinformatics (12 Lectures)

Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.

Unit 3. Biological Sequence Databases (20 Lectures)

National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool,

Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein

Database, Gene Expression Database. EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction,

Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools. DNA Data Bank of Japan (DDBJ):

Introduction, Resources at DDBJ, Data Submission at DDBJ. Protein Information Resource (PIR): About PIR,

Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot: Introduction and Salient Features.

Unit 4. Molecular Phylogeny (8 Lectures)

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

Unit 5. Applications of Bioinformatics (10 Lectures)

Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR)

Practical

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.
5. Construction of phylogenetic tree.

Suggested Readings

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

DSE Paper-4 STRESS BIOLOGY
(Credits: Theory-4, Practical-2)

THEORY
Lectures: 60

Unit 1

Essential Nutrients: Deficiencies And Plant Disorders, Chelates, Treating Nutritional Deficiencies, Heavy-Metal Stress And Homeostasis. **10 lectures**

Unit 2

Stress: Osmotic, Temperature, Salinity, Anaerobic And Oxidative, Responses Of Plants To Environment Stress. **15 lectures**

Unit 3

Stress sensing mechanisms in plants (15 lectures)
Calcium modulation, Phospholipid signaling.

Unit 4: Developmental and physiological mechanisms that protect plants against environmental stress (12 lectures)

Adaptation in plants; Changes in root: shoot ratio; aerenchyna development; Osmotic adjustment; Compatible solute production.

Unit 5: Reactive oxygen species

Production and scavenging mechanisms. **(8 lectures)**

Practical

1. Quantitative estimation of peroxidase activity in the seedlings in the absence and presence of salt stress.
2. Superoxide activity in seedlings in the absence and presence of salt stress.
3. Zymographic analysis of peroxidase.
4. Zymographic analysis of superoxide dismutase activity.
5. Quantitative estimation and zymographic analysis of catalase.

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

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