

# **SYLLABUS IN BOTANY**

**(3-year General & Honours Courses)**

**UNIVERSITY OF NORTH BENGAL**

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**UNIVERSITY OF NORTH BENGAL**  
**B.Sc. Courses in Botany (General)**  
 Total Marks - 400    ::    Duration - 3 years

Full Lecture  
Marks    Period

**PART - I**

Total Marks - 150    ::    Duration - 1 year

<b>Theoretical</b>			
<b>Paper - I</b>	: Diversity of microbes and cryptogams	45	75
<b>Paper - II</b>	: Diversity of seed plants and their systematics, Anatomy	45	75
<b>Practical</b>			
<b>Paper - III</b>	: Corresponding to Paper - I and Paper - II	60	150

**PART - II**

Total Marks - 150    ::    Duration - 1 year

<b>Theoretical</b>			
<b>Paper - IV</b>	: Cell biology and Genetics	45	75
<b>Paper - V</b>	: Plant physiology and biochemistry, Ecology, Plant geography	45	75
<b>Practical</b>			
<b>Paper - VI</b>	: Corresponding to Paper - IV and Paper - V	60	150

**PART - III**

Total Marks - 100    ::    Duration - 1 year

<b>Theoretical</b>			
<b>Paper - VII</b>	: Plant pathology, Plant biotechnology, Plant breeding Utilization of plants	60	170
<b>Practical</b>			
<b>Paper - VIII</b>	: Plant pathology, Microbiology, Plant biotechnology, Plant breeding	40	90

## PART - I

### Paper – I

#### Diversity of microbes and cryptogams

Prokaryotes and viruses: Prokaryotes- structure, nutrition, reproduction and economic importance; general account of viruses

Algae: general characters; classification and economic importance; general account of Cyanophyceae; important features and life history of members of: Chlorophyceae– *Oedogonium*, *Chara*; Xanthophyceae- *Vaucheria*; Phaeophyceae- *Ectocarpus*; Rhodophyceae- *Polysiphonia*.

Fungi: general characters; classification and economic importance; important features and life history of members of: Mastigomycotina- *Phytophthora*; Zygomycotina- *Rhizopus*; Ascomycotina- *Saccharomyces*; *Ascobolus*; Basidiomycotina- *Puccinia*

Bryophytes: amphibians of plant kingdom displaying alteration of generations; structure, reproduction and classification of Hepaticopsida (*Marchantia*); Anthocerotopsida (*Anthoceros*); Bryopsida (*Funaria*)

Pteridophytes: important characteristics of Psilopsida, Lycopsida, Sphenopsida and Pteropsida; structure, reproduction in *Rhynia*, *Psilotum*, *Lycopodium*, *Equisetum*, and *Marsilea*

### Paper – II

#### Diversity of seed plants and their systematics

Characteristics of seed plants; evolution of the seed habit; seed plants with (angiosperms) and without (gymnosperms) fruits

General features of gymnosperms and their classification; geological time scale; fossilization; fossil gymnosperms

Morphology of vegetative and reproductive parts; anatomy of root, stem and leaf; reproduction and life cycle of *Pinus*, *Cycas*, and *Gnetum*

Inflorescence: definition; types of racemose and cymose inflorescences

Flower: types and forms; cohesion and adhesion of stamens; placentation; ovule (typical); self and cross pollination; pre-fertilization changes and fertilization process; endosperm and embryo (dicot); fruit and seed types and their dispersal

Principles of nomenclature; identification and classification of plants; importance of herbaria

Systems of classification: Bentham and Hooker's and Engler & Prantl's systems

Diagnostic characters and economic importance of the following families with examples: Magnoliaceae, Brassicaceae, Malvaceae, Fabaceae (s.l.), Asteraceae, Solanaceae, Verbenaceae, Lamiaceae, Apiaceae, Orchidaceae, and Poaceae

#### Anatomy

Mechanical tissue

Root-stem transition

Secondary growth- normal and anomalous

### Paper – III (Practical)

Work out, drawing, description, microscopic preparation and identification of the following:

**Algae:** *Nostoc*, *Oedogonium*, and *Chara*

**Fungi:** *Rhizopus*, *Ascobolus*/*Peziza*, and *Puccinia*

**Bryophytes:** *Marchantia* and *Funaria*

**Pteridophytes:** *Lycopodium*, *Equisetum*, and *Marsilea*

### **Gymnosperms**

Morphological identification of megasporophyll and microsporophyll of *Cycas* and male female cone of *Pinus*

T. S. of *Cycas* leaflet and *Pinus* needle; L.S. of ovule of *Gnetum* (from permanent slides)

### **Taxonomy of angiosperms**

Dissection, drawing, and description of angiospermic plants with floral parts, floral formulae and floral diagrams of the following families: Brassicaceae, Fabaceae (s.l.), Malvaceae, Solanaceae, Verbenaceae, and Lamiaceae

Spot identification of locally available plants from the families included under theory syllabus

### **Anatomy**

Anatomical studies following double staining method of the following materials:

Stem: sunflower, cucurbit, maize, and *Mirabilis*

Root: gram, orchid, and *Arum*

Leaf: *Nerium*

## **PART – II**

### **Paper – IV**

#### **Cell Biology and Genetics**

The cell envelopes: plasma membrane- lipid bilayer structure; functions; the cell wall

Structure and function of other organelles: Golgi complex, ER, ribosomes, nucleus peroxisomes, vacuoles

Chromosome organization: morphology; ultrastructure, centromere and telomere; chromosome structural alterations; variations in chromosome number – aneuploidy, polyploidy; sex chromosomes

DNA: structure; replication; model; genetic code

Cell division: mitosis; meiosis

Genetic inheritance: Mendelism; preliminary idea of linkage and crossing over; allelic and non-allelic interactions

Gene expression: structure of gene; protein biosynthesis

Genetic variations: mutations; spontaneous and induced; transposable genetic elements

Extranuclear genome: presence and function of mitochondrial and plastid DNA; plasmids

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### **Paper – V**

#### **Plant physiology and biochemistry**

Mechanisms of absorption of water and minerals; transpiration- definition and types, mechanism and significance

Mineral nutrition: essential elements and their role

Translocation of organic solutes, ascent of sap

Respiration: types; aerobic and anaerobic; fermentation; glycolysis; Krebs's cycle; electron transport system; R.Q.

Photosynthesis: photosynthetic pigments; mechanism; C<sub>3</sub> and C<sub>4</sub> pathway, law of limiting factors

Biological nitrogen fixation

Photoperiodism: definition; long-day and short-day plants with examples

Plant hormones: definition; role of IAA, gibberellin, gytokinin, and abscissic acid

Carbohydrates: mono-, di- and oligo-sachharides – elementary idea

Proteins: primary, secondary and tertiary structures – elementary idea  
Enzymes – definition and properties

### **Ecology**

Factors affecting vegetation  
Plant succession  
Adaptations of hydrophytes, xerophytes, and halophytes  
Study of ecosystem  
Conservation of forest

### **Plant geography**

Phytogeographical regions of India (D. Chatterjee, 1960)  
Characteristic regions of Sunderbans and Eastern Himalayas

## **Paper – VI (Practical)**

### **Cytology**

Study of mitotic stages from squash preparation (root tip of onion)  
Identification of following meiotic stages from permanent slides: diakinesis, metaphase I, anaphase I, metaphase II, and anaphase II

### **Plant physiology**

Demonstration of plasmolysis  
Measurement of leaf area (graphical method) and determination of rate of transpiration per unit area by weighing method  
Imbibition of water by dry seeds- proteinaceous and fatty seeds  
Determination of evolution of oxygen during photosynthesis (using graduated tubes) against dark control  
Evolution of carbon dioxide during aerobic respiration and measurement of volume

### **Biochemistry**

Qualitative determination of glucose, starch, tartaric acid, and citric acid

## **PART – III**

## **Paper – VII**

### **Plant pathology**

Terms and definitions: disease; inoculum; pathogenicity; resistance; Koch's postulate; plant quarantine  
Symptoms, causal organism and control of: late blight of potato, brown spot of rice, rust of wheat, and stem rot of jute

### **Plant biotechnology**

Recombinant DNA technology: a preliminary idea of restriction enzymes, vectors, cloning, selection, and identification; application in plant improvement  
Tissue culture: totipotency; techniques of embryo culture; pollen culture and meristem culture; application

### **Plant Breeding**

Propagation: cloning; grafting; bonsai; and aquaculture

### Utilization of plants

Bio-fertilizers: N<sub>2</sub>-fixing microbes; VAM fungi; *Azolla* and their role in agriculture

Study of economically important plants (scientific names, families, parts used, and uses) as follows: Food plants- rice, wheat, and potato

Fibres- cotton and jute

Vegetable oils- groundnut and mustard

Spices- ginger and cumin

Beverages- tea and coffee

Medicinal plants: use and phytochemistry of *Cinchona*, *Citronella*, *Catharanthus*, and *Azadirachta*

Cultivation of edible mushroom- *Pleurotus*

### Paper – VIII

#### Plant pathology, Microbiology, Plant breeding, Plant biotechnology

Acquaintance of common laboratory equipment: balances, autoclave, incubator, and centrifuge

Identification of diseased plant specimens and causal organisms as described in theoretical syllabus

Demonstration of preparation of media and sterilization process

Demonstration of sub-culturing and isolation of pathogen

Histopathological studies on any four diseases of major crop plants

Preparation of curd and study of curd organisms

Spawn preparation and cultivation of mushroom

Demonstration of grafting and layering

Visit to local agricultural farms (2)

### Model question format and marks break-up in Practical papers

#### PART - I

#### Paper III: Cryptogams, Gymnosperms, Taxonomy of angiosperms, Anatomy

Time: 5 h

Full marks: 60

1. Work out – algae/ fungi	8
2. Work out – bryophyte/ pteridophyte	8
3. Work out of angiospermic plant (as per syllabus)	12
4. Anatomy- work out	10
5. Identification of gymnosperms (macroscopic /microscopic) – 3	6
6. Spot identification of angiospermic plant (genus/family) - 2	2
7. Laboratory and field records	8
8. Viva voce	6

**Note:** There should be submission of 10 selected herbarium sheets of angiosperms.

## **PART – II**

### **Paper - VI: Cytology, Plant physiology, Biochemistry**

Time: 5 h

Full Marks: 60

- |  |    |
|--|----|
| 1. Cytology (root tip)                             | 17 |
| 2. Plant physiology experiment                     | 15 |
| 3. Biochemistry – qualitative detection (1 sample) | 10 |
| 4. Identification of slides (meiotic stages) – 3   | 6  |
| 5. Laboratory records                              | 6  |
| 6. Viva voce                                       | 6  |

## **PART - III**

### **Paper VI: Plant Pathology, Microbiology, Plant Breeding, Plant Biotechnology**

Time: 5 h

Full marks: 40

- |  |   |
|--|---|
| 1. Histopathological studies of one specimen                 | 8 |
| 1. Demonstration of subculturing / isolation (any one)       | 6 |
| 2. Study of curd microflora                                  | 8 |
| 3. Demonstration of grafting/layering                        | 5 |
| 4. Identification of diseased specimen (herbarium sheet) – 2 | 3 |
| 5. Laboratory and field records                              | 6 |
| 6. Viva voce   | 4 |

**Note:** There should be at least three excursions, one in each year.

## **Suggested Readings**

- Kumar, H.D. – Phycology  
Vashista, P.C. – Algae, S.C. Chand  
Gangulee, H.C. and Kar, A.K. – College Botany, Vol. I and II  
Mehrotra and Aneja – Introduction to Mycology  
Singh, R.S. – Plant Disease  
Singh, R.S. – Plant Pathology  
Mehrotra – Plant Pathology  
Schlegel, H.G. – General Microbiology, Cambridge University Press  
Pelczar, Chan and Kreig – Microbiology  
Vashista, B.R. – Bryophyte  
Puri, P. – Bryophyte  
Sporne, K.R. – A Morphology of Pteridophyte.  
Vashista, P.C. – Pteridophyte  
Vashista, B.R. – Gymnosperm

Datta, S. C. – Systematic Botany  
Mukherjee, S. – College Botany, Vol. III  
Maheshwari, P. – An introduction to Embryology of Angiosperms  
Bhojwani and Bhatnagar – The Embryology of Angiosperms  
Mitra, Guha and Choudhuri – Studies in Botany. Vol. II  
Malik and Srivastava – Plant Physiology  
Gupta, P.K. – Genetics  
Verma and Agarwal – Concept of Cell Biology  
Verma and Agarwal – Concept of Molecular Biology  
Singh, B.D. – Plant Breeding



## B.Sc. Courses in Botany (Honours)

Total Marks - 800 :: Duration - 3 years

		Full Marks	Lecture Period
<b>PART - I</b>			
Total Marks - 200 :: Duration - 1 year			
<b>Theoretical</b>			
<b>Paper - I</b>	: Phycology, Mycology, Bryology, Pteridology	70	130
<b>Paper - II</b>	: Gymnology, Palaeobotany, Morphology, Anatomy	70	130
<b>Practical</b>			
<b>Paper - III</b>	: Corresponding to Paper-I and Paper-II	60	260
<b>PART - II</b>			
Total Marks - 200 :: Duration - 1 year			
<b>Theoretical</b>			
<b>Paper - IV</b>	: Systematics of angiosperms, Utilization of plants, Ecology, Plant geography	70	130
<b>Paper - V</b>	: Cell biology, Plant biochemistry	70	130
<b>Practical</b>			
<b>Paper - VI</b>	: Corresponding to Paper-IV and Paper-V	60	260
<b>PART - III</b>			
Total Marks - 400 :: Duration - 1 year			
<b>Theoretical</b>			
<b>Paper - VII</b>	: Genetics, Plant breeding, Molecular biology	80	120
<b>Paper - VIII</b>	: Plant physiology, Biostatistics	80	120
<b>Paper - IX</b>	: Microbiology, Plant pathology, Plant biotechnology	80	120
<b>Practical</b>			
<b>Paper - X</b>	: Genetics and Plant breeding, Plant physiology, Biostatistics	80	225
<b>Paper - XI</b>	: Microbiology, Plant pathology	80	225

## PART – I

### Paper – I

#### Phycology

Occurrence and distribution; range of thallus structure; economic and ecological importance  
Classification; general characters and life cycles of typical genera of Chlorophyta (*Zygnema*, *Oedogonium*, *Chara* and *Trentepohlia*), Xanthophyta (*Vaucheria*), Phaeophyta (*Ectocarpus* and *Fucus*), and Rhodophyta (*Batrachospermum* and *Polysiphonia*). General account of Cyanophyta and Bacillariophyta  
Origin and evolution of sex

#### Mycology

Classification (Ainsworth's); fungal hyphae and their modifications; cell wall; nutrition; spore forms; life cycle patterns and reproduction  
Diagnostic characters of Myxomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, and Deuteromycotina; life cycles of *Phytophthora*, *Rhizopus*, *Saccharomyces*, *Eurotium*, *Neurospora*, *Peziza*, *Puccinia*, and *Agaricus*  
Mycorrhiza: ecto- and endo-mycorrhiza; their role in agriculture and forestry  
Mushroom: cultivation and food value  
Lichens: general account; ecological and economic importance

#### Bryology

Classification; habit and habitat; morphology and structural organization of gametophytes and sporophytes; reproductive mechanisms; trends in evolution in main groups; origin  
Life cycles of *Riccia*, *Marchantia*, *Anthoceros*, *Sphagnum*, and *Funaria*  
Ecological aspects and economic importance

#### Pteridology

Classification and general features; origin- telome theory; stelar evolution; heterospory and seed habit  
Life history of *Psilotum*, *Lycopodium*, *Selaginella*, *Isoetes*, *Equisetum*, *Ophioglossum*, *Marsilea*, and *Adiantum*  
General account of fossil genera- *Rhynia*, *Psilophyton*, *Lepidodendron*, *Lepidocarpon*, *Calamites*, and *Archaeopteris*

### Paper - II

#### Gymnology

Classification; ontogeny and structure of seed; evolution of seed habit; economic importance.  
Life-history of *Cycas*, *Pinus*, *Ephedra*, and *Gnetum*

#### Palaeobotany

General account of fossil groups  
Fossil types- *Williamsonia*, *Cordaites*, *Glossopteris*; nomenclature; process of fossilization  
Geological time scale; and major events of plant life through geological times  
Methods of determination of age of fossils

## **Morphology**

Flower: cohesion; adhesion; aestivation; ovule types; placentation; floral formula; floral diagram

Concepts of flower as a modified shoot

Pollination: types and contrivances

Fruits and seeds: general concept, types and dispersal

Embryology: microsporogenesis; megasporogenesis; microgametogenesis; megagametogenesis; development and types of embryo sacs; fertilization; development of embryo in dicot; endosperm development and its types

## **Anatomy**

Meristems and development: shoot apical meristem; root apical meristem; lateral meristems and their functions; theories of origin

Epidermis and its emergences; stomatal types and ontogeny

Range of form and structure of stem, leaf and root; their tissues and functions; stelar types and evolution; root-stem transition

Secondary body of the plant: vascular cambium; secondary xylem; secondary phloem; periderm

Anomalous secondary growth with examples

## **Paper - III (Practical)**

**Phycology:** study of representative genera from different classes such as *Anabaena*, *Nostoc*, *Volvox*, *Oscillatoria*, *Oedogonium*, *Chara*, *Vaucheria*, *Ectocarpus*, and *Polysiphonia*

**Mycology:** study of *Rhizopus*, *Ascobolus* / *Peziza*, *Agaricus*, and *Polyporus*.

**Bryology:** study of morphology, anatomy and reproductive structures in *Riccia*, *Marchantia*, *Anthoceros*, and *Funaria*

**Pteridology:** study of morphology, anatomy and reproductive structures in *Lycopodium*, *Selaginella*, *Equisetum*, *Marsilea*, *Dryopteris*, and *Pteris*

**Gymnology:** study of morphology, anatomy and reproductive structures in *Cycas*, *Pinus*, and *Gnetum*.

**Palaeobotany:** study of fossil slides of: *Lepidodendron*, *Lepidocarpon*, *Sphenophyllum*, *Lyginopteris*, *Medullosa*, and *Glossopteris*

**Morphology:** study of morphological structures with special reference to peculiarities.

**Anatomy:** organization of shoot and root apical meristem (from whole mounts /vertical sections); microscopic studies of trichomes, stomata, sclereids, raphides, cystolith, starch grains, and lenticels; anatomy of root, stem (*Leucus/Leonurus*), and leaf (*Nerium*); study of xylem and phloem by maceration technique; study of anomalous secondary growth in *Tinospora*, *Bignonia*, *Boerhaavia*, *Tecoma*, and *Strychnos*

## **PART – II**

### **Paper - IV**

#### **Systematics of angiosperms**

Principles of nomenclature: elementary knowledge of ICUN; rules of priority; typification; conservation; effective and valid publications

Systems of classification: Bentham & Hooker's, Hutchinson's, Engler & Prantl's, and Takhtajan's systems

Phylogeny of angiosperms: general account of the origin and evolution of angiosperms (special reference to Bennettitalean, Gnetalean, Caytonalean and herbaceous origin theories)  
Modern trends in taxonomy: supporting evidences/inputs for taxonomy; taxonomy in relation to anatomy, palynology, ecology, cytology, and secondary metabolites in plants (chemotaxonomy); numerical taxonomy  
Systematics in practice: importance of herbarium specimens and their preparation; role of herbaria and botanical gardens; documentation; keys for identification of plants; value of computers and data bases for identification  
Diagnostic features and systematic positions of Magnoliaceae, Ranunculaceae, Malvaceae, Fabaceae (s.l.), Euphorbiaceae, Apiaceae, Apocynaceae, Solanaceae, Scrophulariaceae, Acanthaceae, Lamiaceae, Rubiaceae, Cucurbitaceae, Asteraceae, Commelinaceae, Alistamaceae, Poaceae, Orchidaceae, and Araceae

### **Utilization of plants**

Scientific names, families, plant parts used and purpose of use of the following:

Cereals and millets- rice, wheat, maize, sorghum, and bajra

Pulses- soybean, chickpea (Bengal gram), red gram (arahar), masur, and mung

Vegetable oil sources- mustard, groundnut, coconut, and sunflower

Plant fibers- cotton, jute, and coir

Timber- teak, sal, sissoo, and mahogany

Medicinal- at least ten plants including sarpagandha, neem, kalmegh, tulsi, *Ipecac*, thankuni, arjun, and *Swertia chirayita*

Spices – turmeric, ginger, cumin, pepper, coriander, cardamom, and cinnamon

Fruits- mango, orange, banana, guava, pineapple, jackfruit, and grape

Volatile oil- Lemon grass, *Eucalyptus*, *Mentha*, and clove oil

Latex- rubber and *Euphorbia*

Beverages- tea and coffee

Narcotics- opium and ganja

Vegetables

### **Ecology**

Organismal ecology/biotic components: individuals, species, populations, communities and their characteristics

Ecosystems: concepts; homeostasis; structure and functions of ecosystem; energy flow; cycling of C, N and P; the biotic and abiotic components and their inter-relationships; processes within the ecosystem; the trophic organization- autotrophy, heterotrophy, parasitism, detritus, and decomposition

Ecological succession: mechanisms and type; food chains and food webs; ecological pyramids

Ecological adaptations: hydrophytes, xerophytes, halophytes, and epiphytes

### **Plant geography**

Phytogeographical regions of India (D. Chatterjee, 1960)

Characteristic regions of Sunderbans, Eastern Himalayas, and Western Himalayas

## **Paper – V**

### **Cell biology**

The cell: historical background; cell theory; kingdom-wise cell size and cell structure; viroids and prions; concept of three domains- archaea, prokarya and eukarya; comparative account of prokaryotic and eukaryotic cells

Cell division and its regulation: mitosis and meiosis; various stages of cell division and progression; cytokinesis; role of centromere, kinetochore and spindle apparatus; animal and plant cell cycle; mechanisms of cell cycle control; apoptosis

Nucleus and ribosomes: ultrastructure; nuclear envelope and nuclear pore complex; nuclear matrix and nucleoplasm; DNA and histones; chromosome structure – nucleosome concept, metaphase chromosome, solenoid structure; ribosome structure; prokaryotic, eukaryotic and organellar ribosomes and their functional significance

Mitochondrion and chloroplast: origin of organelles; organelle structure and biogenesis; organelle membranes and organization of macromolecular complexes; variation in size, shape and number.

Structure/function of other sub-cellular structures: Golgi complex; endoplasmic reticulum; lysosomes; microbodies – peroxisomes and glyoxisomes; cytoskeleton

Techniques in cell biology: principles of light and electron microscopy- TEM and SEM; phase contrast and fluorescence microscopy

### **Plant biochemistry**

Cellular chemistry: covalent and non-covalent interactions; hydrogen bond; electrostatic interactions; hydrophobic interactions; Van der Waals forces and their significance; structure, properties of water and its biological significance; pH and its significance; pH scale; Henderson-Hasselbach equation; buffers

Bioenergetics and enzymology: laws of thermodynamics; concept of free energy; energy transfer and redox potential; classification and nomenclature of enzymes; kinetics of enzyme action – Michaelis - Menton equation; significance of  $K_m$ ; factors affecting enzyme activity; enzyme inhibitors; allosteric modification and feed back regulation

Amino acids and proteins: structure, characteristics and classification of amino acids; peptide bonds and polypeptide chain; higher order structures of proteins; amino acid biosynthesis- GS/GOGAT cycle; protein biosynthesis and its regulation

Carbohydrates: classification; structures of representative examples of mono-, di- and polysaccharides; stereoisomers; enantiomers and epimers; functions – storage & structural.

Lipids: classification; saturated and unsaturated fatty acids; triglycerides

Nucleic acids: composition of nucleic acids; DNA structure; A, B and Z forms of DNA; denaturation and renaturation of DNA; DNA replication; DNA polymerases; different forms of RNA and their roles

### **Paper – VI (Practical)**

#### **Systematics of angiosperms**

Study of the morphology of locally available plants of following families including floral formula, floral diagram and their identification up to genus by following published keys (eg., Bengal Plants by David Prain, 1903): Malvaceae, Fabaceae (s.l.), Euphorbiaceae, Apiaceae, Apocynaceae, Solanaceae, Scrophulariaceae, Acanthaceae, Lamiaceae, Rubiaceae, Cucurbitaceae, and Commelinaceae

Spot identification up to species, mentioning families of all locally available plants included under the theoretical syllabus

#### **Utilization of plants**

Study of whole drug-yielding medicinal plants (live or from herbarium specimen): *Adhatoda vasica*, *Rauwolfia serpentina*, *Solanum khasianum*, *Ocimum sanctum*, *Zingiber officinale*, *Azadirachta indica*, *Andrographis paniculata*/*Swertia chirata*, *Holarrhena antidysenterica*, *Allium cepa*, and *Centella asiatica*

Study of dye-yielding plants- morphology and identification of plant parts; study of stem of jute with special reference to origin and nature of fibre

### **Ecology**

To study soil properties by spot test: texture, pH, carbonate, and nitrate

Estimation of dissolved CO<sub>2</sub> in water from different sources

To study ecological adaptations (morphological and anatomical) in plants (hydrophytes, xerophytes, and epiphytes)

To determine minimum area of sampling unit (quadrat) for the study of communities

### **Cell biology**

Study of cell structure from onion leaf peels; demonstration of staining and mounting methods and preparation of stains

Comparative study of cell structure in onion cells, *Hydrilla* and *Spirogyra*; study of cyclosis in *Tradescantia* staminal hairs/other materials

Study of mitotic cell division and mitotic index of *Allium cepa* by aceto-orcein squash technique

Study of somatic complement of at least three of the following: *Allium cepa*, *A. sativum*, *Aloe vera*, *Lens esculenta*, and *Sagittaria sagittifolia*

Study of meiosis of *Allium cepa*, *Rhoeo* and *Sagittaria* by aceto-carmines smear technique

### **Plant biochemistry**

Preparation of buffers

Determination of pH of plant juices

Qualitative tests for organic acids (oxalic, citric, tartaric, and malic), carbohydrates (reducing, non-reducing) and proteins from laboratory samples

Quantitative estimation of proteins by Biuret method

Quantitative determination of reducing sugars by arseno-molybdate method

Qualitative detection of catalase, peroxidase, and amylase

## **PART - III**

### **Paper - VII**

#### **Genetics**

Mendel's experiments and principles of inheritance: Mendelism— principles, history, significance, chromosomal basis; back cross and test cross; gene interactions and modified dihybrid ratios— complementary, supplementary, duplicate, and epistatic factors

Allelism: concept of alleles; multiple alleles; pseudoalleles; human blood groups

Quantitative genetics: Hardy-Weinberg law; quantitative traits and quantitative genetics; heritability

Linkage and recombination: linkage and crossing over; three-point crosses and chromosome mapping; interference and coincidence; molecular basis of crossing over; RecA protein

Sex determination and sex differentiation: chromosomal basis of sex determination in *Drosophila*, man, silkworm and *Melandrium*; sex-linked inheritance; sex-limited characters; modern concept of sex determination

Mutations: spontaneous and induced mutations; mutagens—types and mode of action; transitions, transversions and frame-shift mutations; detection of mutations

Alterations in chromosome structure and number: origin, types and effects of duplications, deletions, inversions and translocations; origin, types and effects of auto and allopolyploid; origin and meiosis in nullisomics and trisomics

### **Plant breeding**

Vegetative propagation methods: cutting, grafting, layering, cloning

Hybridization techniques: inter-specific and inter-generic; male sterile lines; and heterosis

Maintenance of germplasm: gene bank; pollen bank; and seed bank

Methods of plant improvement: pure line and mass selection; hybridization in self and cross pollinated crops; introduction and acclimatization

### **Molecular biology**

Gene structure, expression and regulation: gene organization and regulation in prokaryotes and eukaryotes; operon concept; inducible, repressible, positive and negative gene regulation; interrupted genes in eukaryotes; RNA splicing; mRNA stability

Recombinant DNA technology: restriction endonucleases; prokaryotic and eukaryotic cloning vectors; genomic and cDNA libraries; Southern and northern analyses; techniques of gene mapping and DNA fingerprinting (RFLP, RAPD, AFLP); PCR; DNA sequencing

## **Paper - VIII**

### **Plant physiology**

Plant-water relations: water transport processes; diffusion and osmosis; absorption of water and transport; transpiration and its significance; factors affecting transpiration; mechanism of stomatal movement

Mineral nutrition: criteria of essentiality of elements; macro-and micro-nutrients; role and deficiency symptoms of essential elements; nutrient uptake and transport mechanisms

Photosynthesis: photosynthetic pigments and accessory pigments; organization of photosystems; photochemical reactions; electron transport in chloroplast membrane and photophosphorylation; the C<sub>3</sub>, C<sub>4</sub>, and CAM cycles; photorespiration

Respiration: glycolysis; conversion of pyruvate to acetyl-CoA; Krebs cycle; ETS; oxidative pentose phosphate pathway

Nitrogen metabolism: biological nitrogen fixation; reduction of N<sub>2</sub> into ammonia; elementary idea of *nif* and *nod* genes; nitrate and ammonium assimilation

Plant growth regulators: role and application of auxin, gibberellin, kinetin, ABA, and ethylene

Physiology of dormancy and germination

Physiology of flowering: vernalization; photoperiodism; concept of biological clock and biorhythm

### **Biostatistics**

Knowledge of sampling, mean, median, mode, standard deviation, and standard error

Probability; t-test; goodness of fit by chi-square analysis

Preliminary knowledge of correlation coefficient and regression

## **Paper - IX**

### **Microbiology**

Discovery of microorganisms: systematic position of microorganisms in the biological world; classification of microorganisms, and characteristic features of different groups

Cellular organization of bacteria: cell wall; membrane; pili; flagella; chromosome; endospore; and ribosome

Genetic recombination in prokaryotes: conjugation, transformation, and transduction

Principles and modern approach to bacterial taxonomy: numerical taxonomy; DNA-DNA and DNA-RNA hybridization; DNA and RNA fingerprinting

Viruses: properties and classification; characteristic features of host-virus interaction; bacteriophage T4; tobacco mosaic virus

General account of mycoplasmas and actinomycetes  
Role of microorganisms in biogeochemical cycling of nitrogen and carbon; biological N<sub>2</sub> fixation.  
Industrial application of microorganisms: organic acids- citric and glutamic acids; alcohol; food processing; milk products; antibiotics; biopesticides

### **Plant pathology**

Terms and definitions: disease, symptoms, causal complex, primary and secondary inocula, penetration, infection, pathogenesis, resistance, immunity, Koch's postulate, and plant quarantine  
Pathogen attack and defense mechanisms: physical, physiological, biochemical, and molecular aspects  
Plant disease epidemiology: transmission and spread of plant pathogens; disease cycles; epidemics; modelling and disease forecasting  
Genetics of resistance and susceptibility: genes for virulence and avirulence; molecular diagnosis; induced resistance (immunization); molecular manipulation of resistance  
Plant disease management: chemical, biological, IPM systems; development of transgenics; biopesticides  
Symptoms, causal organisms, disease cycle and control measures of: brown spot, tungro virus, and bacterial blight of rice; loose smut and rust of wheat; late blight of potato; stem rot of jute; and blister blight of tea  
Application of Information technology in plant pathology: simulation of epidemics; programmes for diagnosis; prediction of disease control decisions

### **Plant biotechnology**

Cellular differentiation and totipotency; organogenesis and embryogenesis; protoplast isolation and culture; somatic hybridization; clonal propagation  
Genetic engineering of plants: vectors for gene delivery; methods of gene delivery; selectable markers and reporter genes  
*Agrobacterium*- the natural genetic engineer  
Salient achievements in crop biotechnology (with suitable examples) and prospects

### **Paper - X (Practical)**

#### **Genetics and Plant breeding**

Determination of chromosome count from dividing pollen mother cell, root tips and pollen grains  
Study of meiotic slides with chromosomal abnormalities (from permanent slides)  
Study of special chromosomes- salivary gland chromosomes, and lampbrush chromosomes  
Preparation of serial microscopic sections of cytological materials using microtome  
Emasculation and bagging of flowers

#### **Plant physiology**

Effect of detergents and temperature on permeability of plasma membranes (major)  
Determination of osmotic potential of cell by plasmolytic method (minor)  
Determination of ratio of water absorption and transpiration (major)  
Determination of RQ of different types of seeds using Ganong's respirometer or respiroscope (major)  
Determination of stomatal index, stomatal frequency; effect of KNO<sub>3</sub> on stomatal closure (minor)  
Effect of light and CO<sub>2</sub> on rate of photosynthesis (major)  
Separation of plant pigments by paper chromatography (major)  
Determination of total titrable acidity of cell sap (major)  
Determination of rate of evolution of CO<sub>2</sub> during aerobic respiration (major)

#### **Biostatistics**

Measurement of central tendency: mean, median, and mode



Measurement of dispersion: variance, standard deviation, and standard error  
Determination goodness of fit  
Student's t-test

## **Paper – XI (Practical)**

### **Microbiology**

Isolation of microorganisms: streaking on agar plates/pour plate method; isolation of colonies; preservation  
Determination of growth of a microorganism (model organism *Escherichia coli*); effects of nutrients- glucose, fructose, and sucrose  
Determination of microbial population size: use of haemocytometer and serial dilution technique; relation between dilution and cell count  
Gram staining technique: Identification of Gram positive and negative bacteria  
Isolation of bacteroids from root nodules/curd and Gram staining

### **Plant pathology**

Isolation and culture of plant pathogens (*Colletotrichum*, *Fusarium*, and *Alternaria*) and establishment of Koch's postulate and their pathogenicity  
Histopathological study of important plant diseases- brown spot of rice, loose smut of wheat, rust of wheat, wart of potato, late blight of potato, and stem rot of jute  
Study on antagonism *in vitro* between isolated antagonists and plant pathogens  
Demonstration of antibiosis using a bacterial culture and known antibiotics  
Demonstration of biopesticides (essential oils, neem, and garlic) against some pathogens

## **Suggested question format and marks break-up in Practical papers**

### **PART – I**

#### **Paper - III: Phycology, Mycology, Bryology, Pteridology, Gymnology, Palaeobotany, Morphology, Anatomy**

Time: 6 h

Full marks: 60

1. Work out one specimen – alga/ fungus (camara lucida drawing in case of alga and measurement of spore size in case of fungus) 8
2. Work out the vegetative and reproductive structures with suitable staining of one bryophyte/ pteridophyte 10
3. Anatomy- transverse sections of sample with double staining 10
4. Identification (gymnosperms- 3 specimens, and fossil slides- 2) 10
5. Comment on morphology (3 specimens) 6
6. Submission (laboratory and field records, slides) 10
7. Viva voce 6

## PART – II

### Paper - VI: Systematics of angiosperms; Utilization of plants, Ecology, Cell biology, Plant biochemistry

Time: 6 h

Full marks: 60

1. Work out one angiospermic plant (as per syllabus) 12
  2. Study of somatic chromosomes from root tip 10
  3. Estimation of dissolved CO<sub>2</sub>/ soil carbonate/ nitrate 6
  4. Qualitative detection of organic acids (oxalic, citric, tartaric, malic), carbohydrates (reducing, non-reducing) , proteins or enzymes (any 2) 6
- or
- Quantitative estimation of proteins/ reducing sugars from laboratory samples (standard curve to be provided) 6
5. Identification of cytological slides with meiotic stages (2) 4
  6. Identification of whole plant/ plant parts used of economically important plants (2) 4
  7. Identification of adaptations (morphological/ anatomical) of 2 specimens 4
  8. Spotting (2 plants) 2
  9. Submission (laboratory and field records, slides) 6
  10. Viva voce 6

**Note:** There should be 25 selected herbarium sheets on angiospermic specimens.

## PART - III

### Paper - X: Genetics and Plant breeding, Plant physiology, Biostatistics

Time: 6 h

Full marks: 80

1. One major physiological experiment 15
2. One minor physiological experiment 10
3. Microtomy – demonstration (material-embedded paraffin block to be supplied) 12
4. Biostatistics – (mean, median, mode/ variance, standard deviation, standard error/ t-test / goodness of fit) 10
5. Study of special chromosomes/ chromosome count 8
6. Identification of chromosomal aberration in meiotic slides (from permanent slides- 3) 6
7. Demonstration of emasculation and bagging 6
8. Submission (laboratory records) 5
9. Viva voce 8

### Paper - XI: Microbiology, Plant pathology

Time: 6 h

Full marks: 80

7. Gram staining of bacteria to be supplied as a suspension of a pure culture 20
8. Staining and morphological comments of bacteria in curd / bacteroids from root nodule 12
2. Histo-pathological studies of one diseased specimen 16
3. Demonstration of sub-culturing/ isolation 8
4. Identification of plant pathological specimens (4 including 2 herbarium sheets) 8
8. Submission (laboratory and field records, slides) 8
9. Viva voce 8

**Note:** There should be at least three excursions, one in each year.

## Suggested Readings:

### Algae

- Kumar, H. D. – Phycology: Algae Cell Biology  
Lee, Robert – Phycology  
Sharma, O. P. – Text Book of Algae, Tata McGraw-Hill  
Vashista, P. C. – Algae, S. C. Chand  
Gangulee, H.C and Kar, A.K. – College Botany, Vol. II

### Fungi and pathology

- Chopra and Verma – A Text Book of fungi  
Dubey – An Introduction to fungi, Vikash Publishing House.  
Mehrotra and Aneja – Introduction to Mycology  
Alexopoulos and Mims – Introductory Mycology  
Singh, R. S. – i) Plant Disease ii) Plant Pathology  
Vashisthya – Fungi and Pathology  
Mehrotra – Plant Pathology  
Gangulee, H.C and Kar, A.K. – College Botany, Vol. II

### Microbiology

- Atlas, R. M. – Principles of Microbiology, McGraw-Hill  
Schlegel, H.G. – General Microbiology, Cambridge University Press  
Prescott, L.M., Harley, J.P. and Klein, D.A. – General Microbiology, McGraw-Hill  
Pelczar, Chan and Kreig – Microbiology  
Stainier, Adelberg, Ingraham – General Microbiology  
Talaro and Talaro – Microbiology

### Bryophytes

- Vashishta, B. R. – Bryophyte, S. C. Chand  
Gangulee, H.C and Kar, A.K. – College Botany, Vol. II  
Puri, P. – Bryophyte

### Pteridophytes

- Sporne, K.R. – A Morphology of Pteridophyte, Hutchinson Publishing  
Vashistha .P. C. – Pteridophyte, S. C. Chand  
Gangulee, H.C and Kar, A.K. – College Botany, Vol. II  
Mukherjee and Chakraborty – An Introduction to Vascular Histograms (Pteridophyte)

### Gymnosperms

- Sporne, K. R. – The Morphology of Gymnosperms  
Vashista, B. R. – Gymnosperm, S. C. Chand

### Palaeobotany

- Arnold, A. C. – An Introduction to Palaeobotany, Agrobios (India)

### Anatomy

- Esau, K. – Anatomy of seed Plants, John Wiley & Sons  
Gangulee, H.C and Kar, A.K. – College Botany, Vol. I  
Ganguly, Das and Datta – College Botany, Vol. II

### Cell Biology/ Genetics/ Plant breeding/ Biometry/ Tissue culture

- De Robertis and De Robertis – Cell and Molecular Biology  
Rastogi, V.B. – Genetics  
Gupta, P.K. – Genetics  
Verma and Agarwal – Concept of Molecular Biology, S. Chand  
Verma and Agarwal – Concept of Cell Biology, S. Chand  
Singh, B.D. – Plant Breeding  
Bhojwani and Rajdan – Plant Tissue culture: Theory and Practice, Elsevier  
Sheeler and Bianchi – Cell and Molecular Biology

**Taxonomy**

- Datta, S. C. – Systematic Botany  
Mukherjee, S. – College Botany, Vol. III  
Mitra, Guha and Chowdhuri – Studies in Botany, Vol. I

**Morphology and Embryology:**

- Maheshwari, P. – An Introduction to Embryology of Angiosperms.  
Bhojwani and Bhatnagar – The Embryology of Angiosperms

**Ecology and Plant geography**

- Shukla and Chandal – Plant Ecology  
Verma and Agarwal – Concept of Ecology  
Odum – Fundamentals of Ecology  
Mani – Plant Geography of India  
Mitra, Guha and Chowdhuri – Studies in Botany, Vol. II

**Physiology and biochemistry**

- Salisbury and Ross – Plant Physiology  
Ghosh and Mukherjee – Plant Physiology  
Stryer – Biochemistry  
Devlin – Plant Physiology

# **UNIVERSITY OF NORTH BENGAL**

ACCREDITED BY NAAC WITH GRADE "A"



ENLIGHTENMENT TO PERFECTION

## **SYLLABI**

FOR

**B.Sc. Program:**

**BOTANY PORTION**

UNDER

**CHOICE BASED CREDIT SYSTEM**

**(CBCS)**

**WITH EFFECTE FROM: 2018-2019**

**B. Sc. Program (Botany portion)**

**Discipline specific core course (DSC)**

1. Biodiversity (Microbes, Algae, Fungi and Archegoniate)
2. Plant Ecology and Taxonomy
3. Plant Anatomy and Embryology
4. Plant Physiology and Metabolism

**Discipline specific elective course (DSE): (any two to be selected)**

1. Economic Botany and Biotechnology
2. Industrial and Environmental Microbiology
3. Analytical Techniques in Plant Sciences

**Ability Enhancement Course Compulsory (AECC)**

1. Environmental Science
2. English/MIL Communication

**Skill Enhancement Course (SEC): (Any four to be selected)**

1. Biofertilizers
2. Herbal Technology
3. Nursery and Gardening
4. Floriculture
5. Medicinal Botany
6. Plant Diversity and Human Welfare
7. Ethnobotany
8. Mushroom Culture Technology
9. Intellectual Property Right

**Detailed Course structure**

Course Components	B.Sc. Program
Discipline specific Core Course (DSC)	12
Discipline Specific Elective (DSE) Course (Any Four)	6
Generic Electives (GE) Course (Any Four)	-
Ability Enhancement Compulsory Course (AECC)	2
Skill Enhancement Course (SEC) (Any Two)	4
<b>Total courses</b>	<b>24</b>

**Detailed credit of the course B.Sc. Program (Botany)**

Sl.No.	Courses	Credit	
		Theory + Practical	Total
1.	<b>DSC Courses (12 courses)</b>	(12 x 4) + (12 x 2)	<b>72</b>
2.	<b>Elective Courses (6 Courses)</b>		
2A.	DSE (6 Courses)	(6 x 4) + (6 x 2)	36
2B.	GE (4 Courses)	-	-
3.	<b>Ability Enhancement Courses [AECC]</b>		
3A.	AECC-1	(2x1)	2
	AECC-2	(2x1)	2
3B.	SEC (4 Courses of 2 Credits each)	(4x2)	8
<b>Total Credit of all 26 courses</b>			<b>120</b>

### Scheme for CBCS in B.Sc. Program- Botany

Year	Semester	Discipline specific Core Course (DSC)	Ability Enhancement Compulsory Course (AECC)	Skill Enhancement Course (SEC)	Discipline Specific Elective Course (DSE)	
1	1	DSC 1 Paper 1: Biodiversity (Microbes, Algae, Fungi and Archegoniate)	AECC-1 (ENVS)			
		DSC 2 Paper 2:				
		DSC 3 Paper 3:				
	2	DSC 1 Paper 1: Plant Ecology and Taxonomy	AECC-2 (Com. Eng./MIL)			
		DSC 2 Paper 2:				
		DSC 3 Paper 3:				
2	3	DSC 1 Paper 1: Plant Anatomy and Embryology		SEC 1 Paper 1:.....		
		DSC 2 Paper 2:				
		DSC 3 Paper 3:				
	4	DSC 1 Paper 1: Plant Physiology and Metabolism		SEC 1 Paper 2:.....		
		DSC 2 Paper 2:				
		DSC 3 Paper 3:				
3	5			SEC 2 Paper 1:.....	DSE 1 Paper 1: Botany	
					DSE 2 Paper 1:... (to be Selected)	
					DSE 3 Paper 1: (to be Selected)	
	6				SEC 2 Paper 2:.....	DSE 1 Paper 2: Botany
			DSE 2 Paper 2: (to be Selected)			
			DSE 3 Paper 2: (to be Selected)			

- DSE 1 will be the same as DSC 1 Course & DSE 2 will be the same as DSC 2 Course and DSE 3 will be same DSC 3 Course.
- SEC 1 and SEC 2 could be chosen from any of the 3 DSC Courses taken above.



## Details of the syllabi

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### Discipline specific core course (DSC)

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#### Discipline specific core **Paper 1: Biodiversity (Microbes, Algae, Fungi and Archegoniate)** (Credits: Theory-4, Practical-2)

#### **(DSC Paper 1) THEORY**

##### **Lectures: 60**

##### **Unit 1: Microbes**

**(10 lectures)**

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

##### **Unit 2: Algae**

**(12 lectures)**

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas*, *Oedogonium*, *Vaucheria*, *Fucus*, *Polysiphonia*. Economic importance of algae.

##### **Unit 3: Fungi**

**(12 lectures)**

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Penicillium*, *Alternaria* (Ascomycota), *Puccinia*, *Agaricus* (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

##### **Unit 4: Introduction to Archegoniate**

**(2 lectures)**

Unifying features of archegoniate, Transition to land habit, Alternation of generations.

##### **Unit 5: Bryophytes**

**(10 lectures)**

General characteristics, adaptation to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

##### **Unit 6: Pteridophytes**

**(8 lectures)**

General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economical importance of Pteridophytes.

##### **Unit 7: Gymnosperms**

**(6 lectures)**

General characteristics; Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus* (Developmental details not to be included). Ecological and economic 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; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining
4. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), *Oedogonium*, *Vaucheria*, *Fucus*\* and *Polysiphonia* through temporary preparations and permanent slides. (\* *Fucus* - Specimen and permanent slides)
5. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
6. *Alternaria*: Specimens/photographs and tease mounts.
7. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
8. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
10. Mycorrhiza: ectomycorrhiza and endomycorrhiza (Photographs)
11. *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, l.s. sporophyte (all permanent slides).

12. *Funaria*- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
13. *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).
14. *Equisetum*- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry)(temporary slides); t.s. rhizome (permanent slide).
15. *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).
16. *Cycas*- morphology (coralloid roots, bulbil, 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).
17. *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, t.l.s. & r.l.s. stem (permanent slide).

### Suggested Readings

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2<sup>nd</sup> edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10<sup>th</sup> 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. 4<sup>th</sup> 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.

### Discipline specific core course (DSC)

#### Discipline specific core 1 Paper 2: Plant Ecology and Taxonomy (Credits: Theory-4, Practical-2)

#### (DSC 1 Paper 2) THEORY

#### Lectures: 60

<b>Unit 1: Introduction</b>	<b>(2 lectures)</b>
<b>Unit 2: Ecological factors</b>	<b>(10 lectures)</b>
Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes	
<b>Unit 3: Plant communities</b>	<b>(6 lectures)</b>
Characters; Ecotone and edge effect; Succession; Processes and types	
<b>Unit 4: Ecosystem</b>	<b>(8 lectures)</b>
Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous	
<b>Unit 5: Phytogeography</b>	<b>(4 lectures)</b>
Principle biogeographical zones; Endemism	
<b>Unit 6: Introduction to plant taxonomy</b>	<b>(2 lectures)</b>
Identification, Classification, Nomenclature.	
<b>Unit 7: Identification</b>	<b>(4 lectures)</b>
Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access	
<b>Unit 8 Taxonomic evidences from palynology, cytology, phytochemistry and molecular data.</b>	<b>(6 lectures)</b>
<b>Unit 9 Taxonomic hierarchy</b>	<b>(2 lectures)</b>
Ranks, categories and taxonomic groups	
<b>Unit 10 Botanical nomenclature</b>	<b>(6 lectures)</b>
Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.	
<b>Unit 11 Classification</b>	<b>(6 lectures)</b>

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).

**Unit 12 Study of Diagnostic features of the families:** Brassicaceae, Lamiaceae, solanaceae, Asteraceae, commelinaceae **(4 lectures)**

### **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. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each). (b) Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*), Epiphytes, Predation (Insectivorous plants)
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law
7. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Brassicaceae - *Brassica, Alyssum / Iberis*; Asteraceae - *Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax*; Solanaceae - *Solanum Sp./ Physalis*, Lamiaceae - *Salvia, Ocimum/ Leucus* Commelinaceae - *Commeliua / Murdania / Cyanotis*
8. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

### **Suggested Readings**

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4<sup>th</sup> edition.
2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8<sup>th</sup> edition.
3. Simpson, M.G. (2006). *Plant Systematics*. Elsevier Academic Press, San Diego, CA, U.S.A.
4. Singh, G. (2012). *Plant Systematics: Theory and Practice*. Oxford & IBH Pvt. Ltd., New Delhi. 3<sup>rd</sup> edition.

### **Discipline specific core course (DSC)**

#### **Discipline specific core 1 Paper 3: Plant Anatomy and Embryology**

**(Credits: Theory-4, Practical-2)**

#### **(DSC 1 Paper 3) THEORY**

#### **Lectures: 60**

#### **Unit 1: Meristematic and permanent tissues**

**(8 lectures)**

Root and shoot apical meristems; Simple and complex tissues

#### **Unit 2: Organs**

**(4 lectures)**

Structure of dicot and monocot root stem and leaf.

#### **Unit 3: Secondary Growth**

**(8 lectures)**

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

#### **Unit 4: Adaptive and protective systems**

**(8 lectures)**

Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

#### **Unit 5: 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 6: Pollination and fertilization**

**(8 lectures)**

Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

#### **Unit 7: Embryo and endosperm**

**(8 lectures)**

Endosperm types, structure and functions; Dicot and monocot embryo; Embryo-endosperm Relationship

#### **Unit 8: Apomixis and polyembryony**

**(8 lectures)**

Definition, types and Practical applications

### **Practical**

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.
9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.
13. Calculation of percentage of germinated pollen in a given medium.

### **Suggested Readings**

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5<sup>th</sup> edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

## **Discipline specific core course (DSC)**

### **Discipline specific core 1 Paper 4: Plant Physiology and Metabolism (Credits: Theory-4, Practical-2)**

#### **(DSC 1 Paper 4) THEORY**

#### **Lectures: 60**

##### **Unit 1: Plant-water relations**

**(8 lectures)**

Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

##### **Unit 2: Mineral nutrition**

**(8 lectures)**

Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

##### **Unit 3: Translocation in phloem.**

**(6 lectures)**

Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading

##### **Unit 4: Photosynthesis**

**(12 lectures)**

Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reactioncenter, antenna molecules; Electron transport and mechanism of ATP synthesis; C<sub>3</sub>, C<sub>4</sub> and CAM pathways of carbon fixation; Photorespiration.

##### **Unit 5: Respiration**

**(6 lectures)**

Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

##### **Unit 6: Enzymes**

**(4 lectures)**

Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

##### **Unit 7: Nitrogen metabolism**

**(4 lectures)**

Biological nitrogen fixation; Nitrate and ammonia assimilation.

##### **Unit 8: Plant growth regulators**

**(6 lectures)**

Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

##### **Unit 9: Plant response to light and temperature**

**(6 lectures)**

Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

#### **Practical**

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of Hill reaction.

5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
6. To study the effect of light intensity and bicarbonate concentration on O<sub>2</sub> evolution in photosynthesis.
7. Comparison of the rate of respiration in any two parts of a plant.
8. Separation of amino acids by paper chromatography.

**Demonstration experiments (any four)**

1. Bolting.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. R.Q.
5. Respiration in roots.

**Suggested Readings**

1. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6<sup>th</sup> edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4<sup>th</sup> Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

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**Discipline specific elective course (DSE)**

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**Discipline specific elective course (DSE) (Botany) [Any two to be selected]**

**Economic Botany and Plant Biotechnology  
(Credits: Theory-4, Practical-2)**

**THEORY**

**Lectures: 60**

<b>Unit 1: Origin of Cultivated Plants</b>	<b>(4 lectures)</b>
Concept of centres of origin, their importance with reference to Vavilov's work.	
<b>Unit 2: Cereals</b>	<b>(4 lectures)</b>
Wheat -Origin, morphology, uses	
<b>Unit 3: Legumes</b>	<b>(6 lectures)</b>
General account with special reference to Gram and soybean	
<b>Unit 4: Spices</b>	<b>(6 lectures)</b>
General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)	
<b>Unit 5: Beverages</b>	<b>(4 lectures)</b>
Tea (morphology, processing, uses)	
<b>Unit 6: Oils and Fats</b>	<b>(4 lectures)</b>
General description with special reference to groundnut	
<b>Unit 7: Fibre Yielding Plants</b>	<b>(4 lectures)</b>
General description with special reference to Cotton (Botanical name, family, part used, morphology and uses)	
<b>Unit 8: Introduction to biotechnology</b>	<b>(2 lecture)</b>
<b>Unit 9: Plant tissue culture</b>	<b>(8 lectures)</b>
Micropropagation ; haploid production through androgenesis and gynogenesis; brief account of embryo and endosperm culture with their applications.	
<b>Unit 10: Recombinant DNA Techniques</b>	<b>(18 lectures)</b>
Blotting techniques : Northern Southern and Western Blotting ,DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection.Molecular diagnosis of human disease, Human gene Therapy.	

**Practical**

1. Study of economically important plants : Wheat, Gram, Soybean, Black pepper, Clove Tea, Cotton, Groundnut through specimens, sections and microchemical tests
2. Familiarization with basic equipments in tissue culture.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
4. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.

### **Suggested Readings**

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4<sup>th</sup> edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

### **Discipline specific elective course (DSE) (Botany) Industrial and Environmental Microbiology (Credits: Theory-4, Practical-2)**

#### **THEORY**

#### **Lectures: 60**

**Unit 1: Scope of microbes in industry and environment** (6 lectures)

**Unit 2: Bioreactors/Fermenters and fermentation processes** (12 lectures)

Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor, Types of bioreactors-laboratory, pilotscale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations.

**Unit 3: Microbial production of industrial products** (12 lectures)

Microorganisms involved, media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; Hands on microbial fermentations for the production and estimation (qualitative and quantitative) of Enzyme: amylase or lipase activity, Organic acid (citric acid or glutamic acid), alcohol (Ethanol) and antibiotic (Penicillin)

**Unit 4: Microbial enzymes of industrial interest and enzyme immobilization** (8 lectures)

Microorganisms for industrial applications and hands on screening microorganisms for casein hydrolysis; starch hydrolysis; cellulose hydrolysis. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

**Unit 5: Microbes and quality of environment.** (6 lectures)

Distribution of microbes in air; Isolation of microorganisms from soil, air and water.

**Unit 6: Microbial flora of water.** (8 lectures)

Water pollution, role of microbes in sewage and domestic waste water treatment systems. Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples.

**Unit 7: Microbes in agriculture and remediation of contaminated soils.** (8 lectures)

Biological fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.

#### **Practical**

1. Principles and functioning of instruments in microbiology laboratory
2. Hands on sterilization techniques and preparation of culture media.

### **Suggested Readings**

1. Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.

### **Discipline specific elective course (DSE) (Botany) 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, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

**Unit 2: Cell fractionation (8 lectures)**

Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl<sub>2</sub> gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

**Unit 3: Radioisotopes (4 lectures)**

Use in biological research, auto-radiography, pulse chase experiment.

**Unit 4: Spectrophotometry**

Principle and its application in biological research.

**Unit 5: Chromatography (8 lectures)**

Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

**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 nitrogenous bases by paper chromatography.
4. To separate sugars by thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. To separate chloroplast pigments by column chromatography.
7. To estimate protein concentration through Lowry's methods.
8. To separate proteins using PAGE.
9. To separation DNA (marker) using AGE.
10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
11. 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. 3<sup>rd</sup> edition.
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. 3<sup>rd</sup> edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4<sup>th</sup> edition.

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**Skill Enhancement Course (SEC)**

**(any four to be selected)**

**(Papers to be coded as a SEC1 Botany, SEC2 Botany, SEC 3 Botany & SEC 4 Botany)**

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**SEC: Biofertilizers**

**(Credits 2)**

**Lectures: 30**

**Unit 1:** General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis. **(4 lectures)**

**Unit 2:** *Azospirillum*: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. *Azotobacter*: classification, characteristics – crop response to *Azotobacter* inoculum, maintenance and mass multiplication. **(8 lectures)**

**Unit 3:** Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation. **(4 lectures)**

**Unit 4:** Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants. **(8 lectures)**

**Unit 5:** Organic farming – Green manuring and organic fertilizers, Recycling of bio-degradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application. **(6 lectures)**

### Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas, S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming Akta Prakashan, Nadiad

## SEC: Herbal Technology (Credits 2)

### Lectures: 30

**Unit 1:** Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants. **(6 Lectures)**

**Unit 2:** Pharmacognosy - systematic position and medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka. **(6 Lectures)**

**Unit 3:** Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on nervous system), *Clerodendron phlomoides* (anti-rheumatic) and *Centella asiatica* (memory booster). **(6 Lectures)**

**Unit 4:** Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds) **(8 Lectures)**

**Unit 5:** Medicinal plant banks micro propagation of important species (*Withania somnifera*, neem and tulsi - Herbal foods - future of pharmacognosy) **(4 Lectures)**

### Suggested Readings

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.
3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
4. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.
5. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
6. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
7. Pharmacognosy, Dr.C.K.Kokate et al. 1999. Nirali Prakashan.

## SEC: 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 breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion – Seed production 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:**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: Floriculture (Credits 2)**

### **Lectures: 30**

**Unit 1:** Introduction: History of gardening; Importance and scope of floriculture and landscape gardening.

**(2 Lectures)**

**Unit 2:** Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.

**(8 lectures)**

**Unit 3:** Ornamental Plants: Flowering annuals; Herbaceous perennials; Climbing vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor gardening; Bonsai.

**(4 lectures)**

**Unit 4:** Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India.

**(4 lectures)**

**Unit 5:** Landscaping Places of Public Importance: Landscaping highways and Educational institutions.

**(4 lectures)**

**Unit 6:** Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Liliium, Orchids).

**(6 lectures)**

**Unit 7:** Diseases and Pests of Ornamental Plants.

**(2 lectures)**

### **Suggested Readings**

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

## **SEC: Medicinal Botany (Credits 2)**

### **Lectures: 30**

**Unit 1:** History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope- Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umooor-e- tabiya, tumors treatments/ therapy, polyherbal formulations. **(10 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. **(10 Lectures)**

**Unit 3:** Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases. **(10 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, 2<sup>nd</sup> edn. Agrobios, India.

### SEC: 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 legislation and conservations, 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. d) Alcoholic beverages through ages. 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: Ethnobotany (Credits 2)

#### Lectures: 30

**Unit 1: Ethnobotany** **(6 lectures)**

Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.

**Unit 2: Methodology of Ethnobotanical studies** **(6 lectures)**

a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.

**Unit 3: Role of ethnobotany in modern Medicine** **(10 lectures)**

Medico-ethnobotanical sources in India; Significance of the following plants in ethnobotanical practices (along with their habitat and morphology) a) *Azadirachta indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special example *Rauwolfia serpentina*, *Trichopus zeylanicus*, *Artemisia*, *Withania*. Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

**Unit 4: Ethnobotany and legal aspects** **(8 lectures)**

Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

### Suggested Readings

- 1) S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
- 2) S.K. Jain (ed.) Glimpses of Indian Ethnobotany, Oxford and I B H, New Delhi – 1981
- 3) Lone et al., Palaeoethnobotany
- 4) S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
- 5) S.K. Jain, 1990. Contributions of Indian ethnobotany. Scientific publishers, Jodhpur.
- 6) Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester

- 7) Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah. 8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur-1996 9) Faulks, P.J. 1958. An introduction to Ethnobotany, Moredale pub. Ltd.

**SEC: Mushroom Culture Technology  
(Credits 2)**

**Lectures: 30**

**Unit 1:** Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*.

**(5 Lectures)**

**Unit 2:** Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production.

**(12 Lectures)**

**Unit 3:** Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.

**(8 Lectures)**

**Unit 4:** Food Preparation : Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value.

**(5 lectures)**

**Suggested Readings**

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

**SEC: Intellectual Property Rights  
(Credits 2)**

**Lectures: 30**

**Unit 1: Introduction to intellectual property right (IPR)** **(2 lectures)**

Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).

**Unit 2 : Patents** **(3 Lectures)**

Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, working of patents. Infringement.

**Unit 3: Copyrights** **(3 Lectures)**

Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement.

**Unit 4: Trademarks** **(3 Lectures)**

Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defences, Domain name.

**Unit 5: Geographical Indications** **(3 Lectures)**

Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.

**Unit 6: Protection of Traditional Knowledge** **(4 Lectures)**

Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Propecting and Bio-Piracy, Alternative ways, Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.

**Unit 7: Industrial Designs** **(2 Lectures)**

Objectives, Rights, Assignments, Infringements, Defences of Design Infringement

**Unit 8: Protection of Plant Varieties** **(2 Lectures)**

Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

**Unit 9: Information Technology Related Intellectual Property Rights** **(4 Lectures)**

Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection

**Unit 10: Biotechnology and Intellectual Property Rights.** **(4 Lectures)**

Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions.

**Suggested Readings**

1. N.S. Gopalakrishnan & T.G. Agitha, (2009) Principles of Intellectual Property Eastern Book Company, Lucknow.
2. Kerly's Law of Trade Marks and Trade Names (14th Edition) Thomson, Sweet & Maxwell.
3. Ajit Parulekar and Sarita D' Souza, (2006) Indian Patents Law – Legal & Business Implications; Macmillan India Ltd.
4. B.L. Wadehra (2000) Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal Law Publishing Pvt. Ltd., India.
5. P. Narayanan (2010) Law of Copyright and Industrial Designs; Eastern Law House, Delhi.

# UNIVERSITY OF NORTH BENGAL

ACCREDITED BY NAAC WITH GRADE "A"



ENLIGHTENMENT TO PERFECTION

## SYLLABI FOR B.Sc. (HONOURS PROGRAM) IN BOTANY UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

WITH EFFECTE FROM: 2018-2019

## **Structure of B.Sc. Honours Program-Botany under CBCS**

### **Discipline specific Core Course (DSC)**

1. Algae and Microbiology
2. Biomolecules and Cell Biology
3. Mycology and Phytopathology
4. Archegoniate
5. Morphology and Anatomy
6. Economic Botany
7. Genetics
8. Molecular Biology
9. Plant Ecology and Phytogeography
10. Plant Systematics
11. Reproductive Biology of Angiosperms
12. Plant Physiology
13. Plant Metabolism
14. Plant Biotechnology

### **Discipline Specific Elective [DSE] (Any Four)**

1. Analytical Techniques in Plant Sciences
2. Bioinformatics
3. Stress Biology
4. Plant Breeding
5. Natural Resource Management
6. Horticultural Practices and Post-Harvest Technology
7. Research Methodology
8. Industrial and Environmental Microbiology
9. Biostatistics

### **Generic Electives [GE] (Any Four)**

1. Biodiversity (Microbes, Algae, Fungi and Archegoniate)
2. Plant Ecology and Taxonomy
3. Plant Anatomy and Embryology
4. Plant Physiology and Metabolism
5. Economic Botany and Biotechnology
6. Environmental Biotechnology

### **Ability Enhancement Compulsory Course [AECC]**

1. Environmental Science
2. English/MIL Communication

### **Skill Enhancement Course (SEC) (Any Two)**

1. Biofertilizers
2. Herbal Technology
3. Nursery and Gardening
4. Floriculture
5. Medicinal Botany
6. Plant Diversity and Human Welfare
7. Ethnobotany
8. Mushroom Culture Technology
9. Intellectual Property Right

**Detailed Course Structure (Honours Program- Botany)**

<b>Course Components</b>	<b>B.Sc. Honours Program</b>
<b>Discipline specific Core Course (DSC)</b>	14
<b>Discipline Specific Elective (DSE) Course (Any Four)</b>	4
<b>Generic Electives (GE) Course (Any Four)</b>	4
<b>Ability Enhancement Compulsory Course (AECC)</b>	2
<b>Skill Enhancement Course (SEC) (Any Two)</b>	2
<b>Total courses</b>	26

**Detailed credit of the course Honours Program (Botany)**

Sl.No.	Courses	Credit	
		Theory + Practical	Total
1.	<b>Discipline specific Core (DSC) Courses</b>	(14 x 4) + (14 x 2)	84
2.	<b>Elective Courses (8 Courses)</b>		
2.A	DSE (Four Courses)	(4 x 4) + (4 x 2)	24
2.B	GE(Four Courses)	(4 x 4) + (4 x 2)	24
3.	<b>Ability Enhancement Compulsory Courses [AECC]</b>		
3A.	AECC-1 (ENVS)	(2x1)	2
	AECC-2 (Com. Eng./MIL)	(2x1)	2
3B.	SEC (2 Courses of 2 Credits each)	(2x2)	2
<b>Total Credit of all 26 courses</b>			<b>140</b>

**Scheme for CBCS in B.Sc. Honours Program- Botany**

<b>Year</b>	<b>Semester</b>	<b>Discipline specific Core (DSC) Course</b>	<b>Ability Enhancement Compulsory Course (AECC)</b>	<b>Skill Enhancement Course (SEC)</b>	<b>Discipline Specific Elective (DSE) Course</b>	<b>Generic Electives (GE) Course</b>
1	1	Paper 1: Phycology and Microbiology	AECC-1			GE-1
		Paper 2: Biomolecules and Cell Biology	(ENVS)			Paper 1: ...
	2	Paper 3: Mycology and Phytopathology	AECC-2			GE-1
		Paper 4: Archegoniate	(Com. Eng./MIL)			Paper 2: ...
2	3	Paper 5: Morphology and anatomy		SEC		GE-2
		Paper 6: Economic Botany		Paper 1: .....		Paper 1: ...
		Paper 7 : Basics of Genetics				
	4	Paper 8 : Molecular biology		SEC		GE-2
		Paper 9 : Plant Ecology and Phytogeography		Paper 2: .....		Paper 2: ...
		Paper 10 : Plant Systematics				
3	5	Paper 11 : Reproductive biology of angiosperms			DSE Paper 1: .....	
		Paper 12 : Plant Physiology			DSE Paper 2: .....	
	6	Paper 13 : Plant metabolism			DSE Paper 3: .....	
		Paper 14 : Plant Biotechnology			DSE Paper 4: .....	

- Students pursuing DSC in Botany will have to opt for SEC and DSE in Botany only
- GE subject must be different from DSC in Botany



## Core Courses

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### Semester-I

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#### Core Course I: Phycology and Microbiology (DSC Paper 1)

(Credits: Theory-4, Practical-2)

#### (DSC Paper 1) THEORY

**Lectures: 60**

#### **Unit 1: Introduction to microbial world**

**(7 lectures)**

Microbial nutrition, growth and metabolism. Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases. Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).

#### **Unit 2: Viruses**

**(7 lectures)**

Discovery, physiochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV).

#### **Unit 3: Bacteria**

**(7 lectures)**

Discovery, general characteristics; Types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure; Nutritional types; Reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction).

#### **Unit 4: Algae**

**(11 lectures)**

General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; methods of reproduction; Classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); Significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar). Role of algae in the environment, agriculture, biotechnology and industry.

#### **Unit 5: Cyanophyta and Xanthophyta**

**(8 lectures)**

Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycle of *Nostoc* and *Vaucheria*.

#### **Unit 6: Chlorophyta and Charophyta**

**(8 lectures)**

General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Chlamydomonas*, *Volvox*, *Oedogonium*, *Coleochaete*, *Chara*. Evolutionary significance of *Prochloron*.

## Unit 7: Phaeophyta and Rhodophyta

(12 lectures)

Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Ectocarpus*, *Fucus* and *Polysiphonia*.

### (DSC Paper 1) Practical

#### Microbiology

1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle.
2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule.
3. Gram staining.
4. Endospore staining with malachite green using the (endospores taken from soil bacteria).

#### Phycology

Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), *Volvox*, *Oedogonium*, *Coleochaete*, *Chara*, *Vaucheria*, *Ectocarpus*, *Fucus* and *Polysiphonia*, *Prochloron* through electron micrographs, temporary preparations and permanent slides.

#### Suggested Readings

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4<sup>th</sup> edition.
2. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
4. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8<sup>th</sup> edition.
6. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

### Core Course II: Biomolecules and Cell Biology [DSC Paper 2]

(Credits: Theory-4, Practical-2)

### (DSC Paper 2) THEORY

Lectures: 60

#### Unit 1: Biomolecules

(20 lectures)

Types and significance of chemical bonds; Structure and properties of water; pH and buffers.

**Carbohydrates:** Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides.

**Lipids:** Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides.

**Proteins:** Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quaternary; Protein denaturation and biological roles of proteins.

**Nucleic acids:** Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA.

**Unit 2: Bioenergetics** (4 lectures)

Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as a energy currency molecule.

**Unit 3: Enzymes** (6 lectures)

Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theory), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.

**Unit 4: The cell** (4 lectures)

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).

**Unit 5: Cell wall and plasma membrane** (4 lectures)

Chemistry, structure and function of Plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.

**Unit 6: Cell organelles** (16 lectures)

**Nucleus:** Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.

**Cytoskeleton:** Role and structure of microtubules, microfilaments and intermediary filament.

**Chloroplast, mitochondria and peroxisomes:** Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast.

**Endomembrane system:** Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes

**Unit 7: Cell division** (6 lectures)

Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle- checkpoints, role of protein kinases.

**(DSC Paper 2) Practical**

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo/Crinum*.
3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.

4. Measurement of cell size by the technique of micrometry.
5. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).
6. Study of cell and its organelles with the help of electron micrographs.
7. Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.
8. Study the phenomenon of plasmolysis and deplasmolysis.
9. Study the effect of organic solvent and temperature on membrane permeability.
10. Study different stages of mitosis and meiosis.

### Suggested Readings

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6<sup>th</sup> edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
8. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
9. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco

## Semester-II

### Core Course III: Mycology and Phytopathology [DSC Paper 3]

(Credits: Theory-4, Practical-2)

#### **(DSC Paper 3)THEORY**

**Lectures: 60**

#### **Unit 1: Introduction to true fungi**

**(6 lectures)**

General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification.

#### **Unit 2: Chytridiomycota and Zygomycota**

**(5 lecture)**

Characteristic features; Ecology and significance; Thallus organisation; Reproduction; Life cycle with reference to *Synchytrium*, *Rhizopus* .

#### **Unit 4: Ascomycota**

**(10 lectures)**

General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; Life cycle and classification with reference to *Saccharomyces*, *Aspergillus*, *Penicillium*, *Alternaria*, *Neurospora* and *Peziza*.

**Unit 5: Basidiomycota****(8 lectures)**

General characteristics; Ecology; Life cycle and Classification with reference to black stem rust on wheat *Puccinia* (Physiological Specialization), loose and covered smut (symptoms only), *Agaricus*; Bioluminescence, Fairy Rings and Mushroom Cultivation.

**Unit 6: Allied Fungi****(3 lectures)**

General characteristics; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.

**Unit 7: Oomycota****(4 lectures)**

General characteristics; Ecology; Life cycle and classification with reference to *Phytophthora*, *Albugo*.

**Unit 8: Symbiotic associations****(4 lectures)**

Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction; Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance.

**Unit 8: Applied Mycology****(10 Lectures)**

Role of fungi in biotechnology; Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides); Medical mycology.

**Unit 9: Phytopathology****(10 lectures)**

Terms and concepts; General symptoms; Geographical distribution of diseases; Etiology; Symptomology; Host-Pathogen relationships; Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine.

Bacterial diseases – Citrus canker and angular leaf spot of cotton. Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers.

**(DSC Paper 3) Practical**

1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, ascocarps & basidiocarps).
2. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
3. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
4. *Peziza*: sectioning through ascocarp.
5. *Alternaria*: Specimens/photographs and temporary mounts.
6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
7. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown.
8. Study of phaneroplasmodium from actual specimens and /or photograph. Study of *Stemonitis* sporangia (from actual specimens and /or photograph).

9. *Albugo*: Study of symptoms of plants infected with *Albugo*; asexual phase study through section/ temporary mounts and sexual structures through permanent slides.
10. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)
11. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Bacterial wilt of tomato, Viral diseases: TMV, Vein clearing, Fungal diseases: Late blight of potato, Black stem rust of wheat and White rust of crucifers.

### Suggested Readings

1. Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4<sup>th</sup> edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3<sup>rd</sup> edition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

### Core Course IV: Archegoniate [DSC Paper 4]

(Credits: Theory-4, Practical-2)

#### (DSC Paper 4) THEORY

**Lectures: 60**

#### **Unit 1: Introduction**

**(4 lectures)**

Unifying features of archegoniates; Transition to land habit; Alternation of generations.

#### **Unit 2: Bryophytes**

**(6 lectures)**

General characteristics; Adaptations to land habit; Classification; Range of thallus organization.

#### **Unit 3: Type Studies- Bryophytes**

**(12 lectures)**

Classification (up to family), morphology, anatomy and reproduction of *Riccia*, *Marchantia*, *Pellia*, *Porella*, *Anthoceros*, *Sphagnum* and *Funaria*; Reproduction and evolutionary trends in *Riccia*, *Marchantia*, *Anthoceros* and *Funaria* (developmental stages not included). Ecological and economic importance of bryophytes with special reference to *Sphagnum*.

#### **Unit 4: Pteridophytes**

**(6 lectures)**

General characteristics; Classification; Early land plants (*Cooksonia* and *Rhynia*).

#### **Unit 5: Type Studies- Pteridophytes**

**(14 lectures)**

Classification (up to family), morphology, anatomy and reproduction of *Psilotum*, *Selaginella*, *Equisetum* and *Pteris* (Developmental details not to be included). Apogamy, and apospory, heterospory and seed habit, telome theory, stelar evolution; Ecological and economic importance.

## Unit 6: Gymnosperms

(18 lectures)

General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum* (Developmental details not to be included); Ecological and economic importance.

### (DSC Paper 4) Practical

1. **Riccia** – Morphology of thallus.
2. **Marchantia**- Morphology of thallus, whole mount of rhizoids & Scales, vertical section of thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides).
3. **Anthoceros**- Morphology of thallus, dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).
4. **Pellia, Porella**- Permanent slides.
5. **Sphagnum**- Morphology of plant, whole mount of leaf (permanent slide only).
6. **Funaria**- Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, longitudinal section of capsule and protonema.
7. **Psilotum**- Study of specimen, transverse section of synangium (permanent slide/photograph).
8. **Selaginella**- Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanent slide).
9. **Equisetum**- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).
10. **Pteris**- Morphology, transverse section of rachis, vertical section of sporophyll, whole mount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).
11. **Cycas**- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll, transverse section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).
13. **Pinus**- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), transverse section of Needle, transverse section of stem, longitudinal section of / transverse section of male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), longitudinal section of female cone, tangential longitudinal section & radial longitudinal sections stem (permanent slide).
14. **Gnetum**- Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (permanent slide).
15. **Botanical excursion**: Enlistment of plants observed in the field and submission of field note book with 10-25 photographs.

### Suggested Readings

1. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
2. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
3. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
5. Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.

## Semester-III

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### Core Course V: Morphology and Anatomy of Angiosperms [DSC Paper 5]

(Credits: Theory-4, Practical-2)

#### (DSC Paper 5) THEORY

**Lectures: 60**

**Unit 1: Introduction and scope of Plant Morphology and Anatomy (4 Lectures)**

Applications in systematics, forensics and pharmacognosy; Flower and Fruity Morphology

**Unit 2: Structure and Development of Plant Body (6 Lectures)**

Internal organization of plant body: The three tissue systems, types of cells and tissues. Development of plant body: Polarity, Cytodifferentiation and organogenesis during embryogenic development.

**Unit 2: Tissues (12 Lectures)**

Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers.

**Unit 3: Apical meristems (15 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. Origin, development, arrangement and diversity in size and shape of leaves; 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 4: Vascular Cambium and Wood (15 Lectures)**

Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm, rhytidome and lenticels.

**Unit 5: Adaptive and Protective Systems (8 Lectures)**

Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes.



### **(DSC Paper 5) Practical**

1. Study of anatomical details through permanent slides/temporary stain mounts/ macerations/ museum specimens with the help of suitable examples.
2. Apical meristem of root, shoot and vascular cambium.
3. Distribution and types of parenchyma, collenchyma and sclerenchyma.
4. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
5. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
7. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
8. Root: monocot, dicot, secondary growth.
9. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
10. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
11. Adaptive Anatomy: xerophytes, hydrophytes.
12. Secretory tissues: cavities, lithocysts and laticifers.

### **Suggested Readings**

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.
4. Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.

### **Core Course VI: Economic Botany [DSC Paper 6]**

**(Credits: Theory-4, Practical-2)**

### **(DSC Paper 6) THEORY**

**Lectures: 60**

#### **Unit 1: 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 2: Cereals (6 lectures)**

Wheat and Rice (origin, morphology, processing & uses); Brief account of millets.

#### **Unit 3: Legumes**

**(6 lectures)**

Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.

#### **Unit 4: Sources of sugars and starches**

**(4 lectures)**

Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.

**Unit 5: Spices** (6 lectures)

Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper

**Unit 6: Beverages** (4 lectures)

Tea, Coffee (morphology, processing & uses)

**Unit 7: Sources of oils and fats** (10 lectures)

General description, classification, extraction, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.

**Unit 8: Natural Rubber** (3 lectures)

Para-rubber: tapping, processing and uses.

**Unit 9: Drug-yielding plants** (8 lectures)

Therapeutic and habit-forming drugs with special reference to *Cinchona*, *Digitalis*, *Papaver* and *Cannabis*; Tobacco (Morphology, processing, uses and health hazards).

**Unit 10: Timber plants** (3 Lectures)

General account with special reference to teak and pine.

**Unit 11: Fibers** (4 lectures)

Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses).

**(DSC Paper 6) Practical**

1. **Cereals:** Wheat (habit sketch, L. S/T.S. grain, starch grains, micro-chemical tests) Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2. **Legumes:** Soybean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3. **Sources of sugars and starches:** Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato (habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).
4. **Spices:** Black pepper, Fennel and Clove (habit and sections).
5. **Beverages:** Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
6. **Sources of oils and fats:** Coconut- T.S. nut, Mustard-plant specimen, seeds; tests for fats in crushed seeds.
7. **Essential oil-yielding plants:** Habit sketch of *Rosa*, *Vetiveria*, *Santalum* and *Eucalyptus* (specimens/photographs).
8. **Rubber:** specimen, photograph/model of tapping, samples of rubber products.
9. **Drug-yielding plants:** Specimens of *Digitalis*, *Papaver* and *Cannabis*.
10. **Tobacco:** specimen and products of Tobacco.

11. **Woods:** *Tectona, Pinus*: Specimen, Section of young stem.
12. **Fiber-yielding plants:** Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).

### **Suggested Readings**

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
3. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers.

## **Core Course VII: Genetics [DSC Paper 7]**

**(Credits: Theory-4, Practical-2)**

### **(DSC Paper 7) THEORY**

**Lectures: 60**

#### **Unit 1: Mendelian genetics and its extension (16 lectures)**

Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance.

#### **Unit 2: Extrachromosomal Inheritance (6 lectures)**

Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in *Paramecium*.

#### **Unit 3: Linkage, crossing over and chromosome mapping (12 lectures)**

Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage.

#### **Unit 4: Variation in chromosome number and structure (8 lectures)**

Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy

#### **Unit 5: Gene mutations (6 lectures)**

Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: CIB method. Role of Transposons in mutation. DNA repair mechanisms.

**Unit 6: Fine structure of gene**

**(6 lectures)**

Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus.

**Unit 6. Population and Evolutionary Genetics**

**(6 lectures)**

Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

**(DSC Paper 7) Practical**

1. Meiosis through temporary squash preparation.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
3. Chromosome mapping using point test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex linked traits.
5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
6. Blood Typing: ABO groups & Rh factor.
7. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
8. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
9. Study of human genetic traits: Sickle cell anemia, Xeroderma Pigmentosum, Albinism, red-green Colour blindness, Widow's peak, rolling of tongue, Hitchhiker's thumb and attached ear lobe.

**Suggested Readings**

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8<sup>th</sup> edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5<sup>th</sup> edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9<sup>th</sup> edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10<sup>th</sup> edition.

## Core Course VIII: Molecular Biology[DSC Paper 8]

(Credits: Theory-4, Practical-2)

### (DSC Paper 8) THEORY

**Lectures: 60**

#### **Unit 1: Nucleic acids: Carriers of genetic information (4 lectures)**

Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment).

#### **Unit 2. The Structures of DNA and RNA / Genetic Material (10 lectures)**

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves; Organization of DNA- Prokaryotes, Viruses, Eukaryotes. RNA Structure Organelle DNA -- mitochondria and chloroplast DNA. The Nucleosome Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

#### **Unit 2: The replication of DNA (10 lectures)**

Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle,  $\theta$  (theta) mode of replication, replication of linear ds-DNA, replication of the 5' end of linear chromosome; Enzymes involved in DNA replication.

#### **Unit 3: Central dogma and genetic code (2 lectures)**

Key experiments establishing- The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features)

#### **Unit 4: Transcription (18 lectures)**

Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli*. Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.

#### **Unit 5: Processing and modification of RNA (8 lectures)**

Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I and group II intron splicing, alternative splicing eukaryotic mRNA processing (5' cap, 3' polyA tail); Ribozymes; RNA editing and mRNA transport.

#### **Unit 6: Translation (8 lectures)**

Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins.

### **(DSC Paper 8) Practical**

1. Preparation of LB medium and raising *E.Coli*.
2. Isolation of genomic DNA from *E.Coli*.
3. DNA isolation from cauliflower head.
4. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
5. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
6. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
7. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)
8. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

### **Suggested Readings**

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6<sup>th</sup> edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5<sup>th</sup> edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9<sup>th</sup> edition.
4. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3<sup>rd</sup> edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10<sup>th</sup> edition.

### **Core Course IX: Plant Ecology and Phytogeography[DSC Paper 9]**

**(Credits: Theory-4, Practical-2)**

### **(DSC Paper 9) THEORY**

**Lectures: 60**

#### **Unit 1: Introduction**

**(4 lectures)**

Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.

#### **Unit 2: Soil**

**(8 lectures)**

Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.

#### **Unit 3: Water**

**(4 lectures)**

Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.

**Unit 4: Light, temperature, wind and fire** Variations; adaptations of plants to their variation.

**(6 lectures)**

**Unit 5: Biotic interactions** (2 lectures)

Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop.

**Unit 6: Population ecology**

Characteristics and Dynamics .Ecological Speciation (4 lectures)

**Unit 7: Plant communities** (8 lectures)

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

**Unit 8: Ecosystems** (4 lectures)

Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.

**Unit 9: Functional aspects of ecosystem** (8 lectures)

Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

**Unit 10: Phytogeography** (12

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

**(DSC Paper 9) 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 of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.
5. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
7. (a). Study of morphological adaptations of hydrophytes and xerophytes (four each).  
(b). Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants).
8. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
9. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
10. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.

11. 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. 5<sup>th</sup> 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. 8<sup>th</sup> edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4<sup>th</sup> edition.

## **Core Course X: Plant Systematics [DSC Paper 10]**

**(Credits: Theory-4, Practical-2)**

### **(DSC Paper 10) THEORY**

**Lectures: 60**

#### **Unit 1: Significance of Plant systematics (12 lectures)**

Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access.

#### **Unit 2: Taxonomic hierarchy (6 lectures)**

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

#### **Unit 3: Botanical nomenclature (10 lectures)**

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

#### **Unit 4: Systems of classification (12 lectures)**

*Major* contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG III) classification.

#### **Unit 5: Diagnostic features of Families: Ranunculaceae, Brassicaceae, Myrtaceae, Apiaceae, Solanaceae, Lamiaceae, Euphorbiaceae, Asteraceae, Commelinaceae and Poaceae. (10 lectures)**

#### **Unit 6: Phylogeny of Angiosperms (12 lectures)**



Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

### **(DSC Paper 10) Practical**

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):

Ranunculaceae	<i>Ranunculus, Delphinium</i>
Brassicaceae	<i>Brassica, Alyssum / Iberis</i>
Myrtaceae	<i>Eucalyptus, Callistemon</i>
Apiaceae	<i>Coriandrum /Anethum / Foeniculum</i>
Asteraceae	<i>Sonchus/ Launaea, Vernonia/ Ageratum, Eclipta/ Tridax</i>
Solanaceae	<i>Solanum /Physalis</i>
Lamiaceae	<i>Salvia/Ocimum/ Leucas</i>
Euphorbiaceae	<i>Jatropha / Croton / Acalypha</i>
Commelinaceae	<i>Commelina / Murdania / Cyanotis</i>
Poaceae	<i>Triticum/Hordeum/Avena</i>

2) Field visit (local) – Enlistment of plants observed in the field and submission of field note book with 10-25 photographs.

3) Mounting of one properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

### **Suggested Readings**

1. Singh, (2012). *Plant Systematics: Theory and Practice* Oxford & IBH Pvt. Ltd., New Delhi. 3<sup>rd</sup> edition.
2. Jeffrey, C. (1982). *An Introduction to Plant Taxonomy*. Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). *Plant Systematics-A Phylogenetic Approach*. Sinauer Associates Inc., U.S.A. 2<sup>nd</sup> edition.
4. Maheshwari, J.K. (1963). *Flora of Delhi*. CSIR, New Delhi.

5. Radford, A.E. (1986). Fundamentals of *Plant Systematics*. Harper and Row, New York.

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**Semester-V**

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**Core Course XI: Reproductive Biology of Angiosperms [DSC Paper 11]**

**(Credits: Theory-4, Practical-2)**

**(DSC Paper 11) THEORY**

**Lectures: 60**

**Unit 1: Introduction**

**(4 lectures)**

History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope.

**Unit 2: Reproductive development**

**(6 lectures)**

Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.

**Unit 3: Anther and pollen biology**

**(10 lectures)**

Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.

**Unit 4: Ovule**

**(10 lectures)**

Structure; Types; Special structures—endothelium, obturator, aril, caruncle and hypostase; Female gametophyte—megasporeogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of *Polygonum* type); Organization and ultrastructure of mature embryo sac.

**Unit 4: Pollination and fertilization**

**(6 lectures)**

Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.

**Unit 5: Self incompatibility**

**(10 lectures)**

Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self-incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and *in vitro* pollination; Modification of stigma surface, parasexual hybridization; Cybrids, *in vitro* fertilization.

**Unit 6: Embryo, Endosperm and Seed****(10 lectures)**

Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in *Paeonia*. Seed structure, importance and dispersal mechanisms

**Units 7: Polyembryony and apomixis****(06 lectures)**

Introduction; Classification; Causes and applications.

**(DSC Paper 11) Practical**

1. Anther Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
3. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, pseudomonads, polyads, pollinia (slides/photographs, fresh material), ultrastructure of pollen wall (micrograph); Pollen viability: Tetrazolium test. germination: Calculation of percentage germination in different media using hanging drop method.
4. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).
5. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
6. Intra-ovarian pollination; Test tube pollination through photographs.
7. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
8. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

**Suggested Readings**

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5<sup>th</sup> edition.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M. (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

**Core Course XII: Plant Physiology [DSC Paper 12]****(Credits: Theory-4, Practical-2)****(DSC Paper 12) THEORY****Lectures: 60****Unit 1: Plant-water relations****(10 lectures)**

Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap– cohesion-tension theory. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement.

**Unit 2: Mineral nutrition (8 lectures)**

Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.

**Unit 3: Nutrient Uptake (8 lectures)**

Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.

**Unit 4: Translocation in the phloem (8 lectures)**

Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.

**Unit 5: Plant growth regulators (14 lectures)**

Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.

**Unit 6: Physiology of flowering (6 lectures)**

Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.

**Unit 7: Phytochrome , cryptochromes and phototropins (6 lectures)**

Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

**(DSC Paper 12) Practical**

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces).
6. To study the phenomenon of seed germination (effect of light).
7. To study the effect of different concentrations of IAA on *Avena* coleoptile elongation (IAA Bioassay).
8. To study the induction of amylase activity in germinating barley grains.

**Demonstration experiments**

1. To demonstrate suction due to transpiration.
2. Fruit ripening/Rooting from cuttings (Demonstration).
3. Bolting experiment/*Avena* coleoptile bioassay (demonstration).

**Suggested Readings**

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4<sup>th</sup> edition.

2. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6<sup>th</sup> edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

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## Semester-VI

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### Core Course XIII: Plant Metabolism [DSC Paper 13]

(Credits: Theory-4, Practical-2)

#### (DSC Paper 13)THEORY

**Lectures: 60**

#### **Unit 1: Concept of metabolism**

**(6 lectures)**

Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes).

#### **Unit 2: Carbon assimilation**

**(14 lectures)**

Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions,

photosynthetic electron transport, PSI, PSII, Q cycle, CO<sub>2</sub> reduction, photorespiration, C<sub>4</sub> pathways; Crassulacean acid metabolism; Factors affecting CO<sub>2</sub> reduction.

#### **Unit 3: Carbohydrate metabolism**

**(2 lectures)**

Synthesis and catabolism of sucrose and starch.

#### **Unit 4: Carbon Oxidation**

**(10 lectures)**

Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, amphibolic role, anaerobic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.

#### **Unit 5: ATP-Synthesis**

**(8 lectures)**

Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.

#### **Unit 6: Lipid metabolism**

**(8 lectures)**

Synthesis and breakdown of triglycerides,  $\beta$ -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination,  $\alpha$  oxidation.

**Unit 7: Nitrogen metabolism**

**(8 lectures)**

Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

**Unit 8: Mechanisms of signal transduction**

**(4 lectures)**

Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.

**(DSC Paper 13) Practical**

1. Chemical separation of photosynthetic pigments.
2. Experimental demonstration of Hill's reaction.
3. To study the effect of light intensity on the rate of photosynthesis.
4. Effect of carbon dioxide on the rate of photosynthesis.
5. To compare the rate of respiration in different parts of a plant.
6. To demonstrate activity of Nitrate reductase in germinating leaves of different plant sources.
7. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination.
8. Demonstration of fluorescence by isolated chlorophyll pigments.
9. Demonstration of absorption spectrum of photosynthetic pigments.

**Suggested Readings**

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4<sup>th</sup> edition.
2. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6<sup>th</sup> edition.
3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

**Core Course XIV: Plant Biotechnology [DSC Paper 14]**

**(Credits: Theory-4, Practical-2)**

**(DSC Paper 14) THEORY**

**Lectures: 60**

**Unit 1: Plant Tissue Culture**

**(16 lectures)**

Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

**Unit 2: Recombinant DNA technology**

**(12 lectures)**

Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).

### **Unit 3: Gene Cloning**

**(10 lectures)**

Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR

### **Unit 4: Methods of gene transfer**

**(8 lectures)**

*Agrobacterium*-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).

### **Unit 5: Applications of Biotechnology**

**(14 lectures)**

Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

### **(DSC Paper 14) Practical**

1. (a) Preparation of MS medium.  
(b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, *Brassica* etc.
2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
3. Isolation of protoplasts.
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
7. Isolation of plasmid DNA.
8. Restriction digestion and gel electrophoresis of plasmid DNA.

### **Suggested Readings**

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5<sup>th</sup> edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5<sup>th</sup> edition.
5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

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## Discipline Specific Elective Courses (DSE)

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### DSE: Analytical Techniques in Plant Sciences (Credits: Theory-4, Practical-2)

#### DSE: Analytical Techniques in Plant Sciences (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, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

#### **Unit 2: Cell fractionation (8 lectures)**

Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl<sub>2</sub> gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

#### **Unit 3: Radioisotopes (4 lectures)**

Use in biological research, auto-radiography, pulse chase experiment.

#### **Unit 4: Spectrophotometry**

Principle and its application in biological research.

#### **Unit 5: Chromatography (8 lectures)**

Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

#### **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.

#### DSE: Analytical Techniques in Plant Sciences (Practical)

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate nitrogenous bases by paper chromatography.
4. To separate sugars by thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. To separate chloroplast pigments by column chromatography.
7. To estimate protein concentration through Lowry's methods.
8. To separate proteins using PAGE.
9. To separation DNA (marker) using AGE.
10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
11. 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. 3<sup>rd</sup> edition.



- Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
- 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. 3<sup>rd</sup> edition.
- Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4<sup>th</sup> edition.

### **Discipline Specific Elective**

#### **DSE: Bioinformatics**

**(Credits: Theory-4, Practical-2)**

#### **DSE: Bioinformatics (THEORY)**

##### **Lectures: 60**

##### **Unit 1. Introduction to Bioinformatics**

**(5 Lectures)**

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

##### **Unit 2. Databases in Bioinformatics**

**(5 Lectures)**

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

##### **Unit 3. Biological Sequence Databases**

**(25 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. Sequence Alignments**

**(10 Lectures)**

Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

##### **Unit 5. Molecular Phylogeny**

**(8 Lectures)**

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

##### **Unit 6. Applications of Bioinformatics**

**(7 Lectures)**

Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement

#### **DSE: Bioinformatics (Practical)**

- Nucleic acid and protein databases.
- Sequence retrieval from databases.
- Sequence alignment.
- Sequence homology and Gene annotation.
- Construction of phylogenetic tree.

#### **Suggested Readings**

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

**Discipline Specific Elective  
Stress Biology  
Credits: Theory 4, Practical 2**

**DSE: Stress Biology (Theory)**

**Lectures: 60**

**Unit 1: Defining plant stress** (2 lectures)

Acclimation and adaptation.

**Unit 2: Environmental factors** (20 lectures)

Water stress; Salinity stress, High light stress; Temperature stress; Hypersensitive reaction; Pathogenesis– related (PR) proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates.

**Unit 3: Stress sensing mechanisms in plants** (20 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** (6 lectures)

Production and scavenging mechanisms.

**DSE: Stress Biology (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.
6. Quantitative estimation and zymographic analysis of glutathione reductase.
7. Estimation of superoxide anions.

**Suggested Readings**

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4<sup>th</sup> edition.

2. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6<sup>th</sup> edition.

### **Discipline Specific Elective**

#### **Plant Breeding**

**(Credits: Theory-4, Practical-2)**

#### **DSE: Plant Breeding (Theory)**

**Lectures: 60**

#### **Unit 1: Plant Breeding (10 lectures)**

Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.

#### **Unit 2: Methods of crop improvement (20 lectures)**

Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.

#### **Unit 3: Quantitative inheritance (10 lectures)**

Concept, mechanism, examples of inheritance of Kernel colour in wheat, Skin colour in human beings. Monogenic vs polygenic Inheritance.

#### **Unit 4: Inbreeding depression and heterosis (10 lectures)**

History, genetic basis of inbreeding depression and heterosis; Applications.

#### **Unit 5: Crop improvement and breeding (10 lectures)**

Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

#### **DSE: Plant Breeding (Practicals)**

1. Study of germplasm.
2. Study of floral structure of self-pollinated and cross pollinated crops.
3. Emasculation and hybridization techniques in self and cross pollinated crops.
4. Artificial pollination in self-pollinated crop (any one crop).
5. Experiments on epistatic interactions and data analysis.
6. Study on probability and Chi-square test and heritability analysis.

## Suggested Readings

1. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7<sup>th</sup> edition.
2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2<sup>nd</sup> edition.
3. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

## Discipline Specific Elective

### Natural Resource Management

(Credits: Theory-4, Practical-2)

#### DSE: Natural Resource Management (Theory)

Lectures: 60

**Unit 1: Natural resources** (2 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** (12 lectures)

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

**Unit 6: Forests** (6 lectures)

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

**Unit 7: Energy** (6 lectures)

Renewable and non-renewable sources of energy

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

EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.

**Unit 9: National and international efforts in resource management and conservation** (4 lectures)

#### DSE: Natural Resource 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 modeling.

#### 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.

**Discipline Specific Elective**  
**Horticultural Practices and Post-Harvest Technology**  
**(Credits: Theory-4, Practical-2)**

**DSE: Horticultural Practices and Post-Harvest Technology (Theory)**

**Lectures: 60**

**Unit 1: Introduction**

**(4 lectures)**

Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism.

**Unit 2: Ornamental plants**

**(4 lectures)**

Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulents (opuntia, agave and spurges)] Ornamental flowering trees (Indian laburnum, gulmohar, Jacaranda, Lagerstroemia, fishtail and areca palms, semul, coral tree).

**Unit 3: Fruit and vegetable crops**

**(4 lectures)**

Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops; Identification of some fruits and vegetable varieties (citrus, banana, mango, chillies and cucurbits).

**Unit 4: Horticultural techniques**

**(8 lectures)**

Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations.

**Unit 5: Landscaping and garden design**

**(6 lectures)**

Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.

**Unit 6: Floriculture**

**(6 lectures)**

Cut flowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions.

**Unit 7: Post-harvest technology**

**(10 lectures)**

Importance of post harvest technology in horticultural crops; Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cut flowers; Principles, methods of preservation and processing; Methods of minimizing losses during storage and transportation; Food irradiation - advantages and disadvantages; food safety.

**Unit 8: Disease control and management**

**(8 lectures)**

Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices; Crop sanitation; IPM strategies (genetic, biological and chemical methods for pest control); Quarantine practices; Identification of common diseases and pests of ornamentals, fruits and vegetable crops.

**Unit 9: Horticultural crops - conservation and management**

**(10 lectures)**

Documentation and conservation of germplasm; Role of micropropagation and tissue culture techniques; Varieties and cultivars of various horticultural crops; IPR issues; National, international and professional societies and sources of information on horticulture.

**Unit 10: Field trip**

Field visits to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at suitable locations.

### **DSE: Horticultural Practices and Post-Harvest Technology (Practical)**

1. Importance of light and chlorophyll in photosynthesis, pigment identification in horticultural crops and studying the enzyme activity of catalase, estimation of phenols, studying plant movements, root initiation in cuttings. Grafting and layering.
2. Practical Analysis of soil for organic matter, available N,P,K and Micronutrients and interpretations. Gypsum requirement of saline and alkali soils. Lime requirement of acid soils.
3. Practical Study of symptoms of damage, collection, identification, preservation, assessment of damage and population of important insect – pests affecting fruits, plantation, medicinal and aromatic crops in field and storage.
4. Practical Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory.
5. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for herbarium. Mango: bacterial blight / powdery mildew; Citrus: canker / citrus decline; Jackfruit: Rhizopus rot; Pineapple: Head rot, Betel vine: leaf spots/ foot rot; Cucurbits: damping off /downy mildew/ powdery mildew/ wilt; Chill: anthracnose/ fruit rot /leaf spot/ wilt/ leaf curl; Turmeric: leaf spot; Coriander: stem gall; Marigold: Botrytis blight; Rose: dieback/ powdery mildew/ black leaf spot.

### **Suggested Readings**

1. Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
4. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.
5. Capon, B. (2010). Botany for Gardeners. 3<sup>rd</sup> Edition. Timber Press, Portland, Oregon.

### **Discipline Specific Elective Research Methodology Credit: Theory 4; Practical 2**

### **DSE: Research Methodology (Theory)**

#### **Lectures: 60**

#### **Unit 1: Basic concepts of research**

**(10 lectures)**

Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.

#### **Unit 2: General laboratory practices**

**(12 lectures)**

Common calculations in botany laboratories. Understanding the details on the label of reagent bottles. Molarity and normality of common acids and bases. Preparation of solutions. Dilutions. Percentage solutions. Molar, molal and normal solutions. Technique of handling micropipettes; Knowledge about common toxic chemicals and safety measures in their handling.

#### **Unit 3: Data collection and documentation of observations**

**(6 lectures)**

Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissuespecimens and application of scale bars. The art of field photography.

**Unit 4: Overview of Biological Problems (6 lectures)**

History; Key biology research areas, Model organisms in biology (A Brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics-Transcriptional regulatory network.

**Unit 5: Methods to study plant cell/tissue structure (6 lectures)**

Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections.

**Unit 6: Plant microtechniques (12 lectures)**

Staining procedures, classification and chemistry of stains. Staining equipment. Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags). Cytogenetic techniques with squashed plant materials.

**Unit 7: The art of scientific writing and its presentation (8 lectures)**

Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Powerpoint presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

**DSE: Research Methodology (Practical)**

1. Experiments based on chemical calculations.
2. Plant microtechnique experiments.
3. The art of imaging of samples through microphotography and field photography.
4. Poster presentation on defined topics.
5. Technical writing on topics assigned.

**Suggested Readings**

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

**Discipline Specific Elective  
Industrial and Environmental Microbiology  
(Credits: Theory-4, Practical-2)**

**DSE: Industrial and Environmental Microbiology (THEORY)**

**Lectures: 60**

**Unit 1: Scope of microbes in industry and environment (6 lectures)**

**Unit 2: Bioreactors/Fermenters and fermentation processes (12 lectures)**

Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor, Types of bioreactors-laboratory, pilotscale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations.

**Unit 3: Microbial production of industrial products (12 lectures)**

Microorganisms involved, media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; Hands on microbial fermentations for the production and estimation (qualitative and quantitative) of Enzyme: amylase or lipase activity, Organic acid (citric acid or glutamic acid), alcohol (Ethanol) and antibiotic (Penicillin)

**Unit 4: Microbial enzymes of industrial interest and enzyme immobilization (8 lectures)** Microorganisms for industrial applications and hands on screening microorganisms for casein hydrolysis; starch hydrolysis; cellulose hydrolysis. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

**Unit 5: Microbes and quality of environment.(6 lectures)**

Distribution of microbes in air; Isolation of microorganisms from soil, air and water.

**Unit 6: Microbial flora of water. (8 lectures)**

Water pollution, role of microbes in sewage and domestic waste water treatment systems. Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples.

**Unit 7: Microbes in agriculture and remediation of contaminated soils. (8 lectures)**

Biological fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.

### **DSE: Industrial and Environmental Microbiology (Practical)**

- 1.Principles and functioning of instruments in microbiology laboratory
- 2.Hands on sterilization techniques and preparation of culture media.

### **Suggested Readings**

1. Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.

## **Discipline Specific Elective Biostatistics (Credits: Theory-4, Practical-2)**

### **DSE: Biostatistics (THEORY)**

**Lectures: 60**

**Unit 1:Biostatistics (12 lectures)**

Definition - statistical methods - basic principles. Variables - measurements, functions, limitations and uses of statistics.

**Unit 2:Collection of data primary and secondary (12 lectures)**

Types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data - sampling methods.

**Unit 3:Measures of central tendency (14 lectures)**

Mean, median, mode, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co- efficient of variations.



**Unit 4:Correlation****(12 lectures)**

Types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression

**Unit 5:Statistical inference****(10 lectures)**

Hypothesis - simple hypothesis - student't' test - chi square test.

**DSE: Biostatistics (Practical)**

- 1) Calculation of mean, standard deviation and standard error
- 2) Calculation of correlation coefficient values and finding out the probability
- 3) Calculation of 'F' value and finding out the probability value for the F value

**Suggested Readings**

1. Biostatistic, Dannel, 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

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**Generic Elective Courses (GE)**

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**Generic Elective**  
**Biodiversity (Microbes, Algae, Fungi and Archegoniate)**  
**(Credits: Theory-4, Practical-2)**

**GE: Biodiversity (Microbes, Algae, Fungi and Archegoniate) (THEORY)****Lectures: 60****Unit 1: Microbes****(10 lectures)**

Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure;

Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

**Unit 2: Algae**

**(12 lectures)**

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas*, *Oedogonium*, *Vaucheria*, *Fucus*, *Polysiphonia*. Economic importance of algae.

**Unit 3: Fungi**

**(12 lectures)**

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Penicillium*, *Alternaria* (Ascomycota), *Puccinia*, *Agaricus* (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

**Unit 4: Introduction to Archegoniata**

**(2 lectures)**

Unifying features of archegoniates, Transition to land habit, Alternation of generations.

**Unit 5: Bryophytes**

**(10 lectures)**

General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

**Unit 6: Pteridophytes**

**(8 lectures)**

General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economical importance of Pteridophytes.

**Unit 7: Gymnosperms**

**(6 lectures)**

General characteristics; Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus* (Developmental details not to be included). Ecological and economical importance.

**GE: Biodiversity (Microbes, Algae, Fungi and Archegoniata) (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; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining
4. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), *Oedogonium*, *Vaucheria*, *Fucus*\* and *Polysiphonia* through temporary preparations and permanent slides. (\* *Fucus* - Specimen and permanent slides)
5. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
6. *Alternaria*: Specimens/photographs and tease mounts.
7. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
8. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
10. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
11. *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, l.s. sporophyte (all permanent slides).
12. *Funaria*- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
13. *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).
14. *Equisetum*- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry) (temporary slides); t.s. rhizome (permanent slide).
15. *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).

16. *Cycas*- morphology (coralloid roots, bulbil, 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).
17. *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, t.l.s. & r.l.s. stem (permanent slide).

#### **Suggested Readings**

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2<sup>nd</sup> edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10<sup>th</sup> 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. 4<sup>th</sup> 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.

### **Generic Elective** **Plant Ecology and Taxonomy** **(Credits: Theory-4, Practical-2)**

#### **GE: Plant Ecology and Taxonomy (THEORY)**

**Lectures: 60**

<b>Unit 1: Introduction</b>	<b>(2 lectures)</b>
<b>Unit 2: Ecological factors</b>	<b>(10 lectures)</b>
Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes	
<b>Unit 3: Plant communities</b>	<b>(6 lectures)</b>
Characters; Ecotone and edge effect; Succession; Processes and types	
<b>Unit 4: Ecosystem</b>	<b>(8 lectures)</b>
Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous	
<b>Unit 5: Phytogeography</b>	<b>(4 lectures)</b>
Principle biogeographical zones; Endemism	
<b>Unit 6 Introduction to plant taxonomy</b>	<b>(2 lectures)</b>
<b>Unit 7 Identification</b>	<b>(4 lectures)</b>
Identification, Classification, Nomenclature. Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access	
<b>Unit 8 Taxonomic evidences from palynology, cytology, phytochemistry and molecular data.</b>	<b>(6 lectures)</b>
<b>Unit 9 Taxonomic hierarchy</b>	<b>(2 lectures)</b>
Ranks, categories and taxonomic groups	
<b>Unit 10 Botanical nomenclature</b>	<b>(6 lectures)</b>
Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.	
<b>Unit 11 Classification</b>	<b>(6 lectures)</b>
Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).	
<b>Unit 12 Biometrics, numerical taxonomy and cladistics</b>	<b>(4 lectures)</b>

Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

### **GE: Plant Ecology and Taxonomy (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. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each). (b) Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*), Epiphytes, Predation (Insectivorous plants)
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law
7. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Brassicaceae - *Brassica*, *Alyssum* / *Iberis*; Asteraceae - *Sonchus*/*Launaea*, *Vernonia*/*Ageratum*, *Eclipta*/*Tridax*; Solanaceae - *Solanum Sp.*/ *Physalis*, Lamiaceae - *Salvia*, *Ocimum*/ *Leucus* Commelinaceae - *Commelina* / *Murdania* / *Cyanotis*
8. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

### **Suggested Readings**

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4<sup>th</sup> edition.
2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8<sup>th</sup> edition.
3. Simpson, M.G. (2006). *Plant Systematics*. Elsevier Academic Press, San Diego, CA, U.S.A.
4. Singh, G. (2012). *Plant Systematics: Theory and Practice*. Oxford & IBH Pvt. Ltd., New Delhi. 3<sup>rd</sup> edition.

### **Generic Elective**

### **Plant Anatomy and Embryology (Credits: Theory-4, Practical-2)**

### **GE: Plant Anatomy and Embryology (THEORY)**

#### **Lectures: 60**

#### **Unit 1: Meristematic and permanent tissues**

**(8 lectures)**

Root and shoot apical meristems; Simple and complex tissues

#### **Unit 2: Organs**

**(4 lectures)**

Structure of dicot and monocot root stem and leaf.

#### **Unit 3: Secondary Growth**

**(8 lectures)**

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

#### **Unit 4: Adaptive and protective systems**

**(8 lectures)**

Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

#### **Unit 5: 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 6: Pollination and fertilization**

**(8 lectures)**

Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

#### **Unit 7: Embryo and endosperm**

**(8 lectures)**

Endosperm types, structure and functions; Dicot and monocot embryo; Embryo-endosperm Relationship

#### **Unit 8: Apomixis and polyembryony**

**(8 lectures)**

Definition, types and Practical applications

### **GE: Plant Anatomy and Embryology (Practical)**

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.
9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.
13. Calculation of percentage of germinated pollen in a given medium.

#### **Suggested Readings**

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5<sup>th</sup> edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

### **Generic Elective Plant Physiology and Metabolism (Credits: Theory-4, Practical-2)**

#### **GE:Plant Physiology and Metabolism (THEORY)**

**Lectures: 60**

##### **Unit 1: Plant-water relations**

**(8 lectures)**

Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

##### **Unit 2: Mineral nutrition**

**(8 lectures)**

Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

##### **Unit 3: Translocation in phloem.**

**(6 lectures)**

Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading

##### **Unit 4: Photosynthesis**

**(12 lectures)**

Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.

##### **Unit 5: Respiration**

**(6 lectures)**

Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

##### **Unit 6: Enzymes**

**(4 lectures)**

Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

##### **Unit 7: Nitrogen metabolism**

**(4 lectures)**

Biological nitrogen fixation; Nitrate and ammonia assimilation.

##### **Unit 8: Plant growth regulators**

**(6 lectures)**

Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

##### **Unit 9: Plant response to light and temperature**

**(6 lectures)**

Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

#### **GE:Plant Physiology and Metabolism (Practical)**

1. Determination of osmotic potential of plant cell sap by plasmolytic method.

- To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
- Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
- Demonstration of Hill reaction.
- Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
- To study the effect of light intensity and bicarbonate concentration on O<sub>2</sub> evolution in photosynthesis.
- Comparison of the rate of respiration in any two parts of a plant.
- Separation of amino acids by paper chromatography.

**Demonstration experiments (any four)**

- (1) Bolting. (2) Effect of auxins on rooting. (3) Suction due to transpiration. (4) R.Q. (5) Respiration in roots.

**Suggested Readings**

- Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6<sup>th</sup> edition.
- Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4<sup>th</sup> Edition.
- Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

**Generic Elective**  
**Economic Botany and Plant Biotechnology**  
**(Credits: Theory-4, Practical-2)**

**GE: Economic Botany and Plant Biotechnology (THEORY)**

**Lectures: 60**

**Unit 1: Origin of Cultivated Plants (4 lectures)**

Concept of centres of origin, their importance with reference to Vavilov's work.

**Unit 2: Cereals (4 lectures)**

Wheat -Origin, morphology, uses

**Unit 3: Legumes (6 lectures) (6 lectures)**

General account with special reference to Gram and soybean

**Unit 4: Spices**

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

**Unit 5: Beverages (4 lectures)**

Tea (morphology, processing, uses)

**Unit 6: Oils and Fats (4 lectures)**

General description with special reference to groundnut

**Unit 7: Fibre Yielding Plants (4 lectures)**

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

**Unit 8: Introduction to biotechnology (2 lectures)**

**Unit 9: Plant tissue culture (8 lectures)**

Micropropagation ; haploid production through androgenesis and gynogenesis; brief account of embryo and endosperm culture with their applications

**Unit 10: Recombinant DNA Techniques (18 Lectures)**

Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Molecular diagnosis of human disease, Human gene Therapy.

**GE: Economic Botany and Plant Biotechnology (Practical)**

- Study of economically important plants : Wheat, Gram, Soybean, Black pepper, Clove Tea, Cotton, Groundnut through specimens, sections and microchemical tests
- Familiarization with basic equipments in tissue culture.
- Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
- Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.

### **Suggested Readings**

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4<sup>th</sup> edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

### **Generic Elective Environmental Biotechnology (Credits: Theory-4, Practical-2)**

#### **GE: Environmental Biotechnology (THEORY)**

#### **Lectures: 60**

##### **Unit 1: Environment**

**(4 lectures)**

Basic concepts and issues, global environmental problems - ozone depletion, UV-B, greenhouse effect and acid rain due to anthropogenic activities, their impact and biotechnological approaches for management.

##### **Unit 2: Environmental problems**

**(6 lectures)**

Environmental pollution - types of pollution, sources of pollution, measurement of pollution, methods of measurement of pollution, fate of pollutants in the environment, Bioconcentration, bio/geomagnification.

##### **Unit 3: Microbiology of waste water treatment**

**(8 lectures)**

Aerobic process - activated sludge, oxidation ponds, trickling filter, towers, rotating discs, rotating drums, oxidation ditch. Anaerobic process - anaerobic digestion, anaerobic filters, up-flow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar and antibiotic industries.

##### **Unit 4: Xenobiotic compounds**

**(10 lectures)**

Organic (chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, surfactants) and inorganic (metals, radionuclides, phosphates, nitrates). Bioremediation of xenobiotics in environment - ecological consideration, decay behavior and degradative plasmids, molecular techniques in bioremediation.

##### **Unit 5: Role of immobilized cells/enzymes in treatment of toxic compounds**

**(6 lectures)**

Biopesticides, bioreactors, bioleaching, biomining, biosensors, biotechniques for air pollution abatement and odour control.

##### **Unit 6: Sustainable Development**

**(8 lectures)**

Economics and Environment: Economic growth, Gross National Productivity and the quality of life, Tragedy of Commons, Economics of Pollution control, Cost-benefit and cost effectiveness analysis, WTO and Environment, Corporate Social Responsibility, Environmental awareness and Education; Environmental Ethics.

##### **Unit 7: International Legislations, Policies for Environmental Protection**

**(6 lectures)**

Stockholm Conference (1972) and its declaration, WCED (1983) and Brundtland Report (1987), Rio Earth Summit-UNCED (1992) and its declaration, Montreal Protocol - 1987, Basel Convention (1989), Kyoto Protocol- 1997, Ramsar Convention 1971.

##### **Unit 8: National Legislations, Policies for Pollution Management**

**(6 lectures)**

Salient features of Wild life protection act 1972, Water Pollution (Prevention and Control) Act-1974, Forest conservation act 1980, Air Pollution (Prevention and Control) Act-1981, National Environmental Policy -2006, Central and State Pollution Control Boards: Constitution and power.

##### **Unit 9: Public Participation for Environmental Protection**

**(6 lectures)**

Environmental movement and people's participation with special references to Gandhamardan, Chilika and Narmada Bachao Andolan, Chipko and Silent valley Movement; Women and Environmental Protection, Role of NGO in bringing environmental awareness and education in the society.

#### **GE: Environmental Biotechnology (Practical)**

1. Water/Soil analysis - DO, salinity, pH, chloride, total hardness, alkalinity, acidity, nitrate, calcium, Magnesium and phosphorus.
2. Gravimetric analysis-Total solid, dissolved solid, suspended solid in an effluent
3. Microbial assessment of air (open plate and air sample) and water

### **Suggested Readings**

1. Waste water engineering - treatment, disposal and reuse, Metcalf and Eddy Inc., Tata McGraw Hill, New Delhi.
2. Environmental Chemistry, AK. De, Wiley Eastern Ltd, New Delhi.
3. Introduction to Biodeterioration, D.Allsopp and K.J. Seal, ELBS / Edward Arnold.
4. Bioremediation, Baaker, KH and Herson D.S., 1994. Mc.GrawHill Inc, NewYork.
5. Industrial and Environmental Biotechnology - Nuzhat Ahmed, Fouad M. Qureshi and Obaid Y. Khan, 2006. Horizon Press.
6. Environmental Molecular Biology, Paul. A, Rochelle, 2001.Horizon Press.
7. Environmental Protection and Laws by Jadhav and Bhosale, V.M.Himalaya publ. House 13. Biodiversity Assessment and Conservation by PC Trivedi, Agrobios publ.

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### **Skill Enhancement Courses (SEC)**

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#### **Skill Enhancement Course Biofertilizers (Credits 2)**

#### **SEC:Biofertilizers**

#### **Lectures: 30**

**Unit 1:**General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis. **(4 lectures)**

**Unit 2:***Azospirillum*: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms.*Azotobacter*: classification, characteristics – crop response to *Azotobacter* inoculum, maintenance and mass multiplication. **(8 lectures)**

**Unit 3:**Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation. **(4 lectures)**

**Unit 4:** Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants. **(8 lectures)**

**Unit 5:** Organic farming – Green manuring and organic fertilizers, Recycling of bio-degradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application. **(6 lectures)**

#### **Suggested Readings**

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming Akta Prakashan, Nadiad

#### **Skill Enhancement Course Herbal Technology (Credits 2)**

#### **SEC:Herbal Technology**

#### **Lectures: 30**

**Unit 1:**Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage -marketing and utilization of medicinal plants. **(6 Lectures)**



**Unit 2:** Pharmacognosy - systematic position and medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka. **(6 Lectures)**

**Unit 3:** Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on nervous system), *Clerodendron phlomoides* (anti-rheumatic) and *Centella asiatica* (memory booster). **(6 Lectures)**

**Unit 4:** Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds) **(8 Lectures)**

**Unit 5:** Medicinal plant banks micro propagation of important species (*Withania somnifera*, neem and tulsi- Herbal foods-future of pharmacognosy) **(4 Lectures)**

### **Suggested Readings**

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.
3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
4. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.
5. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
6. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
7. Pharmacognosy, Dr.C.K.Kokate et al. 1999. Nirali Prakashan.

## **Skill Enhancement Course Nursery and Gardening (Credits 2)**

### **SEC: Nursery and Gardening**

#### **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 breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion – Seed production 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 – green house - 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:** 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.

## **Skill Enhancement Course Floriculture (Credits 2)**

### **SEC: Floriculture**

**Lectures: 30**

**Unit 1:** Introduction: History of gardening; Importance and scope of floriculture and landscape gardening.

**(2 Lectures)**

**Unit 2:** Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.

**(8 lectures)**

**Unit 3:** Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor gardening; Bonsai.

**(4 lectures)**

**Unit 4:** Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India.

**(4 lectures)**

**Unit 5:** Landscaping Places of Public Importance: Landscaping highways and Educational institutions.

**(4 lectures)**

**Unit 6:** Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Liliium, Orchids).

**(6 lectures)**

**Unit 7:** Diseases and Pests of Ornamental Plants.

**(2 lectures)**

**Suggested Readings**

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

**Skill Enhancement Course****Medicinal Botany**

**(Credits 2)**

**SEC: Medicinal Botany****Lectures: 30**

**Unit 1:** History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope- Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umooor-e- tabiya, tumors treatments/ therapy, polyherbal formulations. **(10 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. **(10 Lectures)**

**Unit 3:** Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases. **(10 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, 2<sup>nd</sup> edn. Agrobios, India.

**Skill Enhancement Course****Plant Diversity and Human Welfare**

**(Credits 2)**

**SEC: Plant Diversity and Human Welfare****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 legislation and conservations, 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. d) Alcoholic beverages through ages. 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

## Skill Enhancement Course Ethnobotany (Credits 2)

### SEC: Ethnobotany

#### Lectures: 30

#### Unit 1: Ethnobotany (6 Lectures)

Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.

#### Unit 2: Methodology of Ethnobotanical studies (6 lectures)

a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.

#### Unit 3: Role of ethnobotany in modern Medicine (10 lectures)

Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*.

Role of ethnobotany in modern medicine with special example *Rauwolfia serpentina*, *Trichopus zeylanicus*, *Artemisia*, *Withania*.

Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

#### Unit 4: Ethnobotany and legal aspects (8 lectures)

Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

## Suggested Readings

1. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
2. S.K. Jain (ed.) Glimpses of Indian. Ethnobotany, Oxford and I B H, New Delhi – 1981
3. Lone et al., Palaeoethnobotany
4. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
5. S.K. Jain, 1990. Contributions of Indian ethnobotany. Scientific publishers, Jodhpur.
6. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
7. Rama Rao, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah. 8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA – SHREE Publishers, Jaipur-1996 9) Faulks, P.J. 1958. An introduction to Ethnobotany, Moredale pub. Ltd.

## Skill Enhancement Course Mushroom Culture Technology

(Credits 2)

**SEC: Mushroom Culture Technology**

**Lectures: 30**

**Unit 1:** Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*.

(5 Lectures)

**Unit 2:** Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production.

(12 Lectures)

**Unit 3:** Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.

(8 Lectures)

**Unit 4:** Food Preparation : Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value.

(5 lectures)

**Suggested Readings**

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

**Skill Enhancement Course  
Intellectual Property Rights  
(Credits 2)**

**SEC: Intellectual Property Rights**

**Lectures: 30**

**Unit 1: Introduction to intellectual property right (IPR)**

(2 lectures)

Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).

**Unit 2 : Patents**

(3 Lectures)

Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents. Infringement.

**Unit 3: Copyrights**

(3 Lectures)

Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement.

**Unit 4: Trademarks**

(3 Lectures)

Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defences, Domain name.

**Unit 5: Geographical Indications**

(3 Lectures)

Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.

**Unit 6: Protection of Traditional Knowledge**

(4 Lectures)

Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy, Alternative ways, Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.

**Unit 7: Industrial Designs**

(2 Lectures)

Objectives, Rights, Assignments, Infringements, Defences of Design Infringement

**Unit 8: Protection of Plant Varieties**

(2 Lectures)

Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers.National gene bank, Benefit sharing.Protection of Plant Varieties and Farmers' Rights Act, 2001.

**Unit 9:Information Technology Related Intellectual Property Rights (4 Lectures)**

Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection

**Unit 10: Biotechnology and Intellectual Property Rights. (4 Lectures)**

Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions.

**Suggested Readings**

1. N.S. Gopalakrishnan & T.G. Agitha, (2009) Principles of Intellectual Property Eastern Book Company, Lucknow.
2. Kerly's Law of Trade Marks and Trade Names (14th Edition) Thomson, Sweet & Maxweel.
3. Ajit Parulekar and Sarita D' Souza, (2006) Indian Patents Law – Legal & Business Implications; Macmillan India Ltd.
4. B.L.Wadehra (2000) Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India.
5. P. Narayanan (2010) Law of Copyright and Industrial Designs; Eastern law House, Delhi.

# UNIVERSITY OF NORTH BENGAL

ACCREDITED BY NAAC WITH GRADE “A”



ENLIGHTENMENT TO PERFECTION

**SYLLABI (50% truncated)**

FOR

**B.Sc. Program:**

**BOTANY PORTION**

UNDER

**CHOICE BASED CREDIT SYSTEM**

**(CBCS)**

**3<sup>rd</sup> and 5<sup>th</sup> Semesters, 2020**

**B. Sc. Program (Botany portion)**

**Discipline specific core course (DSC)**

1. Biodiversity (Microbes, Algae, Fungi and Archegoniate)
2. Plant Ecology and Taxonomy
3. Plant Anatomy and Embryology
4. Plant Physiology and Metabolism

**Discipline specific elective course (DSE): (any two to be selected)**

1. Economic Botany and Biotechnology
2. Industrial and Environmental Microbiology
3. Analytical Techniques in Plant Sciences

**Ability Enhancement Course Compulsory (AECC)**

1. Environmental Science

**Skill Enhancement Course (SEC): (Any four to be selected)**

1. Biofertilizers
2. Herbal Technology
3. Nursery and Gardening
4. Floriculture
5. Medicinal Botany
6. Plant Diversity and Human Welfare
7. Ethnobotany
8. Mushroom Culture Technology
9. Intellectual Property Right

Details of the syllabi

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Discipline specific core course (DSC)  
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Discipline specific core1

**Paper 1: Biodiversity (Microbes, Algae, Fungi and Archegoniate)**  
(Credits: Theory-4, Practical-2)

**(DSC Paper 1) THEORY**

**Lectures: 30**

**Unit 1: Microbes** **(5 lectures)**

Viruses – general structure, DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance;

Bacteria – General characteristics and cell structure of a typical bacterial cell; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

**Unit 2: Algae** **(6 lectures)**

General characteristics; Range of thallus organization; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Oedogonium*, *Vaucheria*, *Fucus*, *Polysiphonia*. Economic importance of algae.

**Unit 3: Fungi** **(6 lectures)**

General characteristics, range of thallus organization, cell wall composition, nutrition, and classification; True Fungi- General characteristics, life cycle of *Rhizopus* (Zygomycota) *Penicillium*, (Ascomycota), *Puccinia*, (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

**Unit 4: Introduction to Archegoniate** **(1 lectures)**

Unifying features of archegoniate, Transition to land habit, Alternation of generations.

**Unit 5: Bryophytes** **(5 lectures)**

General characteristics, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

**Unit 6: Pteridophytes** **(4 lectures)**

General characteristics, Early land plants (*Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. Heterospory and seed habit, stelar evolution. Ecological and economical importance of Pteridophytes.

**Unit 7: Gymnosperms** **(3 lectures)**



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

**DSC PAPER 1: Biodiversity (Microbes, Algae, Fungi and Archegoniate) (Practical)**

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from photographs; EM bacterium; Binary Fission; Conjugation
3. Gram staining
4. Study of vegetative and reproductive structures of *Nostoc*, *Oedogonium*, *Vaucheria*, and *Polysiphonia* through photographs.
5. *Rhizopus* and *Penicillium*: Asexual stage and sexual structures
6. *Alternaria*: photographs
7. *Puccinia*: Study of different spore structures
8. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
9. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
10. *Marchantia*- v.s. of thallus through gemma cup, v.s. of antheridiophore, archegoniophore, l.s. of sporophyte (all permanent slides).
11. *Funaria*- l.s. of capsule
12. *Selaginella*- t.s. of stem, l.s. of strobilus (permanent slide).
13. *Equisetum*- l.s. of strobilus, t.s. of strobilus (permanent slide).
14. *Pteris*- v.s. of sporophyll(permanent slide).
15. *Cycas*- t.s. of coralloid root, v.s. of leaflet, l.s. of ovule (permanent slide).
16. *Pinus*- t.s. of needle, t.s. of stem, , l.s of male cone, l.s. of female cone (permanent slide).

**Suggested Readings**

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2<sup>nd</sup> edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10<sup>th</sup> 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. 4<sup>th</sup> 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.

**Discipline specific core course (DSC)**  
**Discipline specific core 1**  
**Paper 2: Plant Ecology and Taxonomy**  
**(Credits: Theory-4, Practical-2)**

**(DSC Paper 2) THEORY**

**Lectures: 30**

**Unit 1: Introduction and Ecological factors: (5 lectures)**

Interrelationship between the living world and the environment; Soil: Origin , composition, soil profile; Water: Precipitation types; Light and temperature: Variations, optimal and limiting factors ; Shelford Law of tolerance; Adaptation of hydrophytes and Xerophytes

**Unit 2: Plant communities: (3 lectures)**

Ecotone, edge effect; Succession: types

**Unit 3: Ecosystem (definition only): (4 lectures)**

Trophic levels, food chain, food web, ecological pyramids, energy flow in ecosystem; Biogeochemical cycle: Carbon cycle

**Unit 4: Phytogeography: (2 lectures)**

Endemism, Phytogeographical divisions of India

**Unit 5: Introduction to Plant taxonomy and Identification: (4 lectures)**

Plant taxonomy: definition; Identification: brief idea; function of Herbarium, names of important herbaria and botanical gardens of world and India; Documentation: Flora; Keys (definition only).

**Unit 6: Botanical nomenclature: (6 lectures)**

Principles and rules (ICN); ranks and names; binomial system; Typification ( Holotype, Isotype, Syntype, Lectotype, definitions only); author citation(brief idea); valid publication; principle of priority.

**Unit 7: Classification: (3 lectures)**

Types of classification- artificial, natural and phylogenetic; Classification system of Bentham and Hooker (upto series)

**Unit 8: Study of diagnostic features of the families: (3 lectures)**

Solanaceae, Lamiaceae, Commelinaceae

**DSC PAPER 2: Plant Ecology and taxonomy (Practical)**

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, Hygrometer, rain gauge and lux meter. **(Through photograph)**

2. A) Study of morphological adaptations: **(Through photograph)**

Hydrophytes (any four)

Xerophytes (any four)

B) Study of biotic interactions of the following: **(Through photograph)**

Stem parasite (*Cuscuta*)

Root parasite (Orobanche)

Epiphytes

Predation (Insectivorous plant)

3. Study of vegetative and floral characters of the following families: **(any one plant from each family)**

Description, V.S of flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification

Solanaceae- *Solanum/ Physalis*

Lamiaceae- *Ocimum/ Leucus*

Commelinaceae- *Commelina/ Murdania/ Cyanotis*

4. Identification of common taxonomic samples from the following Families: **(Through photograph/live specimen/herbarium)**

Solanaceae, Lamiaceae, Commelinaceae

5. Mounting of a properly dried and pressed specimen of any one wild plant with herbarium label ( to be submitted in the record book).

### **Suggested Readings**

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4<sup>th</sup> edition.
2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8<sup>th</sup> edition.
3. Simpson, M.G. (2006). *Plant Systematics*. Elsevier Academic Press, San Diego, CA, U.S.A.
4. Singh, G. (2012). *Plant Systematics: Theory and Practice*. Oxford & IBH Pvt. Ltd., New Delhi. 3<sup>rd</sup> edition.

**Discipline specific core course (DSC)**  
**Discipline specific core 1**  
**Paper 3: Plant Anatomy and Embryology**  
**(Credits: Theory-4, Practical-2)**

### **(DSC Paper 3) THEORY**

**Lectures: 30**

**Unit 1: Meristematic and permanent tissues**

**(6 lectures)**

Apical meristems definition and examples; Simple and complex tissues (definition and examples)

Structure of dicot and monocot root stem and leaf.

**Unit 2: Secondary Growth (8 lectures)**

Vascular cambium—structure and function. Secondary growth in stem, Wood (heartwood and sapwood);

Adaptive and protective systems: Epidermis and stomata; General account of adaptations in xerophytes.

**Unit 3: Structural organization of flower (4 lectures)**

Structure of anther; Structure and types of ovules; organization and ultrastructure of mature embryo sac.

**Unit 4: Pollination and fertilization (5 lectures)**

Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages.

**Unit 5: Embryo and endosperm (5 lectures)**

Endosperm types, structure and functions; Dicot and monocot embryo;

**Unit 6: Apomixis and polyembryony: Definition and types (2 lectures)**

**DSC PAPER 3: Plant Anatomy and Embryology (Practical)**

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
4. Leaf: Dicot and Monocot leaf (only Permanent slides).
5. Adaptive anatomy: Xerophyte (*Nerium* leaf).
6. Structure of anther (young and mature) (Permanent slides).
7. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/campylotropous.
8. Ultrastructure of mature egg apparatus cells through electron micrographs.
9. Dissection of embryo/endosperm from developing seeds.
10. Calculation of percentage of germinated pollen in a given medium.

**Suggested Readings**

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5<sup>th</sup> edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

**Discipline specific core course (DSC)**  
**Discipline specific core 1**  
**Paper 4: Plant Physiology and Metabolism**  
**(Credits: Theory-4, Practical-2)**

**(DSC Paper 4) THEORY**

**Lectures: 30**

**Unit 1: Plant-water relations** (4 lectures)

Water potential and its components; Transpiration and its significance; Factors affecting transpiration; Guttation.

**Unit 2: Mineral nutrition** (1 lectures)

Essential elements, macro and micronutrients.

**Unit 3: Translocation in phloem.** (1 lectures)

Composition of phloem sap; Phloem loading and unloading

**Unit 4: Photosynthesis** (6 lectures)

Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation.

**Unit 5: Respiration** (5 lectures)

Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Oxidative Pentose Phosphate Pathway.

**Unit 6: Enzymes** (4 lectures)

Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

**Unit 7: Nitrogen metabolism** (1 lectures)

Biological nitrogen fixation.

**Unit 8: Plant growth regulators** (6 lectures)

Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

**Unit 9: Plant response to light and temperature** (2 lectures)

Photoperiodism (SDP, LDP, Day neutral plants); Vernalization.

**DSC PAPER 4: Plant Physiology and Metabolism (Practical)**

1. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
2. Demonstration of Hill reaction.
3. Comparison of the rate of respiration in any two parts of a plant.

**Demonstration experiments**

1. Suction due to transpiration.

### **Suggested Readings**

1. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6<sup>th</sup> edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4<sup>th</sup> Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

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**Discipline specific elective course (DSE)**  
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**Discipline specific elective course (DSE) (Botany)**

[Any two to be selected]

**DSE: Economic Botany and Plant Biotechnology**

(Credits: Theory-4, Practical-2)

**THEORY**

**Lectures: 30**

**Unit 1: Origin of Cultivated Plants (2 lectures)**

Concept of Vavilov's centres of origin of cultivated plants.

**Unit 2: Cereals (2 lectures)**

Wheat –Origin, uses

**Unit 3: Legumes (2 lectures)**

Gram (Botanical name, family and uses)

**Unit 4: Spices (3 lectures)**

Clove (Botanical name, family, morphology, part used and uses)

**Unit 5: Beverages (2 lectures)**

Tea (processing, uses)

**Unit 6: Oils (2 lectures)**

Groundnut (extraction method and uses)

**Unit 7: Fibre Yielding Plants (2 lectures)**

Cotton (Botanical name, family and uses)

**Unit 8: Introduction to biotechnology (1 lecture)**

**Unit 9: Plant tissue culture (4 lectures)**

Micropropagation ; haploid production through androgenesis and gynogenesis; brief account of embryo and endosperm culture.

**Unit 10: Recombinant DNA Techniques (10 lectures)**

Molecular DNA markers i.e. RAPD, RFLP, SNPs; PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Human Gene Therapy

**PRACTICAL**

1. Study of economically important plants: Wheat, Gram, Clove, Tea, Cotton through specimens, sections from permanent slides and photographs.
2. Familiarization with basic equipments in tissue culture.
3. Study through photographs: Anther culture, endosperm and embryo culture; micropropagation.
4. Study of molecular techniques: PCR, AGE and PAGE

### **Suggested Readings**

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4<sup>th</sup> edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

**Discipline specific elective course (DSE) (Botany)**  
**DSE: Industrial and Environmental Microbiology**  
**(Credits: Theory-4, Practical-2)**

### **THEORY**

#### **Lectures: 30**

#### **Unit 1: Bioreactors/Fermenters and fermentation processes (4 lectures)**

Batch and continuous fermentations. Components of a typical bioreactor.

#### **Unit 2: Microbial production of industrial products (4 lectures)**

Microorganisms involved, media, fermentation conditions, downstream processing and uses.

#### **Unit 3: Microbes and quality of environment. (6 lectures)**

Distribution of microbes in air; Isolation of microorganisms from soil, air and water.

#### **Unit 4: Microbial flora of water. (8 lectures)**

Water pollution, role of microbes in sewage and domestic waste water treatment systems. Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples.

#### **Unit 5: Microbes in agriculture and remediation of contaminated soils. (8 lectures)**

Biological fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.

### **PRACTICAL**

1. Hands on sterilization techniques and preparation of culture media.

### **Suggested Readings**

1. Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.

**Discipline specific elective course (DSE) (Botany)**  
**DSE: Analytical Techniques in Plant Sciences**  
**(Credits: Theory-4, Practical-2)**

### **THEORY**



## **Lectures: 30**

### **Unit 1: Imaging and related techniques (7 lectures)**

Principles of microscopy; Light microscopy; Fluorescence microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: FISH, Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining.

### **Unit 2: Cell fractionation (6 lectures)**

Centrifugation: Differential and density gradient centrifugation, analytical centrifugation, ultracentrifugation, marker enzymes.

### **Unit 3: Radioisotopes (4 lectures)**

Use in biological research, auto-radiography, pulse chase experiment.

### **Unit 4: Spectrophotometry (2 lectures)**

Principle and its application in biological research.

### **Unit 5: Chromatography (8 lectures)**

Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

### **Unit 6: Characterization of proteins and nucleic acids (3 lectures)**

Mass spectrometry; Electrophoresis: AGE, PAGE, SDS-PAGE

## **PRACTICAL**

1. Study of Blotting techniques: Southern, Northern and Western through photographs.
2. Demonstration of ELISA.
3. To separate chloroplast pigments by column chromatography through photographs.
4. To separate proteins using PAGE through photographs.
5. To separation DNA (marker) using AGE through photographs.
6. Study of different microscopic techniques using photographs/micrographs (negative staining, fluorescence and FISH).

## **Suggested Readings**

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3<sup>rd</sup> edition.
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. 3<sup>rd</sup> edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4<sup>th</sup> edition.

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**Skill Enhancement Course (SEC)**

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**Skill Enhancement Course (SEC) Botany**  
(any four to be selected)

**Skill Enhancement Course**  
**Biofertilizers**  
(Credits 2)

**SEC: Biofertilizers**

**Lectures: 15**

**Unit 1:** General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication. **(2 lectures)**

**Unit 2:** Azospirillum: isolation and mass multiplication, associative effect of different microorganisms. Azotobacter: classification, maintenance and mass multiplication. **(4 lectures)**

**Unit 3:** Azolla and Anabaena azollae association, blue green algae and Azolla in rice cultivation. **(2 lectures)**

**Unit 4:** Mycorrhizal association, types of mycorrhizal association, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants. **(4 lectures)**

**Unit 5:** Organic farming – Green manuring and organic fertilizers, Recycling of bio-degradable municipal, agricultural and Industrial wastes – biocompost making methods. **(3 lectures)**

**Suggested Readings**

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand& Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John JothiPrakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. SubhaRao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming AktaPrakashan, Nadiad

**Skill Enhancement Course**  
**Herbal Technology**  
(Credits 2)

**SEC: Herbal Technology**

**Lectures: 15**

**Unit 1:** Herbal medicines: history and scope-definition of medical terms; cultivation - harvesting - processing - storage -marketing and utilization of medicinal plants. **(3 Lectures)**

**Unit 2:** Pharmacognosy - systematic position and medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, and Fenugreek. **(3 Lectures)**

**Unit 3:** Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Centella asiatica* (memory booster). **(3 Lectures)**

**Unit 4:** Analytical pharmacognosy: Drug adulteration - types, Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, phenolic compounds) **(4 Lectures)**

**Unit 5:** Medicinal plant banks, micropropagation of *Withania somnifera*; Herbal foods-future of pharmacognosy. **(2 Lectures)**

### **Suggested Readings**

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.
3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
4. Ayurvedic drugs and their plant source. V.V. Sivarajan and BalachandranIndra 1994. Oxford IBH publishing Co.
5. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
6. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
7. Pharmacognosy, Dr.C.K.Kokate et al. 1999. NiraliPrakashan.

### **Skill Enhancement Course Nursery and Gardening (Credits 2)**

#### **SEC: Nursery and Gardening**

#### **Lectures: 15**

**Unit 1:** Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities. **(2 Lectures)**

**Unit 2:** Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy, Seed banks, factors affecting seed viability,. **(3 Lectures)**

**Unit 3:** Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings.. **(3 Lectures)**

**Unit 4:** Gardening: definition, objectives and scope - different types of gardening, Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.

**(4 Lectures)**

**Unit 5:** - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion.

**(3 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.

### **Skill Enhancement Course**

#### **Floriculture**

**(Credits 2)**

### **SEC: Floriculture**

**Lectures: 15**

**Unit 1:** Importance and scope of floriculture and landscape gardening. **(1 lectures)**

**Unit 2:** Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing;Planting and transplanting; Shading; Mulching; Topiary.

**(4 lectures)**

**Unit 3:**Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shadeand ornamental trees; Ornamental bulbous and foliage plants; Cacti and Cycads; Cultivation of plants in pots; Indoor gardening; Bonsai.

**(4 lectures)**

**Unit 6:** Commercial Floriculture: Factors affecting production;Production andpackaging of cut flowers; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Marigold,Rose, Orchids).

**(4 lectures)**

**Unit 7:** Diseases and Pests of Ornamental Plants. **(2 lectures)**

### **Suggested Readings**

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

**Skill Enhancement Course**  
**Medicinal Botany**  
**(Credits 2)**

**SEC: Medicinal Botany**

**Lectures: 15**

**Unit 1:** History, Scope and Importance of Medicinal Plants: Indigenous Medicinal Sciences; Definition and Scope. Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. **(5 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 and important components of a nursery, use of green house for nursery production, propagation through cuttings, layering, grafting and budding. **(6 lectures)**

**Unit 3:** Ethnobotany and Folk medicines: Definition, Applications of Ethnobotany: folk medicines of ethnobotany, ethnomedicine. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, blood pressure and skin diseases. **(4 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, 2<sup>nd</sup> edn. Agrobios,

**Skill Enhancement Course**  
**Plant Diversity and Human Welfare**  
**(Credits 2)**

**SEC: Plant Diversity and Human Welfare**

**Lectures: 15**

**Unit 1:** Plant diversity and its scope-Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agrobiodiversity and cultivated plant taxa, wild taxa. Uses of plants and microbes. **(4 lectures)**

**Unit 2: Loss of Biodiversity:** Loss of genetic, species and agrobiodiversity diversity.

**Management of Plant Biodiversity:** Organizations associated with biodiversity management- Methodology for execution-IUCN, WWF, NBPGR; Biodiversity legislation, biodiversity information management and communication. **(4 lectures)**

**Unit 3: Conservation of Biodiversity:** Conservation of genetic, species and ecosystem diversity, *In situ* and *ex situ* conservation, Biodiversity awareness programmes, Sustainable development. **(4 lectures)**

**Unit 4: Role of plants in relation to Human Welfare;**

- a) Importance of forestry their utilization and commercial aspects
- b) Ornamental plants of India
- c) Alcoholic beverages through ages.

Fruits and nuts: Important fruit crops their commercial importance. **(3 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

### **Skill Enhancement Course**

#### **Ethnobotany (Credits 2)**

### **SEC: Ethnobotany**

**Lectures: 15**

#### **Unit 1: Ethnobotany**

Introduction, concept, scope and objectives; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses. **(4 Lectures)**

#### **Unit 2: Methodology of Ethnobotanical studies**

a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places. **(3 lectures)**

#### **Unit 3: Role of ethnobotany in modern Medicine**

Significance of the following plants in ethno botanical practices (along with their habitat and morphology):

- a) *Azadirachta indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superb* e) *Tribulus terrestris*
- f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*.

Role of ethnobotany in modern medicine with special example *Rauwolfia serpentina*, *Trichopus zeylanicus*, *Artemisia*, *Withania*. **(5 lectures)**

#### **Unit 4: Ethnobotany and legal aspects**

Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

**(3 lectures)**

### **Suggested Readings**

1. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
2. S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981
3. Lone et al., Palaeoethnobotany
4. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
5. S.K. Jain, 1990. Contributions of Indian ethnobotny. Scientific publishers, Jodhpur.
6. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
7. Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah. 8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur-1996 9) Faulks, P.J. 1958. An introduction to Ethnobotany, Moredale pub. Ltd.

### **Skill Enhancement Course Mushroom Culture Technology (Credits 2)**

#### **SEC: Mushroom Culture Technology**

#### **Lectures: 15**

**Unit 1:** Introduction, History, Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. **(2 Lectures)**

**Unit 2:** Cultivation Technology: Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house), water sprayer, tray, small polythene bag; preparation of spawn. Mushroom bed preparation - paddy straw; factors affecting the mushroom bed preparation. Composting technology in mushroom production. **(9 Lectures)**

**Unit 3:** Storage: Short-term storage (Refrigeration – up to 24 hours), Long term Storage (canning, pickels, papads), drying, storage in salt solutions. **(2 Lectures)**

**Unit 4:** Food Preparation: Types of foods prepared from mushroom. Research Centres: National level and Regional level. Export Value. **(2 Lectures)**

#### **Suggested Readings**

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.

2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

**Skill Enhancement Course  
Intellectual Property Rights  
(Credits 2)**

**SEC: Intellectual Property Rights**

**Lectures: 15**

**Unit 1: Introduction to intellectual property right (IPR) (1 lectures)**

Concept and kinds. IPR in India and world: some important examples. IPR and WTO (TRIPS, WIPO).

**Unit 2: Patents (2 Lectures)**

Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents,

**Unit 3: Copyrights and Trademarks (1 Lectures)**

Introduction, Works protected under copyright law and trademarks, Rights, Transfer of Copyright, Infringement,

**Unit 4: Geographical Indications (1 Lectures)**

Objectives, Justification, International Position, Multilateral Treaties.

**Unit 5: Protection of Traditional Knowledge (2 Lectures)**

Objective, Concept of Traditional Knowledge, Bio-Prospecting and Bio-Piracy, Alternative ways, Traditional Knowledge on the International Arena, at WTO, at National level.

**Unit 6: Protection of Plant Varieties (3 Lectures)**

Objectives: International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

**Unit 7: Information Technology Related Intellectual Property Rights (2 Lectures)**

Computer Software and Intellectual Property, Database and Data Protection, Protection of Semiconductor chips, Domain Name Protection

**Unit 8: Biotechnology and Intellectual Property Rights. (3 Lectures)**

Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions.

**Suggested Readings**



1. N.S. Gopalakrishnan & T.G. Agitha, (2009) Principles of Intellectual Property Eastern Book Company, Lucknow.
2. Kerly's Law of Trade Marks and Trade Names (14th Edition) Thomson, Sweet & Maxwell.
3. Ajit Parulekar and Sarita D' Souza, (2006) Indian Patents Law – Legal & Business Implications; Macmillan India Ltd.
4. B.L.Wadehra (2000) Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India.
5. P. Narayanan (2010) Law of Copyright and Industrial Designs; Eastern law House, Delhi.

# UNIVERSITY OF NORTH BENGAL

ACCREDITED BY NAAC WITH GRADE "A"



ENLIGHTENMENT TO PERFECTION

## SYLLABI

FOR

**B.Sc. Program:**

**BOTANY PORTION**

UNDER

**CHOICE BASED CREDIT SYSTEM**

**(CBCS) (Truncated to 75%)**

UNDER

**CHOICE BASED CREDIT SYSTEM**

**For 2<sup>nd</sup>, 4<sup>th</sup> and 6<sup>th</sup> Semester**

**(for the year 2021 only)**

**B. Sc. Program (Botany portion)**

**Discipline specific core course (DSC)**

1. Biodiversity (Microbes, Algae, Fungi and Archegoniate)
2. Plant Ecology and Taxonomy
3. Plant Anatomy and Embryology
4. Plant Physiology and Metabolism

**Discipline specific elective course (DSE): (any two to be selected)**

1. Economic Botany and Biotechnology
2. Industrial and Environmental Microbiology
3. Analytical Techniques in Plant Sciences

**Ability Enhancement Course Compulsory (AECC)**

1. Environmental Science
2. English/MIL Communication

**Skill Enhancement Course (SEC): (Any four to be selected)**

1. Biofertilizers
2. Herbal Technology
3. Nursery and Gardening
4. Floriculture
5. Medicinal Botany
6. Plant Diversity and Human Welfare
7. Ethnobotany
8. Mushroom Culture Technology
9. Intellectual Property Right

**Detailed Course structure**

Course Components	B.Sc. Program
Discipline specific Core Course (DSC)	12
Discipline Specific Elective (DSE) Course (Any Four)	6
Generic Electives (GE) Course (Any Four)	-
Ability Enhancement Compulsory Course (AECC)	2
Skill Enhancement Course (SEC) (Any Two)	4
<b>Total courses</b>	<b>24</b>

**Detailed credit of the course B.Sc. Program (Botany)**

Sl.No.	Courses	Credit	
		Theory + Practical	Total
1.	<b>DSC Courses (12 courses)</b>	(12 x 4) + (12 x 2)	72
2.	<b>Elective Courses (6 Courses)</b>		
2A.	DSE (6 Courses)	(6 x 4) + (6 x 2)	36
2B.	GE (4 Courses)	-	-
3.	<b>Ability Enhancement Courses [AECC]</b>		
3A.	AECC-1	(2x1)	2
	AECC-2	(2x1)	2
3B.	SEC (4 Courses of 2 Credits each)	(4x2)	8
<b>Total Credit of all 26 courses</b>			<b>120</b>

### Scheme for CBCS in B.Sc. Program- Botany

Year	Semester	Discipline specific Core Course (DSC)	Ability Enhancement Compulsory Course (AECC)	Skill Enhancement Course (SEC)	Discipline Specific Elective Course (DSE)	
1	1	DSC 1 Paper 1: Biodiversity (Microbes, Algae, Fungi and Archegoniate)	AECC-1 (ENVS)			
		DSC 2 Paper 2:				
		DSC 3 Paper 3:				
	2	2	DSC 1 Paper 1: Plant Ecology and Taxonomy	AECC-2 (Com. Eng./MIL)		
			DSC 2 Paper 2:			
			DSC 3 Paper 3:			
2	3	DSC 1 Paper 1: Plant Anatomy and Embryology		SEC 1 Paper 1:....		
		DSC 2 Paper 2:				
		DSC 3 Paper 3:				
	4	4	DSC 1 Paper 1: Plant Physiology and Metabolism		SEC 1 Paper 2:.....	
			DSC 2 Paper 2:			
			DSC 3 Paper 3:			
3	5			SEC 2 Paper 1:.....	DSE 1 Paper 1: Botany	
					DSE 2 Paper 1:.... (to be Selected)	
					DSE 3 Paper 1: (to be Selected)	
	6				SEC 2 Paper 2:.....	DSE 1 Paper 2: Botany
						DSE 2 Paper 2: (to be Selected)
						DSE 3 Paper 2: (to be Selected)

- DSE 1 will be the same as DSC 1 Course & DSE 2 will be the same as DSC 2 Course and DSE 3 will be same DSC 3 Course.
- SEC 1 and SEC 2 could be chosen from any of the 3 DSC Courses taken above.

## Details of the syllabi

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### Discipline specific core course (DSC)

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#### Discipline specific core **Paper 1: Biodiversity (Microbes, Algae, Fungi and Archegoniate)** (Credits: Theory-4, Practical-2)

#### **(DSC Paper 1) THEORY**

##### **Lectures: 45**

##### **Unit 1: Microbes**

**(10 lectures)**

Viruses – Discovery, general structure, replication (general account), Lytic and lysogenic cycle, Economic importance; Bacteria – General characteristics and cell structure; Reproduction –recombination (conjugation, transformation and transduction); Economic importance.

##### **Unit 2: Algae**

**(8 lectures)**

General characteristics; Ecology and distribution; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Oedogonium*, *Polysiphonia*. Economic importance of algae.

##### **Unit 3: Fungi**

**(10 lectures)**

Introduction- General characteristics, ecology and significance, reproduction and classification; True Fungi- General characteristics, life cycle of *Rhizopus* (Zygomycota) *Penicillium*, (Ascomycota), *Agaricus*, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

##### **Unit 4: Introduction to Archegoniate**

**(2 lectures)**

Unifying features of archegoniate, Transition to land habit, Alternation of generations.

##### **Unit 5: Bryophytes**

**(5 lectures)**

General characteristics, Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included).

##### **Unit 6: Pteridophytes**

**(5 lectures)**

General characteristics, Classification (up to family), morphology, anatomy and reproduction of *Equisetum* and *Pteris* (Developmental details not to be included); Stelar evolution. Ecological and economical importance of Pteridophytes.

##### **Unit 7: Gymnosperms**

**(5 lectures)**

General characteristics; morphology, anatomy and reproduction of *Cycas* and *Pinus* (Developmental details not to be included); Economic importance.

#### **Practical**

1. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
2. Gram staining
3. Study of vegetative and reproductive structures of *Nostoc*, *Oedogonium* and *Polysiphonia* through temporary preparations and permanent slides.
4. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
5. *Puccinia*: Herbarium specimens of Black Stem Rust of wheat
6. *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, l.s. sporophyte (all permanent slides).
7. *Equisetum*- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry)(temporary slides); t.s. rhizome (permanent slide).
8. *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).
9. *Cycas*- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaf let, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).
10. *Pinus*- ts. needle, t.s. stem, l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

#### **Suggested Readings**

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2<sup>nd</sup> edition.
  - Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10<sup>th</sup> edition.

- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
- Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4<sup>th</sup> edition.
- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
- Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
- Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
- Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

### **Discipline specific core course (DSC)**

#### **Discipline specific core 1 Paper 2: Plant Ecology and Taxonomy (Credits: Theory-4, Practical-2)**

#### **(DSC 1 Paper 2) THEORY**

#### **Lectures: 45**

#### **Unit 1: Introduction and Ecological factors (10 lectures)**

Inter-relationships between the living world and the environment, Soil: Origin, composition, soil profile. Water: precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes

#### **Unit 2: Plant communities (4 lectures)**

Ecotone and edge effect; Succession; Processes and types

#### **Unit 3: Ecosystem (6 lectures)**

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

#### **Unit 4: Phytogeography (4 lectures)**

Principle biogeographical zones; Endemism

#### **Unit 5: Introduction to plant taxonomy (1 lectures)**

#### **Unit 6: Identification (4 lectures)**

Identification, Classification, Nomenclature. Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora,

#### **Unit 7: Taxonomic evidences from palynology, cytological data. (2lectures)**

#### **Unit 8: Botanical nomenclature (5 lectures)**

Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, principle of priority and its limitations.

#### **Unit 9: Classification (5 lectures)**

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series).

#### **Unit 10: Study of Diagnostic features of the families:(4 lectures)**

Lamiaceae, solanaceae, Asteraceae, Commelinaceae

#### **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 by rapid field test.
3. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
4. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each). (b) Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobancha*), Epiphytes, Predation (Insectivorous plants)
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
7. Study of vegetative and floral characters of the following families (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 -*Sonchus/Launaea*, *Vernonia/Ageratum*, *Eclipta/Tridax*; Solanaceae -*Solanum Sp./Physalis*, Lamiaceae -*Salvia, Ocimum/Leucus* Commelinaceae - *Commelina /Murdania /Cyanotis*
8. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

### **Suggested Readings**

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4<sup>th</sup> edition.
2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8<sup>th</sup> edition.
3. Simpson, M.G. (2006). *Plant Systematics*. Elsevier Academic Press, San Diego, CA, U.S.A.
4. Singh, G. (2012). *Plant Systematics: Theory and Practice*. Oxford & IBH Pvt. Ltd., New Delhi. 3<sup>rd</sup> e

### **Discipline specific core course (DSC)**

#### **Discipline specific core 1 Paper 3: Plant Anatomy and Embryology (Credits: Theory-4, Practical-2)**

#### **(DSC 1 Paper 3) THEORY**

#### **Lectures: 45**

#### **Unit 1: Meristematic and permanent tissues**

**(5 lectures)**

Root and shoot apical meristems; Simple and complex tissues

#### **Unit 2: Organs**

**(5 lectures)**

Structure of dicot and monocot root stem and leaf.

#### **Unit 3: Secondary Growth**

**(5 lectures)**

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

#### **Unit 4: Adaptive and protective systems**

**(8 lectures)**

Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

#### **Unit 5: Structural organization of flower**

**(5 lectures)**

Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs

#### **Unit 6: Pollination and fertilization**

**(5 lectures)**

Pollination mechanisms and adaptations; Double fertilization;

#### **Unit 7: Embryo and endosperm**

**(6 lectures)**

Endosperm types, structure and functions; Dicot and monocot embryo;

#### **Unit 8: Apomixis and polyembryony**

**(6 lectures)**

Definition, types and Practical applications

#### **GE: Plant Anatomy and Embryology (Practical)**

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Phloem (Permanent slides, photographs)
3. Stem: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*;
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
7. Structure of anther (young and mature), (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.
9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanism (Photographs and specimens).

### **Suggested Readings**



1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5<sup>th</sup> edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

### **Discipline specific core course (DSC)**

#### **Discipline specific core 1 Paper 4: Plant Physiology and Metabolism (Credits: Theory-4, Practical-2)**

#### **(DSC 1 Paper 4) THEORY**

#### **Lectures: 45**

<b>Unit 1: Plant-water relations</b>	<b>(6 lectures)</b>
Water potential and its components; Transpiration and its significance.	
<b>Unit 2: Mineral nutrition</b>	<b>(6 lectures)</b>
Essential elements, macro and micronutrients; Role of essential elements; Transport of ions across cell membrane, active and passive transport,	
<b>Unit 3: Translocation in phloem.</b>	<b>(3 lectures)</b>
Composition of phloem sap, Pressure flow model;	
<b>Unit 4: Photosynthesis</b>	<b>(6 lectures)</b>
Photosystem I and II, Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation;	
<b>Unit 5: Respiration</b>	<b>(6 lectures)</b>
Glycolysis, TCA cycle; Oxidative phosphorylation,	
<b>Unit 6: Enzymes</b>	<b>(6 lectures)</b>
Structure and properties; Mechanism of enzyme catalysis	
<b>Unit 7: Nitrogen metabolism</b>	<b>(5 lectures)</b>
Biological nitrogen fixation;	
<b>Unit 8: Plant growth regulators</b>	<b>(3 lectures)</b>
Discovery and physiological roles of auxins, gibberellins, cytokinins,	
<b>Unit 9: Plant response to light and temperature</b>	<b>(4 lectures)</b>
Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis;	

#### **Practical**

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
3. To study the effect of light intensity and bicarbonate concentration on O<sub>2</sub> evolution in photosynthesis.
4. Comparison of the rate of respiration in any two parts of a plant.

#### **Demonstration experiments**

1. Effect of auxins on rooting.
2. R.Q.
3. Respiration in roots.

#### **Suggested Readings**

1. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6<sup>th</sup> edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4<sup>th</sup> Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

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**Discipline specific elective course (DSE)**

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**Discipline specific elective course (DSE) (Botany)** [Any two to be selected]

**Economic Botany and Plant Biotechnology**

**(Credits: Theory-4, Practical-2)**

**THEORY**

**Lectures: 45**

**Unit 1: Origin of Cultivated Plants** (3 lectures)

Concept of centres of origin, their importance with reference to Vavilov's work.

**Unit 2: Cereals** (3 lectures)

Wheat –Origin, morphology, uses

**Unit 3: Legumes** (4 lectures)

Gram and Soybean (Botanical name, family and uses)

**Unit 4: Spices** (4 lectures)

Clove and black pepper (Botanical name, family, morphology, part used and uses)

**Unit 5: Beverages** (3 lectures)

Tea (morphology, processing, uses)

**Unit 6: Oils and Fats** (2 lectures)

Groundnut (extraction method and uses)

**Unit 7: Fibre Yielding Plants** (3 lectures)

Cotton (Botanical name, family, parts used, morphology and uses)

**Unit 8: Introduction to biotechnology** (1 lecture)

**Unit 9: Plant tissue culture** (5 lectures)

Micropropagation ; haploid production through androgenesis and gynogenesis; brief account of embryo and endosperm culture with their applications.

**Unit 10: Recombinant DNA Techniques** (17 lectures)

Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Molecular diagnosis of human disease, Human gene Therapy.

**GE: Economic Botany and Plant Biotechnology (Practical)**

1. Study of economically important plants: Wheat, Gram, Clove, Tea, Cotton through specimens, sections from permanent slides and photographs.

2. Familiarization with basic equipments in tissue culture.

3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.

4. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.

**Suggested Readings**

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4<sup>th</sup> edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

**Discipline specific elective course (DSE) (Botany)**  
**Industrial and Environmental Microbiology**  
**(Credits: Theory-4, Practical-2)**

**THEORY**

**Lectures: 45**

**Unit 1: Bioreactors/Fermenters and fermentation processes (9 lectures)**

Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor

**Unit 2: Microbial production of industrial products (9 lectures)**

Microorganisms involved, media, fermentation conditions, downstream processing and uses.

**Unit 3: Microbes and quality of environment (7 lectures)**

Distribution of microbes in air; Isolation of microorganisms from soil, air and water.

**Unit 4: Microbial flora of water. (11 lectures)**

Water pollution, role of microbes in sewage and domestic waste water treatment systems. Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples.

**Unit 5: Microbes in agriculture and remediation of contaminated soils. (9 lectures)**

Biological fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.

**DSE: Industrial and Environmental Microbiology (Practical)**

1. Principles and functioning of instruments in microbiology laboratory
2. Hands on sterilization techniques and preparation of culture media.

**Suggested Readings**

1. Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.

**Discipline specific elective course (DSE) (Botany)**  
**Analytical Techniques in Plant Sciences**  
**(Credits: Theory-4, Practical-2)**

## THEORY

### Lectures: 45

#### Unit 1: Imaging and related techniques

(8 lectures)

Principles of microscopy; Light microscopy; Fluorescence microscopy; (b) Applications of fluorescence microscopy: Chromosome banding, Transmission and Scanning electron microscopy.

#### Unit 3: Radioisotopes

(5 lectures)

Use in biological research, auto-radiography, pulse chase experiment.

#### Unit 4: Spectrophotometry

(2 lectures)

Principle and its application in biological research.

#### Unit 5: Chromatography

(5 lectures)

Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

#### Unit 6: Characterization of proteins and nucleic acids

(10 lectures)

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.

1. To separate sugars by thin layer chromatography.
2. To separate chloroplast pigments by column chromatography.
3. To estimate protein concentration through Lowry's methods.
4. To separate proteins using PAGE.
5. 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. 3<sup>rd</sup> edition.
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. 3<sup>rd</sup> edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4<sup>th</sup> edition.

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### Skill Enhancement Course (SEC)

(any four to be selected)

(Papers to be coded as a SEC1 Botany, SEC2 Botany, SEC 3 Botany & SEC 4 Botany)

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### SEC: Biofertilizers

(Credits 2)

### Lectures: 20

**Unit 1:** General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication. (3 lectures)

**Unit 2:** Azospirillum: isolation and mass multiplication, carrier based inoculant associative effect of different microorganisms. Azotobacter: classification, maintenance and mass multiplication. (4 lectures)

**Unit 3:** Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, blue green algae and Azolla in rice cultivation.

(3 lectures)

**Unit 4:** Mycorrhizal association, types of mycorrhizal association, occurrence and distribution phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants. (5 lectures)

**Unit 5:** Organic farming – Green manuring and organic fertilizers, Recycling of bio-degradable municipal, agricultural and Industrial wastes – biocompost making methods , types and method of vermicomposting – field Application. (5 lectures)

### **Suggested Readings**

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming Akta Prakashan, Nadiad

### **SEC: Herbal Technology (Credits 2)**

#### **Lectures: 20**

**Unit 1:** Herbal medicines: history and scope-definition of medical terms; cultivation - harvesting - processing - storage -marketing and utilization of medicinal plants. (3 Lectures)

**Unit 2:** Pharmacognosy - systematic position and medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek and Ashoka. (3 Lectures)

**Unit 3:** Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on nervous system) *Centella asiatica* (memory booster). (5 Lectures)

**Unit 4:** Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation; Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, phenolic compounds) (6 Lectures)

**Unit 5:** Medicinal plant banks, micropropagation of *Withania somnifera* and neem; Herbal foods-future of pharmacognosy. (3 Lectures)

### **Suggested Readings**

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.
3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
4. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.
5. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
6. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
7. Pharmacognosy, Dr.C.K.Kokate et al. 1999. Nirali Prakashan.

### **SEC: Nursery and Gardening (Credits 2)**

#### **Lectures: 20**

**Unit 1:**Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants. (2 Lectures)

**Unit 2:** Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability; Seed production technology **(4 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 – green house - shade house .

**(5 Lectures)**

**Unit 4:**Gardening: definition, objectives and scope - different types of gardening - computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.

**(5 Lectures)**

**Unit 5:**Sowing/raising of seeds and seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, tomatoes.

**(4 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: Floriculture (Credits 2)**

### **Lectures: 20**

**Unit 1:** Importance and scope of floriculture and landscape gardening. **(1 lectures)**

**Unit 2:** Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing;Planting and transplanting; Shading; Mulching; Topiary; Role of plant growth Regulators

**(4 lectures)**

**Unit 3:** Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and Cycads; Cultivation of plants in pots; Indoor gardening; Bonsai.

**(4 lectures)**

**Unit 4 :** Principles of Garden Design: English, Italian, Mughal and Japanese Garden **(3 Lectures)**

**Unit 5 :** Landscaping highways and educational Institutions **(2 Lectures)**

**Unit 6:** Commercial Floriculture: Factors affecting production;Production andpackaging of cut flowers; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Marigold,Rose, Orchids).

**(4 lectures)**

**Unit 7:** Diseases and Pests of Ornamental Plants. **(2 lectures)**

### **Suggested Readings**

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

## **SEC: Medicinal Botany (Credits 2)**

### **Lectures: 20**

**Unit 1:** Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, plants used in ayurvedic treatments, Siddha:

Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umooor-e- tabiya, polyherbal formulations. ( 7 Lectures)

**Unit 2:** Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, In situ conservation: Biosphere reserves, National Parks; Ex situ conservation: Botanic 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. (7 Lectures)

**Unit 3:** Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, diabetics, Blood pressure and skin diseases. ( 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, 2<sup>nd</sup> edn. Agrobios, India.

## **SEC: Plant Diversity and Human Welfare (Credits 2)**

### **Lectures: 20**

**Unit 1:** Plant diversity and its scope-Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Values and uses of Biodiversity; Agrobiodiversity and cultivated plant taxa, wild taxa. Uses of plants and microbes. (5 lectures)

**Unit 2: Loss of Biodiversity:** Loss of genetic, species and agrobiodiversity diversity.

**Management of Plant Biodiversity:** Organizations associated with biodiversity management-Methodology for execution-IUCN, WWF, NBPGR; Biodiversity legislation, biodiversity information management and communication. (5 lectures)

**Unit 3: Conservation of Biodiversity:** Conservation of genetic, species and ecosystem diversity, *In situ* and *ex situ* conservation, Biodiversity awareness programmes, Sustainable development. (5 lectures)

### **Unit 4: Role of plants in relation to Human Welfare;**

- a) Importance of forestry their utilization and commercial aspects
- b) Ornamental plants of India
- c) Alcoholic beverages through ages.

Fruits and nuts: Important fruit crops their commercial importance. Wood and its uses (5 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: Ethnobotany (Credits 2)**

### **Lectures: 20**

#### **Unit 1: Ethnobotany**

**(3 Lectures)**

Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. Major and minor ethnic groups or Tribals of India, Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.

**Unit 2: Methodology of Ethnobotanical studies** (4 lectures)

a) Field work c) Ancient Literature d) Archaeological findings e) sacred places.

**Unit 3: Role of ethnobotany in modern Medicine** (7 lectures)

Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiracantha indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superba* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*.

Role of ethnobotany in modern medicine with special example *Rauwolfia serpentina*, *Artemisia*, *Withania*.

Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

**Unit 4: Ethnobotany and legal aspects** (6 lectures)

Ethnobotany as a tool to protect interests of ethnic groups. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

### Suggested Readings

1. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
2. S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981
3. Lone et al., Palaeoethnobotany
4. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
5. S.K. Jain, 1990. Contributions of Indian ethnobotny. Scientific publishers, Jodhpur.
6. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
7. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
8. Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah. 8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA – SHREE Publishers, Jaipur-1996 9) Faulks, P.J. 1958. An introduction to Ethnobotany, Moredale pub. Ltd.

### SEC: Mushroom Culture Technology (Credits 2)

**Lectures: 20**

**Unit 1:** Introduction, History, Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*.

(4 Lectures)

**Unit 2:** Cultivation Technology: Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house), water sprayer, tray, small polythene bag; Pure culture: Medium, sterilization preparation of spawn. Mushroom bed preparation - paddy straw; factors affecting the mushroom bed preparation. Composting technology in mushroom production.

(10 Lectures)

**Unit 3:** Storage and nutrition: Short-term storage (Refrigeration – up to 24 hours), Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Pure culture: Medium, sterilization (4 Lectures)

**Unit 4:** Food Preparation: Types of foods prepared from mushroom. Research Centres: National level and Regional level. Export Value. (2 Lectures)

### Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

### SEC: Intellectual Property Rights (Credits 2)

**Lectures: 20**



**Unit 1: Introduction to intellectual property right (IPR)****(2 lectures)**

Concept and kinds. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).

**Unit 2: Patents****(2 Lectures)**

Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, working of patents. Infringement.

**Unit 3: Copyrights****(2 Lectures)**

Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement.

**Unit 4: Trademarks****(2 Lectures)**

Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defences, Domain name.

**Unit 5: Geographical Indications****(2 Lectures)**

Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.

**Unit 6: Protection of Traditional Knowledge****(2 Lectures)**

Objective, Concept of Traditional Knowledge, Holders, Bio-Prospecting and Bio-Piracy, Alternative ways, Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.

**Unit 7: Industrial Designs****(1 Lecture)**

Objectives, Rights, Assignments, Infringements, Defences of Design Infringement

**Unit 8: Protection of Plant Varieties****(2 Lectures)**

Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

**Unit 9: Information Technology Related Intellectual Property Rights****(2 Lectures)**

Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection

**Unit 10: Biotechnology and Intellectual Property Rights.****(3 Lectures)**

Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions.

**Suggested Readings**

1. N.S. Gopalakrishnan & T.G. Agitha, (2009) Principles of Intellectual Property Eastern Book Company, Lucknow.
2. Kerly's Law of Trade Marks and Trade Names (14th Edition) Thomson, Sweet & Maxwell.
3. Ajit Parulekar and Sarita D' Souza, (2006) Indian Patents Law – Legal & Business Implications; Macmillan India Ltd.
4. B.L. Wadehra (2000) Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India.
5. P. Narayanan (2010) Law of Copyright and Industrial Designs; Eastern law House, Delhi.

# UNIVERSITY OF NORTH BENGAL

ACCREDITED BY NAAC WITH GRADE "A"



ENLIGHTENMENT TO PERFECTION

## **SYLLABI**

**FOR**

### **B.Sc. (HONOURS PROGRAM) IN BOTANY**

**(Truncated to 75%)**

**UNDER**

### **CHOICE BASED CREDIT SYSTEM**

**For 2<sup>nd</sup>, 4<sup>th</sup> and 6<sup>th</sup> Semester**

**(for the year 2021 only)**

## **Structure of B.Sc. Honours Program-Botany under CBCS for 2<sup>nd</sup>, 4<sup>th</sup> and 6<sup>th</sup> Semester**

### **Discipline specific Core Course (DSC)**

1. CC-3 Mycology and Phytopathology
2. CC-4 Archegoniate
3. CC-8 Molecular Biology
4. CC-9 Plant Ecology and Phytogeography
5. CC-10 Plant Systematics
6. CC-13 Plant Metabolism
7. CC-14 Plant Biotechnology

### **Discipline Specific Elective [DSE] (Any Four)**

1. Analytical Techniques in Plant Sciences
2. Bioinformatics
3. Stress Biology
4. Plant Breeding
5. Natural Resource Management
6. Horticultural Practices and Post-Harvest Technology
7. Research Methodology
8. Industrial and Environmental Microbiology
9. Biostatistics

### **Generic Electives [GE] (Any Four)**

1. Biodiversity (Microbes, Algae, Fungi and Archegoniate)
2. Plant Ecology and Taxonomy
3. Plant Anatomy and Embryology
4. Plant Physiology and Metabolism
5. Economic Botany and Biotechnology
6. Environmental Biotechnology

### **Ability Enhancement Compulsory Course [AECC]**

1. English/MIL Communication

### **Skill Enhancement Course (SEC) (Any Two)**

1. Biofertilizers
2. Herbal Technology
3. Nursery and Gardening
4. Floriculture
5. Medicinal Botany
6. Plant Diversity and Human Welfare
7. Ethnobotany
8. Mushroom Culture Technology
9. Intellectual Property Right

**Detailed Course Structure (Honours Program- Botany)**

<b>Course Components</b>	<b>B.Sc. Honours Program</b>
<b>Discipline specific Core Course (DSC)</b>	14
<b>Discipline Specific Elective (DSE) Course (Any Four)</b>	4
<b>Generic Electives (GE) Course (Any Four)</b>	4
<b>Ability Enhancement Compulsory Course (AECC)</b>	2
<b>Skill Enhancement Course (SEC) (Any Two)</b>	2
<b>Total courses</b>	26

**Detailed credit of the course Honours Program (Botany)**

Sl.No.	Courses	Credit	
		Theory + Practical	Total
1.	<b>Discipline specific Core (DSC) Courses</b>	(14 x 4) + (14 x 2)	84
2.	<b>Elective Courses (8 Courses)</b>		
2.A	DSE (Four Courses)	(4 x 4) + (4 x 2)	24
2.B	GE(Four Courses)	(4 x 4) + (4 x 2)	24
3.	<b>Ability Enhancement Compulsory Courses [AECC]</b>		
3A.	AECC-1 (ENVS)	(2x1)	2
	AECC-2 (Com. Eng./MIL)	(2x1)	2
3B.	SEC (2 Courses of 2 Credits each)	(2x2)	2

<b>Total Credit of all 26 courses</b>	<b>140</b>
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**Scheme for CBCS in B.Sc. Honours Program- Botany**

<b>Ye ar</b>	<b>Semester</b>	<b>Discipline specific Core (DSC) Course</b>	<b>Ability Enhancement Compulsory Course (AECC)</b>	<b>Skill Enhancement Course (SEC)</b>	<b>Discipline Specific Elective (DSE) Course</b>	<b>Generic Electives (GE) Course</b>	
1	1	Paper 1: Phycology and Microbiology	AECC-1			GE-1	
		Paper 2: Biomolecules and Cell Biology	(ENVS)			Paper 1: ...	
	2	Paper 3: Mycology and Phytopathology	AECC-2			GE-1	
		Paper 4: Archegoniate	(Com. Eng./MIL)			Paper 2: ...	
2	3	Paper 5: Morphology and anatomy		SEC		GE-2	
		Paper 6: Economic Botany		Paper 1: .....		Paper 1: ...	
		Paper 7 : Basics of Genetics					
	4	Paper 8 : Molecular biology			SEC		GE-2
		Paper 9 : Plant Ecology and Phytogeography			Paper 2: .....		Paper 2: ...
		Paper 10 : Plant Systematics					
3	5	Paper 11 : Reproductive biology of angiosperms			DSE Paper 1: .....		
		Paper 12 : Plant Physiology			DSE Paper 2: .....		

	6	Paper 13 : Plant metabolism		DSE Paper 3: .....	
		Paper 14 : Plant Biotechnology		DSE Paper 4: .....	

- Students pursuing DSC in Botany will have to opt for SEC and DSE in Botany only
- GE subject must be different from DSC in Botany

### Core Courses

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### Semester-II

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#### Core Course III: Mycology and Phytopathology [DSC Paper 3]

(Credits: Theory-4, Practical-2)

#### (DSC Paper 3)THEORY

**Lectures: 45**

**Unit 1: Introduction to true fungi (3 lectures)**

General characteristics; Cell wall composition; Nutrition.

**Unit 2: Chytridiomycota and Zygomycota (3 lecture)**

Characteristic features; Life cycle with reference to *Synchytrium*, *Rhizopus* .

**Unit 4: Ascomycota (10 lectures)**

General characteristics (asexual and sexual fruiting bodies); Heterokaryosis and parasexuality; Life cycle and with reference to *Saccharomyces*, *Aspergillus*, *Penicillium*, and *Peziza*.

**Unit 5: Basidiomycota (8 lectures)**

General characteristics; Ecology; Life cycle with reference to black stem rust on wheat (*Puccinia*) and *Agaricus*; Bioluminescence, Fairy Rings and Mushroom Cultivation.

**Unit 6: Allied Fungi (3 lectures)**

General characteristics; Status and occurrence of Slime molds; Types of plasmodia; Types of fruiting bodies.

**Unit 7: Oomycota (4 lectures)**

General characteristics; Life cycle with reference to *Phytophthora*

**Unit 8: Symbiotic associations (4 lectures)**

Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction; Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance.

### **Unit 8: Applied Mycology**

**(10 Lectures)**

Role of fungi in biotechnology; Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides);

### **Unit 9: Phytopathology**

**(10 lectures)**

Terms and concepts; General symptoms; Geographical distribution of diseases; Host-Pathogen relationships; Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine.

Bacterial diseases – Citrus canker and angular leaf spot of cotton. Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers.

### **(DSC Paper 3) Practical**

1. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
2. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
3. *Peziza*: sectioning through ascocarp.
4. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
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) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)
7. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Bacterial wilt of tomato, Viral diseases: TMV, Vein clearing, Fungal diseases: Late blight of potato, Black stem rust of wheat and White rust of crucifers.

### **Suggested Readings**

1. Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4<sup>th</sup> edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3<sup>rd</sup> edition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

## Core Course IV: Archegoniate [DSC Paper 4]

(Credits: Theory-4, Practical-2)

### (DSC Paper 4) THEORY

**Lectures: 45**

**Unit 1: Introduction**

**(2 lectures)**

Unifying features of archegoniates; Alternation of generations.

**Unit 2: Bryophytes**

**(4 lectures)**

General characteristics; Adaptation to land habit; Classification.

**Unit 3: Type Studies- Bryophytes**

**(9 lectures)**

Classification (up to family), morphology, anatomy and reproduction of *Riccia*, *Marchantia*, *Porella*, *Anthoceros* and *Funaria*; Evolutionary trends in *Marchantia* and *Anthoceros*; Ecological and economic importance of bryophytes with special reference to *Sphagnum*.

**Unit 4: Pteridophytes**

**(6 lectures)**

General characteristics; Classification; Early land plants (*Cooksonia* and *Rhynia*).

**Unit 5: Type Studies- Pteridophytes**

**(10 lectures)**

Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris* (Developmental details not to be included); Heterospory and seed habit; Telome theory; Stelar evolution.

**Unit 6: Gymnosperms**

**(14 lectures)**

General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum* (Developmental details not to be included).

### PRACTICAL

1. *Riccia*- Morphology of thallus.
2. *Marchantia*- Morphology of thallus; Whole mount of rhizoids and scales, vertical section of thallus through gemma cup, vertical section of antheridiophore, archegoniophore, longitudinal section of sporophyte (all temporary/permanent slides).
3. *Anthoceros*- Morphology of thallus; Section of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary/ permanent slide).
4. *Funaria*- Morphology; Whole mount of peristome, longitudinal section of capsule (all temporary/ permanent slides).
5. *Selaginella*- Morphology; Transverse section of stem, longitudinal section of strobilus (all temporary/ permanent slides).
6. *Equisetum*- Morphology; Transverse section of internode, longitudinal section of strobilus, transverse section of strobilus (all temporary/ permanent slides).
7. *Pteris*- Morphology; Transverse section of rachis, section of sporophyll, whole mount of sporangium (all temporary/ permanent slides).



8. *Cycas*- Morphology (coralloid roots, leaf), microsporophyll, megasporophyll; Section of leaflet, longitudinal section of ovule (all temporary/ permanent slides).

9. *Pinus*- Morphology (long and dwarf shoots, male and female cones); Transverse section of Needle, longitudinal section of male cone, whole mount of microsporophyll (all temporary/ permanent slides).

10. *Gnetum*- Morphology (male & female cones); Transverse section of stem, vertical section of ovule (all permanent slides)

### **Suggested Readings**

1. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
2. Bhatnagar, S.P., Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
3. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
5. Vanderpoorten, A., Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.

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## **Semester-IV**

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### **Core Course VIII: Molecular Biology[DSC Paper 8]**

**(Credits: Theory-4, Practical-2)**

#### **(DSC Paper 8) THEORY**

**Lectures: 45**

**Unit 1: Nucleic acids: Carriers of genetic information (2 lectures)**

DNA as the carrier of genetic information (Griffith's, Avery, McLeod & McCarty's, Hershey & Chase, experiment).

**Unit 2. The Structures of DNA and RNA / Genetic Material (7 lectures)**

DNA Structure, Types of DNA, denaturation and renaturation, cot curves; RNA structure; The Nucleosome Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

**Unit 2:The replication of DNA (8 lectures)**

General principles – bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle,  $\theta$  (theta) mode of replication, replication of linear ds-DNA, replication of the 5' end of linear chromosome; Enzymes involved in DNA replication.

**Unit 3: Central dogma and genetic code (2 lectures)**

Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features)

**Unit 4: Transcription**

**(15 lectures)**

Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Regulation of lactose metabolism in *E.coli*. Eukaryotic transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.

**Unit 5: Processing and modification of RNA**

**(6 lectures)**

Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I and group II intron splicing, mRNA processing (5' cap, 3' polyA tail); Ribozymes

**Unit 6: Translation**

**(5 lectures)**

Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis.

**(DSC Paper 8) Practical**

1. Preparation of LB medium and raising *E. coli*.
2. Isolation of genomic DNA from *E. coli*.
3. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
4. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
5. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
6. Photographs establishing nucleic acid as genetic material (Avery *et al*, Griffith's, Hershey & Chase's experiments)
7. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns;

**Core Course IX: Plant Ecology and Phytogeography[DSC Paper 9]**

**(Credits: Theory-4, Practical-2)**

**(DSC Paper 9) THEORY**

**Lecture: 45**

**Unit 1: Introduction (2 lectures)**

Basic concepts; Inter-relationships between the living world and the environment, homeostasis.

homeostasis.

**Unit 2: Soil (4 lectures)**

Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile.

**Unit 3: Water (3 lectures)**

Importance: States of water in the environment; Atmospheric moisture; Hydrological Cycle; Water in soil.

**Unit 4:Light, temperature, wind and fire(4 lectures)**

Variations; adaptations of plants to their variation.

**Unit 5:Biotic interactions(2 lectures)**

Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; biomass, standing crop.

**Unit 6:Population ecology(4 lectures)**

Characteristics and Dynamics. Ecological Speciation

**Unit 7:Plant communities(6 lectures)**

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

**Unit 8:Ecosystem and its Functional aspects(12 lectures)**

Ecosystem structure and processes; Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon and Nitrogen.

**Unit 9:Phytogeography (8 lectures)**

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

**(DSC Paper 9) Practical**

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter (Through photograph).
2. Comparison of pH among different types of soil and water samples. (pH meter, universal indicator/Lovibond comparator and pH paper)
3. Analysis for carbonates, chlorides, nitrates from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.
5. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
7. (a). Study of morphological adaptations of  
Hydrophytes and Xerophytes (four each).
- (b). Study of biotic interactions of the following:  
Stem parasite (*Cuscuta*)  
Root parasite (*Orobanche*)

Epiphytes

Predation (Insectivorous plants).

8. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).

**Suggested Readings:**

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5<sup>th</sup> 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. 8<sup>th</sup> edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4<sup>th</sup> edition.

**Core Course X: Plant Systematics [DSC Paper 10]**

**(Credits: Theory-4, Practical-2)**

**(DSC Paper 10) THEORY**

**Lectures: 45**

**Unit 1: Significance of Plant systematic**

**(8 lectures )**

Introduction to systematics; Plant identification, Evidences from palynology, phytochemistry and molecular data. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Keys: Single access and Multi-access.

**Unit 2: Taxonomic hierarchy**

**(4 lectures)**

Concept of taxa (genus, species); taxonomic hierarchy; Species concept (taxonomic, biological).

**Unit 3: Botanical nomenclature**

**(8 lectures)**

Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, principle of priority and its limitations;

**Unit 4: Systems of classification**

**(8 lectures)**

*Major* contributions of Theophrastus, Bauhin, Linnaeus, Bessey, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) Brief reference of Angiosperm Phylogeny Group (APG III) classification.

**Unit 5: Diagnostic features of Families:** Ranunculaceae, Brassicaceae, Apiaceae, Solanaceae, Lamiaceae, Euphorbiaceae, Asteraceae, Commelinaceae and Poaceae. **( 9 lectures)**

**Unit 6: Phylogeny of Angiosperms** **( 8 lectures)**

Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Methods of illustrating evolutionary relationship (phylogenetic tree).

**(DSC Paper 10) Practical**

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):

Ranunculaceae	<i>Ranunculus, Delphinium</i>
Brassicaceae	<i>Brassica, Alyssum / Iberis</i>
Apiaceae	<i>Coriandrum /Anethum / Foeniculum</i>
Asteraceae	<i>Sonchus/ Launaea, Vernonia/ Ageratum, Eclipta/ Tridax</i>
Solanaceae	<i>Solanum /Physalis</i>
Lamiaceae	<i>Salvia/Ocimum/ Leucas</i>
Euphorbiaceae	<i>Jatropha / Croton / Acalypha</i>
Commelinaceae	<i>Commelina / Murdania / Cyanotis</i>
Poaceae	<i>Triticum/Hordeum/Avena</i>

2) Field visit (local) – Enlistment of plants observed in the field and submission of field note book with 10-25 photographs.

3) Mounting of one properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

**Suggested Readings**

1. Singh, (2012). *Plant Systematics: Theory and Practice* Oxford & IBH Pvt. Ltd., New Delhi. 3<sup>rd</sup>edition.
2. Jeffrey, C. (1982). *An Introduction to Plant Taxonomy*. Cambridge University Press, Cambridge.

3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). *Plant Systematics-A Phylogenetic Approach*. Sinauer Associates Inc., U.S.A. 2<sup>nd</sup> edition.
4. Maheshwari, J.K. (1963). *Flora of Delhi*. CSIR, New Delhi.
5. Radford, A.E. (1986). *Fundamentals of Plant Systematics*. Harper and Row, New York.

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**Semester-VI**

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**Core Course XIII: Plant Metabolism [DSC Paper 13]**

**(Credits: Theory-4, Practical-2)**

**(DSC Paper 13)THEORY**

**Lectures: 45**

**Unit 1: Concept of metabolism**

**(5 lectures)**

Introduction, anabolic and catabolic pathways, role of regulatory enzymes (allosteric ,covalent modulation and Isozymes).

**Unit 2: Carbon assimilation**

**(13 lectures)**

Photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions.

photosynthetic electron transport, PSI, PSII, Q cycle, CO<sub>2</sub> reduction, photorespiration, C<sub>4</sub>pathways; Crassulacean acid metabolism.

**Unit 3: Carbon Oxidation**

**(07 lectures)**

Glycolysis, fate of pyruvate, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate,; TCA cycle,amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.

**Unit 4: ATP-Synthesis**

**(5 lectures)**

Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase ; role of uncouplers.

**Unit 5: Lipid metabolism**

**(5 lectures)**

Synthesis and breakdown of triglycerides,  $\beta$ -oxidation, gluconeogenesis.

**Unit 6: Nitrogen metabolism****(6 lectures)**

Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation;

**Unit 7: Mechanisms of signal transduction****(4 lectures)**

Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.

**(DSC Paper 13) Practical**

1. Chemical separation of photosynthetic pigments.
2. Experimental demonstration of Hill's reaction.
3. To study the effect of light intensity on the rate of photosynthesis.
4. Effect of carbon dioxide on the rate of photosynthesis.
5. To compare the rate of respiration in different parts of a plant.
6. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination.
7. Demonstration of fluorescence by isolated chlorophyll pigments.

**Suggested Readings**

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4<sup>th</sup> edition.
2. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6<sup>th</sup> edition.
3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

**Core Course XIV: Plant Biotechnology [DSC Paper 14]****(Credits: Theory-4, Practical-2)****(DSC Paper 14) THEORY****Lectures: 45**

All units Carry 15 marks and 9 lectures

**Unit 1: Plant Tissue Culture****(9 lectures)**

Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast culture Tissue culture applications (micropropagation, androgenesis, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

**Unit 2: Recombinant DNA technology****(9 lectures)**

Restriction Endonucleases (Types I-IV, biological role and application); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).

**Unit 3:Gene Cloning****(9 lectures)**

Recombinant DNA, PCR- mediated gene cloning; construction of genomic and cDNA libraries, complementation, colony hybridization; PCR

**Unit 4: Methods of gene transfer****(9 lectures)**

*Agrobacterium*-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase,).

**Unit 5: Applications of Biotechnology****(9 lectures)**

Pest resistant (Bt-cotton); Transgenic crops with improved quality traits (Golden rice); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase,); Genetically Engineered Products– Human Growth Hormone; Humulin; Biosafety concerns.

**(DSC Paper 14) Practical**

1. Preparation of MS medium.
- (b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, *Brassica* etc.
2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
3. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
4. Study of steps of genetic engineering for production of Bt cotton, Golden rice through photographs.
5. Isolation of plasmid DNA.
6. Restriction digestion and gel electrophoresis of plasmid DNA.

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**Discipline Specific Elective Courses (DSE)**

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**Discipline specific elective course (DSE) (Botany)  
Analytical Techniques in Plant Sciences  
(Credits: Theory-4, Practical-2)****THEORY****Lectures: 45****Unit 1: Imaging and related techniques****(8 lectures)**

Principles of microscopy; Light microscopy; Fluorescence microscopy; (b) Applications of fluorescence microscopy: Chromosome banding, Transmission and Scanning electron microscopy.

**Unit 3: Radioisotopes****(5 lectures)**

Use in biological research, auto-radiography, pulse chase experiment.

**Unit 4: Spectrophotometry****(2 lectures)**

Principle and its application in biological research.

**Unit 5: Chromatography****(5 lectures)**

Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

**Unit 6: Characterization of proteins and nucleic acids****(10 lectures)**

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. To separate sugars by thin layer chromatography.
3. To separate chloroplast pigments by column chromatography.
4. To estimate protein concentration through Lowry's methods.
5. To separate proteins using PAGE.
6. 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. 3<sup>rd</sup> edition.
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. 3<sup>rd</sup> edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4<sup>th</sup> edition.

**Discipline Specific Elective**  
**DSE: Bioinformatics**  
**(Credits: Theory-4, Practical-2)**

### **DSE: Bioinformatics (THEORY)**

**Lectures: 45**

**Unit 1. Introduction to Bioinformatics (3 Lectures)**

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

**Unit 2. Databases in Bioinformatics (4 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. Sequence Alignments (7 Lectures)**

Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, and Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

**Unit 5. Molecular Phylogeny (6 Lectures)**

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

**Unit 6. Applications of Bioinformatics (5 Lectures)**

Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement

### **DSE: Bioinformatics (Practical)**

1. Nucleic acid and protein databases: NCBI (**1**), SwissProt(**2**), PDB(**3**).
2. Sequence retrieval from databases: NCBI GenBank (**4**), SwissProt(**5**), and MiRBase(**6**).
3. Sequence alignment: Clustal Omega (MSA) (**7**), PIR (PWA) (**8**).
4. Sequence homology: BLAST (**9**).
5. Construction of phylogenetic tree: Clustal Omega / Simple Phylogeny (**10**).

**(The numbers in the bold in parentheses are the number of experiments to be performed by each students, i.e. 10 in total)**

### **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.

### **Discipline Specific Elective Stress Biology Credits: Theory 4, Practical 2**

### **DSE: Stress Biology (Theory)**

**Lectures: 45**

**Unit 1: Defining plant stress** (2 lectures)

Acclimation and adaptation.

**Unit 2: Environmental factors** (16 lectures)

Water stress; Salinity stress; Temperature stress; Hypersensitive reaction; Pathogenesis Related (PR) proteins; Systemic acquired resistance.

**Unit 3: Stress sensing mechanism in plants** (12 lectures)

Calcium modulation; Phospholipid signalling (Emphasizing the signalling pathway)

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

Adaptation in plants; Changes in root:shoot ratio; Compatible solutes.

**Unit 5: Reactive oxygen species** (3 lectures)

Production and scavenging mechanisms (Brief account).

### **DSE: Stress Biology (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 (from zymogram photographs/ demonstration)

4. Zymographic analysis of superoxide dismutase activity (from zymogram photographs/demostration)

### **Suggested Readings**

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

## **Discipline Specific Elective Plant Breeding (Credits: Theory-4, Practical-2)**

### **DSE: Plant Breeding (Theory)**

**Lectures: 45**

#### **Unit 1: Plant Breeding**

**(5 lectures)**

Introduction and objectives. Breeding systems: modes of reproduction in crop plants.

#### **Unit 2: Methods of crop improvement**

**(16 lectures)**

Introduction: Centers of Origin and domestication of plant crops; plant genetic resources; Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.

#### **Unit 3: Quantitative inheritance**

**(8 lectures)**

Concept, mechanism, examples of inheritance of Kernel colour in wheat, Monogenic vs polygenic Inheritance.

#### **Unit 4: Inbreeding depression and heterosis**

**(6 lectures)**

Genetic basis of inbreeding depression and heterosis; Applications.

#### **Unit 5 : Crop improvement and breeding**

**(10 lectures)**

Role of mutations; Polyploidy; Role of biotechnology

### **DSE: Plant Breeding (Practical)**

2. Study of floral structure of self-pollinated and cross pollinated crops.
3. Emasculation and hybridization techniques in self and cross pollinated crops.
4. Artificial pollination in self-pollinated crop (any one crop).
5. Experiments on epistasis and data analysis
6. Study on probability and Chi- square test

### **Suggested Readings**

1. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7<sup>th</sup> edition.
2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2<sup>nd</sup> edition.
3. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

**Discipline Specific Elective  
Natural Resource Management  
(Credits: Theory-4, Practical-2)**

**DSE: Natural Resource Management (Theory)**

**Lectures: 45**

**Unit 1: Natural resources** (2 lectures)

Definition and types.

**Unit 2: Sustainable utilization** (5 lectures)

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

**Unit 3 : Land** (6 lectures)

Utilization (general); Soil degradation and management

**Unit 4 : Water** (3 lectures)

Threats and management strategies

**Unit 5: Biological Resources** (9 lectures)

Biodiversity – definition, significance, management strategies; IPR; CBD

**Unit 6 : Forests** (7 lectures)

Forest cover and its significance (with reference to India); Depletion and management

**Unit 7: Energy** (6 lectures)

Renewable and non-renewable sources of energy

**Unit 8: Contemporary practices in resource management** (7 lectures)

EIA, GIS, Ecological Footprint with emphasis on carbon footprint, Waste management.

**DSE: Natural Resource Management (Practical)**

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.
2. Measurement of dominance of woody species by DBH (diameter at breast height) method.
3. Calculation and analysis of ecological footprint
3. Ecological modeling.

**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.

**Discipline Specific Elective**

## **Horticultural Practices and Post-Harvest Technology**

**(Credits: Theory-4, Practical-2)**

### **DSE: Horticultural Practices and Post-Harvest Technology (Theory)**

**Lectures: 45**

#### **Unit 1: Introduction (3 lectures)**

Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Urban horticulture and ecotourism.

#### **Unit 2: Ornamental plants (5 lectures)**

Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, orchids, poppies, tuberose. Ornamental flowering trees (Indian laburnum, gulmohar, Jacaranda, Lagerstroemia, fishtail and areca palms,).

#### **Unit 3: Fruit and vegetable crops (3 lectures)**

Identification of some fruits and vegetable varieties (citrus, banana, mango, chillies and cucurbits).

#### **Unit 4: Horticultural techniques (8 lectures)**

Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations.

#### **Unit 5 : Landscaping and garden design (5 lectures)**

Gardening traditions – ancient Indian, European, Mughal and Japanese Gardens; Urban forestry : policies and practices

#### **Unit 6: Floriculture (5 lectures)**

Cut flowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions.

#### **Unit 7: Post-harvest technology (6 lectures)**

Importance of post harvest technology in horticultural crops; Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cut flowers; Principles, methods of preservation and processing; food safety.

#### **Unit 8: Disease control and management (6 lectures)**

Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices; Crop sanitation; IPM strategies (genetic, biological and chemical methods for pest control); Quarantine practices.

#### **Unit 9: Horticultural crops - conservation and management (4 lectures)**

Documentation and conservation of germplasm; Role of micropropagation and tissue culture techniques; Varieties and cultivars of various horticultural crops.

### **DSE: Horticultural Practices and Post-Harvest Technology (Practical)**

1. Importance of light and chlorophyll in photosynthesis, pigment identification in horticultural crops , root initiation in cuttings. Grafting and layering.

2. Practical Analysis of soil for organic matter, available N, P, K and Micronutrients.
3. Practical Study of symptoms of damage, collection, identification, preservation, assessment of damage and population of important insect – pests affecting fruits, plantation, medicinal and aromatic crops in field and storage.
4. Practical Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory.
5. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for herbarium. Mango: bacterial blight / powdery mildew; Citrus: canker / citrus decline; Jackfruit: Rhizopus rot; Pineapple: Head rot, Betel vine: leaf spots/ foot rot; Cucurbits: damping off /downy mildew/ powdery mildew/ wilt; Chilli: anthracnose/ fruit rot /leaf spot/ wilt/ leaf curl; Turmeric: leaf spot; Coriander: stem gall; Marigold: Botrytis blight; Rose: dieback/ powdery mildew/ black leaf spot.

### **Suggested Readings**

1. Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
4. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.
5. Capon, B. (2010). Botany for Gardeners. 3<sup>rd</sup> Edition. Timber Press, Portland, Oregon.

### **Discipline Specific Elective Research Methodology Credit: Theory 4; Practical 2**

#### **DSE: Research Methodology (Theory)**

**Lectures: 45**

#### **Unit 1: Basic concepts of research (5 lectures)**

Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Literature-review and its consolidation.

#### **Unit 2: General laboratory practices (7 lectures)**

Common calculations in botany laboratories. Preparation of solutions. Dilutions. Percentage solutions. Molar, molal and normal solutions. Knowledge about common toxic chemicals and safety measures in their handling.

#### **Unit 3: Data collection and documentation of observations (5 lectures)**

Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars.

#### **Unit 4: Overview of Biological Problems (4 lectures)**

Model organisms in biology (A Brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics-Transcriptional regulatory network.

**Unit 5: Methods to study plant cell/tissue structure (7 lectures)**

Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections.

**Unit 6: Plant microtechniques (10 lectures)**

Staining procedures, classification and chemistry of stains. Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags).

**Unit 7: The art of scientific writing and its presentation (7 lectures)**

Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

**DSE: Research Methodology (Practical)**

1. Experiments based on chemical calculations
2. Plant microtechnique experiments.
3. The art of imaging of samples through microphotography and field photography.
4. Technical writing on topics assigned.

**Discipline Specific Elective  
Industrial and Environmental Microbiology  
(Credits: Theory-4, Practical-2)**

**DSE: Industrial and Environmental Microbiology (THEORY)**

**Lectures: 45**

**Unit 1: Bioreactors/Fermenters and fermentation processes (9 lectures)**

Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor

**Unit 2: Microbial production of industrial products (9 lectures)**

Microorganisms involved, media, fermentation conditions, downstream processing and uses.

**Unit 3: Microbes and quality of environment (7 lectures)**

Distribution of microbes in air; Isolation of microorganisms from soil, air and water.

**Unit 4: Microbial flora of water. (11 lectures)**

Water pollution, role of microbes in sewage and domestic waste water treatment systems. Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples.

**Unit 5: Microbes in agriculture and remediation of contaminated soils. (9 lectures)**

Biological fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.

### **DSE: Industrial and Environmental Microbiology (Practical)**

- 1.Principles and functioning of instruments in microbiology laboratory
- 2.Hands on sterilization techniques and preparation of culture media.

#### **Suggested Readings**

1. Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.

### **Discipline Specific Elective Biostatistics (Credits: Theory-3, Practical-2)**

#### **DSE: Biostatistics (THEORY)**

**Lectures: 45**

##### **Unit 1: Biostatistics (8 lectures)**

Definition - statistical methods - basic principles. limitations and uses of statistics.

##### **Unit 2:Collection of data primary and secondary (12 lectures)**

Types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data - sampling methods.

##### **Unit 3:Measures of central tendency (10 lectures)**

Mean, median, mode, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation, mean deviation.

##### **Unit 4:Correlation (10 lectures)**

Types and methods of correlation, regression, simple regression equation, similarities and dissimilarities of correlation and regression.

##### **Unit 5: Statistical inference (5 lectures)**

Hypothesis -student't' test.

#### **DSE: Biostatistics (Practical)**

- 1) Calculation of mean, standard deviation and standard error.
- 2) Calculation of correlation coefficient values and significance Test of Correlation Coefficient.

#### **Suggested Readings**

- 1.Fundamentals of Biostatistics,Irfan A. Khan & Atiya Khanum, Ukaaz Publications
- 2.Biostatistic, Danniel, W.W., 1987.New York, John Wiley Sons.
3. An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S and Richards, J. Christian Medical College, Vellore
4. Statistical Analysis of epidemiological data, Selvin, S., 1991. New York University Press.
- 5.Statistics for Biology, Boston, Bishop, O.N. Houghton, Mifflin.
6. The Principles of scientific research, Freedman, P. New York, Pergamon Press



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## Generic Elective Courses (GE)

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### Generic Elective Biodiversity (Microbes, Algae, Fungi and Archegoniate) (Credits: Theory-4, Practical-2)

#### GE: Biodiversity (Microbes, Algae, Fungi and Archegoniate) (THEORY)

**Lectures: 45**

**Unit 1: Microbes**

**(10 lectures)**

Viruses – Discovery, general structure, replication (general account), Lytic and lysogenic cycle, Economic importance; Bacteria – General characteristics and cell structure; Reproduction –recombination (conjugation, transformation and transduction); Economic importance.

**Unit 2: Algae**

**(8 lectures)**

General characteristics; Ecology and distribution; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Oedogonium*, *Polysiphonia*. Economic importance of algae.

**Unit 3: Fungi**

**(10 lectures)**

Introduction- General characteristics, ecology and significance, reproduction and classification; True Fungi- General characteristics, life cycle of *Rhizopus* (Zygomycota) *Penicillium*, (Ascomycota), *Agaricus*, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

**Unit 4: Introduction to Archegoniate**

**(2 lectures)**

Unifying features of archegoniate, Transition to land habit, Alternation of generations.

**Unit 5: Bryophytes**

**(5 lectures)**

General characteristics, Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included).

**Unit 6: Pteridophytes**

**(5 lectures)**

General characteristics, Classification (up to family), morphology, anatomy and reproduction of *Equisetum* and *Pteris* (Developmental details not to be included); Stellar evolution. Ecological and economical importance of Pteridophytes.

**Unit 7: Gymnosperms**

**(5 lectures)**

General characteristics; morphology, anatomy and reproduction of *Cycas* and *Pinus* (Developmental details not to be included); Economic importance.

#### Practical

1. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
2. Gram staining
3. Study of vegetative and reproductive structures of *Nostoc*, *Oedogonium* and *Polysiphonia* through temporary preparations and permanent slides.
4. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
5. *Puccinia*: Herbarium specimens of Black Stem Rust of wheat
6. *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, l.s. sporophyte (all permanent slides).
7. *Equisetum*- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry)(temporary slides); t.s. rhizome (permanent slide).
8. *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).

9. *Cycas*- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaf let, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).
10. *Pinus*- ts. needle, t.s. stem, l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

#### **Suggested Readings**

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2<sup>nd</sup> edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10<sup>th</sup> 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. 4<sup>th</sup> 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.

### **Generic Elective Plant Ecology and Taxonomy (Credits: Theory-4, Practical-2)**

#### **GE: Plant Ecology and Taxonomy (THEORY)**

##### **Lectures: 45**

##### **Unit 1: Introduction and Ecological factors (10 lectures)**

Inter-relationships between the living world and the environment, Soil: Origin, composition, soil profile. Water: precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes

##### **Unit 2: Plant communities (4 lectures)**

Ecotone and edge effect; Succession; Processes and types

##### **Unit 3: Ecosystem (6 lectures)**

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

##### **Unit 4: Phytogeography (4 lectures)**

Principle biogeographical zones; Endemism

##### **Unit 5: Introduction to plant taxonomy (1 lectures)**

##### **Unit 6: Identification (4 lectures)**

Identification, Classification, Nomenclature. Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora,

##### **Unit 7: Taxonomic evidences from palynology, cytological data. (2lectures)**

##### **Unit 8: Botanical nomenclature (5 lectures)**

Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, principle of priority and its limitations.

##### **Unit 9: Classification (5 lectures)**

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series).

**Unit 10: Study of Diagnostic features of the families:(4 lectures)**

Lamiaceae, solanaceae, Asteraceae,Commelinaceae

**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 by rapid field test.
3. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
4. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each). (b) Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobancha*), Epiphytes, Predation (Insectivorous plants)
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
7. Study of vegetative and floral characters of the following families (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 -*Sonchus/Launaea*, *Vernonia/Ageratum*, *Eclipta/Tridax*; Solanaceae -*Solanum Sp./Physalis*, Lamiaceae -*Salvia, Ocimum/Leucus* Commelinaceae – *Commelina /Murdania /Cyanotis*
8. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

**Suggested Readings**

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4<sup>th</sup> edition.
2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8<sup>th</sup> edition.
3. Simpson, M.G. (2006). *Plant Systematics*. Elsevier Academic Press, San Diego, CA, U.S.A.
4. Singh, G. (2012). *Plant Systematics: Theory and Practice*. Oxford & IBH Pvt. Ltd., New Delhi. 3<sup>rd</sup> e

**Generic Elective**  
**Plant Anatomy and Embryology**  
**(Credits: Theory-4, Practical-2)**

**GE: Plant Anatomy and Embryology (THEORY)**

**Lectures: 45**

**Unit 1: Meristematic and permanent tissues** (5 lectures)

Root and shoot apical meristems; Simple and complex tissues

**Unit 2: Organs** (5 lectures)

Structure of dicot and monocot root stem and leaf.

**Unit 3: Secondary Growth** (5 lectures)

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

**Unit 4: Adaptive and protective systems** (8 lectures)

Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

**Unit 5: Structural organization of flower** (5 lectures)

Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs

**Unit 6: Pollination and fertilization** (5 lectures)

Pollination mechanisms and adaptations; Double fertilization;

**Unit 7: Embryo and endosperm** (6 lectures)

Endosperm types, structure and functions; Dicot and monocot embryo;

**Unit 8: Apomixis and polyembryony** (6 lectures)

Definition, types and Practical applications

**GE: Plant Anatomy and Embryology(Practical)**

1. Study of meristems through permanent slides and photographs.

2. Tissues (parenchyma, collenchyma and sclerenchyma); Phloem (Permanent slides, photographs)
3. Stem: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*;
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
7. Structure of anther (young and mature), (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.
9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanism (Photographs and specimens).

### **Suggested Readings**

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5<sup>th</sup> edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

## **Generic Elective Plant Physiology and Metabolism (Credits: Theory-4, Practical-2)**

### **GE:Plant Physiology and Metabolism (THEORY)**

#### **Lectures: 45**

<b>Unit 1: Plant-water relations</b>	<b>(6 lectures)</b>
Water potential and its components; Transpiration and its significance.	
<b>Unit 2: Mineral nutrition</b>	<b>(6 lectures)</b>
Essential elements, macro and micronutrients; Role of essential elements; Transport of ions across cell membrane, active and passive transport,	
<b>Unit 3: Translocation in phloem.</b>	<b>(3 lectures)</b>
Composition of phloem sap, Pressure flow model;	
<b>Unit 4: Photosynthesis</b>	<b>(6 lectures)</b>
Photosystem I and II, Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation;	
<b>Unit 5: Respiration</b>	<b>(6 lectures)</b>
Glycolysis, TCA cycle; Oxidative phosphorylation,	
<b>Unit 6: Enzymes</b>	<b>(6 lectures)</b>
Structure and properties; Mechanism of enzyme catalysis	
<b>Unit 7: Nitrogen metabolism</b>	<b>(5 lectures)</b>
Biological nitrogen fixation;	
<b>Unit 8: Plant growth regulators</b>	<b>(3 lectures)</b>
Discovery and physiological roles of auxins, gibberellins, cytokinins,	
<b>Unit 9: Plant response to light and temperature</b>	<b>(4 lectures)</b>
Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis;	

### **Practical**

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
3. To study the effect of light intensity and bicarbonate concentration on O<sub>2</sub> evolution in photosynthesis.
4. Comparison of the rate of respiration in any two parts of a plant.

### **Demonstration experiments**

1. Effect of auxins on rooting.
2. R.Q.

3. Respiration in roots.

### **Suggested Readings**

1. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6<sup>th</sup> edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4<sup>th</sup> Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

**Generic Elective**  
**Economic Botany and Plant Biotechnology**  
**(Credits: Theory-4, Practical-2)**

### **GE: Economic Botany and Plant Biotechnology (THEORY)**

**Lectures: 45**

**Unit 1: Origin of Cultivated Plants** (3 lectures)

Concept of centres of origin, their importance with reference to Vavilov's work.

**Unit 2: Cereals** (3 lectures)

Wheat –Origin, morphology, uses

**Unit 3: Legumes** (4 lectures)

Gram and Soybean (Botanical name, family and uses)

**Unit 4: Spices** (4 lectures)

Clove and black pepper (Botanical name, family, morphology, part used and uses)

**Unit 5: Beverages** (3 lectures)

Tea (morphology, processing, uses)

**Unit 6: Oils and Fats** (2 lectures)

Groundnut (extraction method and uses)

**Unit 7: Fibre Yielding Plants** (3 lectures)

Cotton (Botanical name, family, parts used, morphology and uses)

**Unit 8: Introduction to biotechnology** (1 lecture)

**Unit 9: Plant tissue culture** (5 lectures)

Micropropagation ; haploid production through androgenesis and gynogenesis; brief account of embryo and endosperm culture with their applications.

**Unit 10: Recombinant DNA Techniques** (17 lectures)

Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Molecular diagnosis of human disease, Human gene Therapy.

**GE: Economic Botany and Plant Biotechnology (Practical)**

1. Study of economically important plants: Wheat, Gram, Clove, Tea, Cotton through specimens, sections from permanent slides and photographs.
2. Familiarization with basic equipments in tissue culture.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
4. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.

**Suggested Readings**

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4<sup>th</sup> edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

**Generic Elective  
Environmental Biotechnology  
(Credits: Theory-4, Practical-2)**

**GE: Environmental Biotechnology (THEORY)**

**Lectures: 45**

**Unit 1: Environment**

**(3 lectures)**

Global environmental problems - ozone depletion, UV-B, greenhouse effect and acid rain due to anthropogenic activities

**Unit 2: Environmental problems**

**(4 lectures)**

Environmental pollution - types of pollution, sources of pollution, Bioconcentration, bio/geomagnification.

**Unit 3: Microbiology of waste water treatment**

**(5 lectures)**

Aerobic process - activated sludge and oxidation ponds. Anaerobic process - anaerobic digestion and anaerobic filters. Treatment schemes for waste waters of dairy and antibiotic industries.

**Unit 4: Xenobiotic compounds**

**(7 lectures)**

Organic (polyaromatic hydrocarbons, pesticides and surfactants) and inorganic (metals and radionuclides). Bioremediation of xenobiotics in environment - ecological consideration, decay behaviour and degradative plasmids

**Unit 5: Role of immobilized cells/enzymes in treatment of toxic compounds**

**(5 lectures)**

Biopesticides, bioreactors, biosensors, biotechniques for air pollution abatement and odour control.

**Unit 6: Sustainable Development (7 lectures)**

Economics and Environment: Economics of Pollution control, Environmental awareness and Education; Environmental Ethics.

**Unit 7: International Legislations, Policies for Environmental Protection (5 lectures)**

Stockholm Conference (1972) and its declaration, Rio Earth Summit-UNCED (1992) and its declaration, Montreal Protocol -1987; Kyoto Protocol- 1997; Ramsar Convention-1971

**Unit 8: National Legislations, Policies for Pollution Management (4 lectures)**

Salient features of Wild life protection act 1972, Water Pollution (Prevention and Control) Act-1974, Forest conservation act 1980, National Environmental Policy -2006

**Unit 9: Public Participation for Environmental Protection (5 lectures)**

Environmental movement and people's participation with special references to Narmada Bachao Andolan, Chipko and Silent valley Movement; Role of NGOs

**GE: Environmental Biotechnology (Practical)**

1. Water/Soil analysis - DO, salinity, pH, chloride, alkalinity, acidity
2. Microbial assessment of air (open plate and air sample) and water
3. Estimation of total dissolved solids in effluent.

**Suggested Readings**

1. Waste water engineering - treatment, disposal and reuse, Metcalf and Eddy Inc., Tata McGraw Hill, New Delhi.
2. Environmental Chemistry, AK. De, Wiley Eastern Ltd, New Delhi.
3. Introduction to Biodeterioration, D.Allsopp and K.J. Seal, ELBS / Edward Arnold.
4. Bioremediation, Baaker, KH and Herson D.S., 1994. Mc.GrawHill Inc, NewYork.
5. Industrial and Environmental Biotechnology - Nuzhat Ahmed, Fouad M. Qureshi and Obaid Y. Khan, 2006. Horizon Press.
6. Environmental Molecular Biology, Paul. A, Rochelle, 2001.Horizon Press.
7. Environmental Protection and Laws by Jadhav and Bhosale, V.M.Himalaya publ. House 13. Biodiversity Assessment and Conservation by PC Trivedi, Agrobios publ

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**Skill Enhancement Courses (SEC)**

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**Skill Enhancement Course  
Biofertilizers  
(Credits 2)**

**SEC:Biofertilizers**

**Lectures: 20**

**Unit 1:** General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication. **(3 lectures)**

**Unit 2:** Azospirillum: isolation and mass multiplication, carrier based inoculant associative effect of different microorganisms. Azotobacter: classification, maintenance and mass multiplication. **(4 lectures)**

**Unit 3:** Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, blue green algae and Azolla in rice cultivation.

**(3 lectures)**

**Unit 4:** Mycorrhizal association, types of mycorrhizal association, occurrence and distribution phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants. **(5 lectures)**

**Unit 5:** Organic farming – Green manuring and organic fertilizers, Recycling of bio-degradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application. **(5 lectures)**

**Suggested Readings**

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas, S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming Akta Prakashan, Nadiad

**Skill Enhancement Course  
Herbal Technology  
(Credits 2)**

**SEC:Herbal Technology****Lectures: 20**

**Unit 1:** Herbal medicines: history and scope-definition of medical terms; cultivation - harvesting - processing - storage -marketing and utilization of medicinal plants. **(3 Lectures)**

**Unit 2:** Pharmacognosy - systematic position and medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek and Ashoka. **(3 Lectures)**

**Unit 3:** Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on nervous system) *Centella asiatica* (memory booster). **(5 Lectures)**

**Unit 4:** Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation; Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, phenolic compounds) **(6 Lectures)**



**Unit 5:** Medicinal plant banks, micropropagation of *Withania somnifera* and neem; Herbal foods-future of pharmacognosy. **(3 Lectures)**

**Suggested Readings**

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.
3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
4. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.
5. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
6. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
7. Pharmacognosy, Dr.C.K.Kokate et al. 1999. Nirali Prakashan.

**Skill Enhancement Course  
Nursery and Gardening  
(Credits 2)**

**SEC: Nursery and Gardening**

**Lectures: 20**

**Unit 1:**Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants. **(2 Lectures)**

**Unit 2:** Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability; Seed production technology **(4 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 – green house - shade house . **(5 Lectures)**

**Unit 4:**Gardening: definition, objectives and scope - different types of gardening - computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting. **(5 Lectures)**

**Unit 5:**Sowing/raising of seeds and seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, tomatoes. **(4 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.

**Skill Enhancement Course  
Floriculture  
(Credits 2)**

**SEC: Floriculture**

**Lectures: 20**

**Unit 1:** Importance and scope of floriculture and landscape gardening. **(1 lectures)**

**Unit 2:** Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Planting and transplanting; Shading; Mulching; Topiary; Role of plant growth Regulators  
(4 lectures)

**Unit 3:** Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and Cycads; Cultivation of plants in pots; Indoor gardening; Bonsai.  
(4 lectures)

**Unit 4 :** Principles of Garden Design: English, Italian, Mughal and Japanese Garden (3 Lectures)

**Unit 5 :** Landscaping highways and educational Institutions (2 Lectures)

**Unit 6:** Commercial Floriculture: Factors affecting production; Production and packaging of cut flowers; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Marigold, Rose, Orchids).  
(4 lectures)

**Unit 7:** Diseases and Pests of Ornamental Plants. (2 lectures)

#### **Suggested Readings**

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

### **Skill Enhancement Course Medicinal Botany (Credits 2)**

#### **SEC: Medicinal Botany**

##### **Lectures: 20**

**Unit 1:** Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, polyherbal formulations. ( 7 Lectures)

**Unit 2:** Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, In situ conservation: Biosphere reserves, National Parks; Ex situ conservation: Botanic 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. 7 Lectures)

**Unit 3:** Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, diabetics, Blood pressure and skin diseases.  
( 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, 2<sup>nd</sup> edn. Agrobios, India.

### **Skill Enhancement Course Plant Diversity and Human Welfare (Credits 2)**

#### **SEC: Plant Diversity and Human Welfare**

**Lectures: 20**

**Unit 1:** Plant diversity and its scope-Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Values and uses of Biodiversity; Agrobiodiversity and cultivated plant taxa, wild taxa. Uses of plants and microbes.

**(5 lectures)**

**Unit 2: Loss of Biodiversity:** Loss of genetic, species and agrobiodiversity diversity.

**Management of Plant Biodiversity:** Organizations associated with biodiversity management-Methodology for execution-IUCN, WWF, NBPGR; Biodiversity legislation, biodiversity information management and communication.

**(5 lectures)**

**Unit 3: Conservation of Biodiversity:** Conservation of genetic, species and ecosystem diversity, *In situ* and *ex situ* conservation, Biodiversity awareness programmes, Sustainable development.

**(5 lectures)**

**Unit 4: Role of plants in relation to Human Welfare;**

- a) Importance of forestry their utilization and commercial aspects
- b) Ornamental plants of India
- c) Alcoholic beverages through ages.

Fruits and nuts: Important fruit crops their commercial importance. Wood and its uses

**(5**

**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

**Skill Enhancement Course**

**Ethnobotany**

**(Credits 2)**

**SEC: Ethnobotany**

**Lectures: 20**

**Unit 1: Ethnobotany**

**(3 Lectures)**

Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. Major and minor ethnic groups or Tribals of India, Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.

**Unit 2: Methodology of Ethnobotanical studies**

**( 4 lectures)**

a) Field work c) Ancient Literature d) Archaeological findings e) sacred places.

**Unit 3: Role of ethnobotany in modern Medicine**

**( 7 lectures)**

Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superba* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*.

Role of ethnobotany in modern medicine with special example *Rauwolfia sepentina*, *Artemisia*, *Withania*.

Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

**Unit 4: Ethnobotany and legal aspects**

**(6 lectures)**

Ethnobotany as a tool to protect interests of ethnic groups. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

### **Suggested Readings**

1. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
2. S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981
3. Lone et al., Palaeoethnobotany
4. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
5. S.K. Jain, 1990. Contributions of Indian ethnobotny. Scientific publishers, Jodhpur.
6. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
7. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
8. Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah. 8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA – SHREE Publishers, Jaipur-1996 9) Faulks, P.J. 1958. An introduction to Ethnobotany, Moredale pub. Ltd.

### **Skill Enhancement Course Mushroom Culture Technology (Credits 2)**

#### **SEC: Mushroom Culture Technology**

#### **Lectures: 20**

**Unit 1:** Introduction, History, Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*.

**(4 Lectures)**

**Unit 2:** Cultivation Technology: Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house), water sprayer, tray, small polythene bag; Pure culture: Medium, sterilization preparation of spawn. Mushroom bed preparation - paddy straw; factors affecting the mushroom bed preparation. Composting technology in mushroom production.

**(10 Lectures)**

**Unit 3:** Storage and nutrition: Short-term storage (Refrigeration – up to 24 hours), Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Pure culture: Medium, sterilization

**(4 Lectures)**

**Unit 4:** Food Preparation: Types of foods prepared from mushroom. Research Centres: National level and Regional level. Export Value.

**(2 Lectures)**

#### **Suggested Readings**

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

### **Skill Enhancement Course Intellectual Property Rights (Credits 2)**

#### **SEC: Intellectual Property Rights**

#### **Lectures: 20**

**Unit 1: Introduction to intellectual property right (IPR)**

**(2 lectures)**

Concept and kinds. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).

**Unit 2: Patents (2 Lectures)**

Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, working of patents. Infringement.

**Unit 3: Copyrights (2 Lectures)**

Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement.

**Unit 4: Trademarks (2 Lectures)**

Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defences, Domain name.

**Unit 5: Geographical Indications (2 Lectures)**

Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.

**Unit 6: Protection of Traditional Knowledge (2 Lectures)**

Objective, Concept of Traditional Knowledge, Holders, Bio-Prospecting and Bio-Piracy, Alternative ways, Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.

**Unit 7: Industrial Designs (1 Lecture)**

Objectives, Rights, Assignments, Infringements, Defences of Design Infringement

**Unit 8: Protection of Plant Varieties (2 Lectures)**

Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

**Unit 9: Information Technology Related Intellectual Property Rights (2 Lectures)**

Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection

**Unit 10: Biotechnology and Intellectual Property Rights. (3 Lectures)**

Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions.

**Suggested Readings**

1. N.S. Gopalakrishnan & T.G. Agitha, (2009) Principles of Intellectual Property Eastern Book Company, Lucknow.
2. Kerly's Law of Trade Marks and Trade Names (14th Edition) Thomson, Sweet & Maxwell.
3. Ajit Parulekar and Sarita D' Souza, (2006) Indian Patents Law – Legal & Business Implications; Macmillan India Ltd.
4. B.L. Wadehra (2000) Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India.
5. P. Narayanan (2010) Law of Copyright and Industrial Designs; Eastern law House, Delhi.

