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To
All the teachers of Botany in colleges affiliated to WBSU,

Dear colleagues,

The **draft** syllabi appended below for both BSc. Botany (Honours) and BSc. with Botany under the Choice Based Credit System (CBCS) has been prepared by the Undergraduate Board of Studies in Botany at WBSU taking into consideration the UGC model syllabi. It is prefaced by the details of course and credit distribution for BSc. (Honous) and BSc. which will be followed uniformly for all other Science departments in WBSU. Similarly, the regulations which will be finalized shortly will also be uniformly followed for all departments in WBSU

Feedback on the draft syllabi if any, are requested to be sent in a signed pro-forma containing (i) Name, Designation and affiliation of the teacher (ii) Contact details of the teacher: phone & email (iii) specific part of the syllabus for which the feedback has been sent (iv) and the proposed change/(s) if any. The filled in preformat is to be mailed to the Chairman, UGBoS in Botany, Department of Botany, West Bengal State University, Barasat, Kolkata-700126 and an email of the same sent to **s_guharoy@wbsu.ac.in** within 15 days of uploading the draft syllabus to the website. Any other mode of sending the feedback will NOT be entertained and deliberated upon.

Teachers' are kindly requested to familiarize themselves with the syllabi, distribution of credits and general instructions for facilitating implementation of Choice Based Credit System (CBCS) before sending the feedback to make it relevant and useful.

A workshop on the CBCS syllabi may be held subsequently to inform about the general structure, regulations and to deliberate on the feedback (**ONLY** of those received in the requisite preformat and mode mentioned above). The tentative date of the workshop may be towards the end of first week of April 2018 and will be notified on the website in due course.

Sd/-

Chairman,
Undergraduate Board of Research Studies,
Department of Botany, WBSU

Dated: 28.02.2018

WEST BENGAL STATE UNIVERSITY

DRAFT SYLLABI IN BOTANY UNDER CHOICE BASED CREDIT (CBCS) SYSTEM

2018

A

Details of courses under B.Sc. (Honors)

Course	*Credits	
	Theory+ Practical	Theory + Tutorial
I. Core Course		
(14 Papers)	14X4= 56	14X5=70
Core Course Practical / Tutorial*		
(14 Papers)	14X2=28	14X1=14
II. Elective Course		
(8 Papers)		
A.1. Discipline Specific Elective	4X4=16	4X5=20
(4 Papers)		
A.2. Discipline Specific Elective Practical/ Tutorial*	4 X 2=8	4X1=4
(4 Papers)		
B.1. Generic Elective/ Interdisciplinary	4X4=16	4X5=20
(4 Papers)		
B.2. Generic Elective Practical/ Tutorial*	4 X 2=8	4X1=4
(4 Papers)		
III. Ability Enhancement Courses		
1. **Ability Enhancement Compulsory Courses (AECC)**		
(2 Papers of 2 credit each)	2 X 2=4	2 X 1=4
Environmental Science		
English/MIL Communication		
2. **Skill Enhancement Courses (SEC)**		
(Minimum 2)	2 X 2=4	2 X 1=4
(2 Papers of 2 credit each)		

- **Optional Dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th Semester**

Distribution of courses in different semesters for Undergraduate (Honours) courses

Semester	Core	DSE	GE	AECC	SEC	Total credit
I	C1 C2		GE1	Environmental Science		20
II	C3 C4		GE2	English/MIL Communication		20
III	C5 C6 C7		GE3		SEC1	26
IV	C8 C9 C10		GE4		SEC2	26
V	C11 C12	DSE1, DSE2				24
VI	C13 C14	DSE3, DSE4				24
Total number of courses	14	4	4	2	2	140

WEST BENGAL STATE UNIVERSITY

B.Sc. (Honours) Botany

Details of Courses offered

Core Courses (C)

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 Electives (DSE)

1. Analytical Techniques in Plant Sciences
2. Bioinformatics
3. Natural Resource Management
4. Horticultural Practices and Post-Harvest Technology
5. Industrial and Environmental Microbiology
6. Biostatistics

Generic Electives (GE)

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 Course Compulsory (AECC)

1. Environmental Science
2. English/MIL Communication

Skill Enhancement Courses Elective (SEC)

1. Biofertilizers
2. Medicinal Botany
3. Ethnobotany
4. Mushroom Culture Technology

Semester-I

Course I: Phycology and Microbiology

(Credits: Theory-4, Practical-2)

THEORY
Lectures: 60

Unit 1: Introduction to microbial world **(7 lectures)**

Primary concept of microorganism – 3 domain concept; Microbial nutrition, growth and metabolism. Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics and 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)**

Physiochemical and biological characteristics; general structure with special reference to viroids and prions; groups of virus, DNA virus (T-phage), lytic and lysogenic cycle, RNA virus (TMV) – physico-chemical characteristics and its mode of multiplication.

Unit 3: Bacteria **(7 lectures)**

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, evolutionary classification of Lee (only up to groups); 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 *Volvox, Oedogonium,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.*

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. Demonstration of the preparation of media, sterilization and sub culturing.
4. Gram staining; Endospore staining with malachite green using the (endospores taken from soil bacteria).

Phycology

1. Study of vegetative and reproductive structures of *Nostoc, Volvox*, *Oedogonium, Chara, Vaucheria, Ectocarpus, Fucus and Polysiphonia,*through temporary preparations and permanent slides.

   Procholoron through electron micrographs

2. Illustration through drawing prism with magnification of vegetative and reproductive structure of *Oedogonium*, *Chara*,*Vaucheria and Polysiphonia.*

Suggested Readings

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th 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. 8th edition.
6. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

Core Course II: Biomolecules and Cell Biology
(Credits: Theory-4, Practical-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; triacylglycerols structure, functions and properties; phosphoglycerides.

Proteins: Structure of amino acids; levels of protein structure-primary, secondary, tertiary and quarternary; 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: Bioenergenetics (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 and Lineweaver-Burk Plot, enzyme inhibition and factors affecting enzyme activity.

Unit4: 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: **(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.

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

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. TymoczkoJL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, TymoczkoJL 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. 6th 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

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Introduction to true fungi (6 lectures)

General characteristics; affinities with plants and animals; thallus organization; cell wall composition; nutrition; sexual (with reference to sporocarp) and asexual (spore forming bodies in deuteromycetes) reproduction; classification (Hawksworth *et al* 1995).

Unit 2: Chytridiomycota and Zygomycota (5 lecture)

Characteristic features; ecology and significance; thallus organisation; reproduction; life cycle with reference to *Synchytrium, Rhizopus*.

Unit 3: Ascomycota (10 lectures)

General characteristics (asexual and sexual fruiting bodies); ecology; life cycle, heterokaryosis and parasexuality; life cycle with reference to *Saccharomyces, Aspergillus*, *Penicillium, Alternaria, Neurospora* and *Ascobolus.*

Unit 4: Basidiomycota (8 lectures)

General characteristics;ecology; life cycle with reference to Black stem rust of wheat *Puccinia* (physiological specialization), Loose and covered smut (symptoms only), *Agaricus*; bioluminescence, fairy rings and mushroom cultivation (general account).

Unit 5: Allied Fungi (3 lectures)

General characteristics; status of slime molds; occurrence; types of plasmodia; types of fruiting bodies.

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

General characteristics; ecology; life cycle and classification with reference to *Phytophthora* & *Albugo.*

Unit 7: 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 disease and role of quarantine.

Bacterial diseases – Citrus canker. Viral diseases – Tobacco

Mosaic virus, vein clearing. Fungal and Oomycete diseases – Early and Late blight of potato, Black stem rust of wheat, Blast of Rice.

Practical

1. Introduction to the world of fungi (unicellular, coenocytic/septate mycelium, ascocarps & basidiocarps) through permanent slides.
2. Micrometry (measurement of reproductive unit)
3. *Rhizopus* - study of asexual stage from temporary mounts and sexual structures through permanent slides.
4. *Aspergillus* and *Penicillium* - study of asexual stage from temporary mounts and sexual stage from permanent slides/photographs.

5. *Ascobolus* - sectioning through ascocarp and micrometry.
6. *Alternaria* - Specimens/photographs and temporary mounts.
7. *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.
8. *Agaricus* - Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown.
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.

    Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)
11. Phytopathology: Herbarium specimens of bacterial diseases; Citrus canker;

    Viral diseases: TMV, Vein clearing symptom from any available specimen;

    Fungal diseases: Early and Late blight of potato, Black stem rust of wheat and Blast of Rice.

Suggested Readings

1. Agrios, G.N. (2006) Plant Pathology, 5th edition, Academic Press, U.K.
2. Peter McCoy (2006) Radical Mycology: A Treatise On Seeing And Working With Fungi. Chthaeus Press.
3. Bryce Kendrick (2012) The Fifth Kingdom: An Introduction to Mycology. 4th Ed. Focus Publishing/R Pullins & Co.
4. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
5. H. S. Chaube and V. S. Pundhir. (2009) Crop Diseases and their Management. Prentice Hall (India).
6. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.

Core Course IV: Archegoniate
(Credits: Theory-4, Practical-2)
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 Proskauer 1954(up to class); range of thallus organization.

Unit 3: Type Studies- Bryophytes (12 lectures)

Systematic position, 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, Sporne 1975 (up to Class); early land plants (*Cooksonia* and *Rhynia*).

Unit 5: Type Studies- Pteridophytes (14 lectures)

Systematic position, 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 (Sporne up to family), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum* (developmental details not to be included); ecological and economic importance.

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), vertical section of thallus (all permanent slide).
4. ***Sphagnum***- Morphology of plant, whole mount of leaf (permanent slide only).
5. ***Funaria***- Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus, spores, longitudinal section of capsule (temporary slides); permanent slides showing antheridial and archegonial heads,
6. ***Psilotum***- Study of specimen, transverse section of synangium (permanent slide).
7. ***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).
8. ***Equisetum***- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (temporary slide).
9. ***Pteris***- Morphology, vertical section of sporophyll, whole mount of sporangium, whole mount of spores (temporary slides),
10. ***Cycas***- Morphology and TS of leaflet, morphology of microsporophyll and megasporophyll (temporary slides) whole mount of spore (temporary slides) ; TS of coralloid root, LS of ovule (all permanent slide).
11. ***Pinus***- Morphology of long and dwarf shoots , male and female cones, transverse section of needle (temporary slide), LS of male cone and femalecone (permanent slide);microspores(permanent slides),
13. ***Gnetum***- Morphology (shoot, male & female cones), VS of ovule (permanent slide).

14. One Botanical excursion to an appropriate location.

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

Core Course V: Morphology and Anatomy of Angiosperms

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: **(2 Lectures)**

Inflorescence – Types with examples, concept of advanced and primitive types.

Unit 2: **(5 Lectures)**

Flower – Types with examples, aestivation, floral parts – various types of cohesion and adhesion with examples; carpel-types, advance and primitive ones and placentations.

Unit 3: **(3 Lectures)**

Fruits and Seeds –types with examples

Unit 4: Introduction and scope of Plant Anatomy **(3 Lectures)**

Applications in systematics, forensics and pharmacognosy**.**

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

Internal organization of plant body; the three tissue systems, types of cells and tissues.

Unit 6: Tissues **(10 Lectures)**

Classification of tissues; simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; pits and plasmodesmata; ergastic substances; hydathodes, cavities, lithocysts and laticifers.

Unit 7: Apical meristems **(12 Lectures)**

Evolution of the concept of organization of the shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, types of vascular bundles; structure of dicot and monocot stem; structure of dicot and monocot leaf, Kranz anatomy; organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); quiescent centre; root cap; structure of dicot and monocot root.

Unit 8: Vascular Cambium and Wood **(12 Lectures)**

Structure, function and seasonal activity of cambium; secondary growth in root and stem ; types of rays and axial parenchyma; sapwood and heartwood; ring and diffuse porous wood; early and late wood, tyloses; development and composition of periderm, rhytidome and lenticels.

Unit 9: Adaptive and Protective Systems **(8 Lectures)**

Epidermal tissue system, cuticle, trichomes (uni and multicellular, glandular and nonglandular, two examples of each), stomata (classification); adcrustation and incrustation; anatomical adaptations of xerophytes and hydrophytes.

Practical

1. Study of anatomical details of the following through permanent slides/temporary stain mounts/ macerations/museum specimens with the help of suitable representatives.

a. Apical meristem of root, shoot and vascular cambium.

b. Distribution and types of parenchyma, collenchyma and sclerenchyma

c. Xylem: Tracheary elements- tracheids, vessel elements; thickenings; perforation plates; Xylem fibres.(permanent slides)

d. Wood: ring porous; diffuse porous; tyloses; heart and sapwood (permanent slides)

e. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres. (permanent slides)

f. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular (permanent slides)

g. Periderm; lenticels; C4 leaves (Kranz anatomy); Secretory tissues: cavities, lithocysts and laticifers.

2. Workout and preparation of permanent slides by following double staining method.

a. Root anatomy (monocot – Orchid), dicot (Sunflower); secondary growth.

b. Stem anatomy (monocot- maize), (dicot – *Cucurbita*) - primary and secondary growth. c. Leaf: isobilateral (Tube rose), dorsiventral (Mango),

d. Adaptive anatomy: xerophytes (*Nerium* leaf), hydrophytes (*Nymphaea* petiole).

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 Benjammin/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
(Credits: Theory-4, Practical-2)
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.

Unit 2: Cereals (6 lectures)

Wheat and rice- origin, morphology, cultivation & uses; brief account on millets.

Unit 3: Legumes (6 lectures)

Origin, morphology and uses of Chick pea & Pigeon pea; 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 and coffee - morphology, processing & uses.

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

General description, classification, extraction, their uses and health implications of groundnut, linseed, soybean, mustard and coconut (botanical name, family & uses). Essential oils - *Santalum* and Eucalyptus: 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 C*inchona, Digitalis, Papaver* and *Cannabis*; Tobacco - Morphology, processing, uses and health hazards.

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

General account with special reference to teak, sal and pine.

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

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

Practical

1. **Cereals**: Wheat : habit sketch, L. S/T.S. grain, starch grains – type; micro-chemical tests – iodine spot test.

Rice: habit sketch, study of paddy and grain, starch grains– type; micro-chemical tests – iodine spot test.

2. **Legumes**: Soybean and Ground nut: habit sketch, fruit, seed structure and micro-chemical tests (Millon test- Soyabean, Sudan IV test- Groundnut).
3. **Sources of sugars and starches**: Sugarcane - habit sketch; cane juice- micro-chemical tests (Molisch test)

Potato - habit sketch, tuber morphology, T.S. of tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests (Iodine test)

4. **Spices:** Black pepper, Fennel and Clove - Demonstration, habit sketch and comments
5. **Beverages**: Tea leaf and coffee bean - extraction and comments.
6. **Sources of oils and fats**: Coconut - kernel and Mustard - seeds: tests for fats (Sudan IV test)
7. **Essential oil-yielding plants**: Habit sketch of *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 and Shorea*; Specimen; Section of young stem.
12. **Fiber-yielding plants**: Cotton – specimen whole mount of fiber and test for cellulose – general test with benzene and/or aniline acetate test. Jute - transverse section of stem, test for lignin – phloroglucinol test 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

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

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

Mendelism: 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: ClB 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.

Practical

1a. Mitosis through temporary squash preparation (*Allium cepa, Lens esculentus, Aloe vera)*

b. Meiosis through temporary smear preparation (*Allium cepa, Rhoeo discolour*)

2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
3. Chromosome mapping using point test cross data.
4. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
5. Blood Typing: ABO groups & Rh factor.
6. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes (demonstration through pictures)

7. Photographs and permanent slides showing translocation ring, Laggards and Inversion Bridge.
8. 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. (demonstration through pictures)

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th 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. 10th edition.

Semester-IV

Core Course VIII: Molecular Biology

THEORY (Credit: 4)

Lectures: 60

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

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: 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 3: 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, θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5'end of linear chromosome; Enzymes involved in DNA replication.

Unit 4: Central dogma and genetic code **(2 lectures)**

Key experiments establishing-the central dogma (adaptor hypothesis and discovery of mRNA template), Genetic code: salient features and deciphering (triplete binding assay**).**

Unit 5: Transcription **(18 lectures)**

Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation (Operon concept). Prokaryotes: regulation of lactose metabolism and tryptophan synthesis in *E.coli.*

Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.

Unit 6: 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 7: 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.

Practical

1. Preparation of LB medium
2. DNA isolation from cauliflower head.
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 (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)
7. 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. 6th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
4. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd 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. 10th edition.

Core Course IX: Plant Ecology and Phytogeography

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Introduction **(4 lectures)**

Basic concepts; Levels of organization. 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; hydrological cycle; water in soil; water table.

Unit 4: Light, temperature, wind and fire **(6 lectures)**

Variations; adaptations of plants to their variation.

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

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

Unit 6: Population ecology **(4 lectures)**

Characteristics and Dynamics, r and k selection, Ecological Speciation.

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 and 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 and theory of tolerance (brief account); endemism; brief description of major terrestrial biomes – Tropical rain forest, Temperate grassland and Tundra; Phytogeographical division of India (BSI 19..) ; Local Vegetation.

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, organic matter and base deficiency from two soil samples by rapid field tests.
4. Determination of organic carbon of different soil samples by Walkley & Black rapid titration

method.

5. Determination of dissolved oxygen and carbon dioxide of water samples from polluted and unpolluted sources.
6. (a). Study of ~~morphological~~ anatomical adaptations of hydrophytes and xerophytes – by preparation of temporary slides of *Nymphaea* petiole, *Hydrilla* stem, *Nerium* and *Casuarina* leaf.

   (b). Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Epiphytes (*Vanda* root), Predation (Insectivorous plants) – from permanent slides and preserved specimens.
7. Determination of minimum size of quadrate for the study of herbaceous vegetation by species area curve method (species to be listed).
8. Quantitative analysis of herbaceous vegetation for frequency and comparison with Raunkiaer's frequency distribution law.
9. Quantitative analysis of herbaceous vegetation for density and abundance.
10. Field visit to familiarize students with ecology of different sites.

Suggested Readings

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
4. 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. 4th edition. 6.Misra R (1968) Ecology Workbook. Oxford and IBH Publ. Co., Calcutta

7.Ambasht and Ambasht (2012) A text book of Plant Ecology.
CBS Publ. 8.BSI –

Core Course X: Plant Systematics

(Credits: Theory-4, Practical-2)

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. Functions of herbarium and botanical gardens; importance of 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, Linnaeus, Bessey, Hutchinson, Takhtajan and Cronquist; classification systems of Bentham and Hooker (up to series) and Engler and Prantl (up to series); brief reference of angiosperm phylogeny Group (APG III) classification.

Unit 5: Biometrics, numerical taxonomy and cladistics (10 lectures)

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

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.

Practical

1. Study of the vegetative and floral characters of the following any ten families and fifteen species (description, VS of flower, section of ovary, floral diagram/s, floral formula and systematic position according to Bentham & Hooker's system of classification):

Ranunculaceae - *Ranunculus, Delphinium*

Brassicaceae - *Brassica, Alyssum / Iberis/Nastertium*

Myrtaceae - *Eucalyptus, Callistemon*

Apiaceae (Umbelliferae) - *Coriandrum /Anethum / Foeniculum/Seseli*

Asteraceae (Compositae) - *Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax/Synedrella*

Solanaceae - *Solanum spp./Withania/Physalis*

Lamiaceae (Labiatae)- *Salvia/Ocimum/Leucus/Leonurus/Anisomeles/Hyptis*

Euphorbiaceae - *Euphorbia spp., Jatropha/Acalypha/Croton*

Liliaceae - *Asphodelus/Lilium/Allium*

Poaceae - *Triticum/Hordeum/Avena/Eleusine indica/Dactyloctenium aegyptium*

Malvaceae –*Sida spp./Urena/Malachra capitata/Hibiscus vitifolius*

Polygonaceae – *Polygonum spp/Rumex*

Acanthaceae –*Justicia/Rungia/Ecbolium/Hygrophila*

Scrophulariaceae – *Lindenbergia/Mazus/Vandellia (Lindernia)/*

Rubiaceae – *Oldenlandia/ Dentella/ Spermacocce*

2. Field visit (local) – Subject to grant of funds from the university.

3. Mounting of properly dried and pressed specimens of wild plants with herbarium label (to be submitted in the examination.)

4. Botanical excursion **–**At least Three in number

i) Visit to Indian Botanic Garden (Acharya Jagadish Chandra Bose Indian Botanic Garden, Botanical Survey of India)

ii) Two different ecological zones

iii) Submission of 25 well mounted and identified herbarium sheets of angiospermic specimen arranged after Bentham and Hooker system of classification

Semester-V

Core Course XI: Reproductive Biology of Angiosperms

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Introduction **(4 lectures)**

History 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.

Unit 4: Ovule **(10 lectures)**

Structure; types; female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of *Polygonum* type); organization 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 **(6 lectures)**

Introduction; classification; causes and applications.

Practical

1. Anther: Tapetum (amoeboid and glandular); spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, monads, dyads, 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.
3. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).
4. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
5. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
6. Embryogenesis: Study of ~~development of~~ dicot embryo through permanent slides/photoghraphs

   ;Study of embryos at various developmental stages through permanent slide/ photographs; 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. 5th 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. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

Core Course XII: Plant Physiology

(Credits: Theory-4, Practical-2)

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 molecular aspects of the physiological roles of auxin, gibberellins, cytokinin, abscisic acid, ethylene. Brief account of Brassinosteroids and Jasmonic acid.

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

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

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

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

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 ~~velocit~~y and light on the rate of transpiration in *Colocasia* leaf.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte (*Basella*) and xerophytes (*Ficus benghalensis*).
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte *(Basella*) and xerophyte *(Ficus benghalensis)* (both surfaces).
6. To study the phenomenon of epigeal and hypogeal seed germination with respect to light (gram and corn seeds).
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 wheat/barley grains.

Demonstration experiments

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

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

Semester-VI

Core Course XIII: Plant Metabolism

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Concept of metabolism (6 lectures)

Introduction, anabolic and catabolic pathways, regulation of metabolism, enzymes - mechanism and factors, kinetics, role of regulatory enzymes (allosteric, covalent modulation and isozymes), enzyme inhibition.

Unit 2: Carbon assimilation (14 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_2 reduction,photorespiration,C_4pathways; Crassulacean acid metabolism; factors affecting CO_2 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, anaplerotic 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; role of uncouplers.

Unit 6: Lipid metabolism (8 lectures)

Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α 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; G protein; second messenger concept, calcium calmodulin, MAP kinase cascade.

Practical

1. Chemical separation of photosynthetic pigments.
2. Demonstration of fluorescence by isolated chlorophyll pigments.

3 . Demonstration of absorption spectrum of photosynthetic pigments

4. To study the effect of light intensity on the rate of photosynthesis.
5. Effect of carbon dioxide on the rate of photosynthesis.
6. To compare the rate of respiration in different parts of a plant.
7. To demonstrate activity of Nitrate reductase in germinating leaves of different plant sources.
8. To study the activity of lipases in germinating oilseeds.

Suggested Readings

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

Core Course XIV: Plant Biotechnology

(Credits: Theory-4, Practical-2)

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), hardening of the tissue culture raised plants for field plantation.

Unit 2: Recombinant DNA technology **(12 lectures)**

Restriction Endonucleases (Types I-IV, biological role and application); Restriction mapping (linear and circular); cloning vectors: prokaryotic (pBR322, Ti plasmid, BAC); lambda phage, cosmid; 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 (round up ready soybean); transgenic crops with improved quality traits (Golden rice); improved horticultural varieties (Moondust carnations); role of transgenics in bioremediation (Superbug); edible vaccines; industrial enzymes (aspergillase, protease, lipase); gentically engineered products–human growth hormone; humulin; biosafety concerns.

Practical

1. (a) Preparation of MS medium.

   (b) Process of *in vitro* sterilization and inoculation methods by using different explants (leaf, nodal bud and seeds of tobacco, *Datura*, *Brassica*)

2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
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 genomic DNA and its gel electrophoresis.

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. 5th edition.

4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.

5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

Discipline Specific Elective Courses

Discipline Specific Elective
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, $CsCl_2$gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3: Radioisotopes (4 lectures)

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

Unit 4: Spectrophotometry (4 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 (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. 3rd 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. 3rd edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

Discipline Specific Elective
Bioinformatics
(Credits: Theory-4, Practical-2)
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

Practical

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

Suggested Readings

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

Discipline Specific Elective
Natural Resource Management
(Credits: Theory-4, Practical-2)
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; Bioprospecting; IPR; CBD; National Biodiversity Action Plan).

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

Definition, Cover and its significance (with special reference to India); Major and minor 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)**

Practical

1. Estimation of solid waste generated by a domestic system (biodegradable and nonbiodegradable) 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)

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, coraltree).

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 loses 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 andchemical methods for pest control); Quarantine practices; Identification of common diseases andpests 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 Agri-Horticultural Society/ Agricultural Research stations/ State/Central Agricultural Universities/ IARI or other suitable locations.

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.

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

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, Danniel, 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.
4. The Principles of scientific research, Freedman, P. New York, Pergamon Press.
5. Statistics for Biologists, Campbell, R.C., 1998.Cambridge University Press.

Generic Elective Courses

Generic Elective
Biodiversity (Microbes, Algae, Fungi and Archegoniate)
(Credits: Theory-4, Practical-2)
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 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, stellar evolution. Ecological and economical importance of Pteridophytes.

Unit 4: 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.

Practical

5. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.

6. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
7. Gram staining
8. 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)
9. *Rhizopus and Penicillium*: Asexual stage from temporary mounts and sexual structuresthrough permanent slides.
10. *Alternaria:* Specimens/photographs and tease mounts.
11. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberryleaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
12. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
13. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
14. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
15. *Marchantia*- morphology of thallus, w.m. rhizoids and scales, v.s. thallus throughgemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
16. *Funaria*- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores(temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
17. *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).
18. *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).
19. *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
65
slide).
20. *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).
21. *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. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John

Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

Generic Elective
Plant Ecology and Taxonomy
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Unit 1: Introduction **(2 lectures)**

Unit 2: Ecological factors **(10 lectures)**

Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes

Unit 3: Plant communities **(6 lectures)**

Characters; Ecotone and edge effect; Succession; Processes and types

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

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

Unit 5: Phytogeography **(4 lectures)**

Principle biogeographical zones; Endemism

U nit 6 Introduction to plant taxonomy **(2 lectures)**

Identification, Classification, Nomenclature.

Unit 7 Identification **(4 lectures)**

Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access

Unit 8 Taxonomic evidences from palynology, cytology, phytochemistry and molecular data. **(6 lectures)**

Unit 9 Taxonomic hierarchy (**2 lectures)**

Ranks, categories and taxonomic groups

Unit 10 Botanical nomenclature **(6 lectures)**

Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Unit 11 Classification **(6 lectures)**

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

Unit 12 Biometrics, numerical taxonomy and cladistics **(4 lectures)**

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

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 nigrum, Withania;* Lamiaceae -*Salvia, Ocimum*; Liliaceae - *Asphodelus / Lilium / Allium.*
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. 4th edition.
2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th 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. 3rd edition.

Generic Elective
Plant Anatomy and Embryology
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Unit 1: Meristematic and permanent tissues **(8 lectures)**

Root and shoot apical meristems; Simple and complex tissues

U nit 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. 5th edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

Generic Elective
Plant Physiology and Metabolism
(Credits: Theory-4, Practical-2)
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; C_3, C_4 and CAM pathways of carbon fixation; Photorespiration.

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

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

U nit 6: Enzymes **(4 lectures)**

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

U nit 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_2 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. 6th edition.

1. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.

2. 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)
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)**
General account with special reference to Gram and soybean

U nit 4: Spices **(6 lectures)**
General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)

U nit 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 lecture)**

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.

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. 4th 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)
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, upflow 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.

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. Bioremidation, 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.

Skill Enhancement Courses

Skill Enhancement Course
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 biodegradable 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
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: Umoor-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, 2nd edn. Agrobios, India.

Skill Enhancement Course
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 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 *Rauvolfia sepentina, 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. 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)
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 saltsolutions. 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.

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