

CBCS SYLLABUS
FOR
THREE YEARS UNDER-GRADUATE COURSE
IN
BOTANY (HONOURS)
(w.e.f. 2017)



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1. Introduction

The syllabus for Botany at undergraduate level using the Choice Based Credit system has been framed in compliance with model syllabus given by UGC. While framing the syllabus as per the UGC guideline, the topics have been kept as generic as possible as per our own infrastructure, expertise and strength.

The main objective of framing this new syllabus is to give the students a holistic understanding of the subject giving substantial weightage to both the core content and techniques used in Botany.

Keeping in mind and in tune with the changing nature of the subject, adequate emphasis has been given on new techniques and understanding of the subject.

The syllabus has also been framed in such a way that the basic skills of subject are taught to the students, and everyone might not need to go for higher studies and the scope of securing a job after graduation will increase.

Considering the latest trends in the development of Plant Science and in compliance with the UGC model syllabus in Botany some new topics in the fields of Disciplines specific elective courses as well as Skill enhancement courses like Plant Biotechnology, Research Methodology, Industrial and Environmental Microbiology, Nursery and Gardening, Herbal Technology, Ethnobotany, Floriculture etc. have been included in the syllabus for the benefit of students from both theoretical and practical point of view.



2. Scheme for CBCS Curriculum

2.1 Credit Distribution across Courses

Course Type	Total Papers	Credits	
		Theory + Practical	Theory*
Core Courses	14	14*4 =56	14*5 =70
		14*2 =28	14*1=14
Discipline Specific Electives	4	4*4=16	4*5=20
		4*2=8	4*1=4
Generic Electives	4	4*4=16	4*5=20
		4*2=8	4*1=4
Ability Enhancement Language Courses/ENVS	2	1*2=2 (ENG / MIL)	1*2=2 (ENG / MIL)
		1*4=4 (ENVS)	1*4=4 (ENVS)
Skill Enhancement Courses	2	2*2=4	2*2=4
Totals	26	142	142

*Tutorials of 1 Credit will be conducted in case there is no practical component

**2.2 Scheme for CBCS Curriculum in Botany (Honours)****SEMESTER –I**

Course Code	Course Title	Credit	Marks			No. of Hours / Week		
			I. A.	ESE	Total	Lec.	Tu.	Pr.
SHBOT / 101/C-1	Phycology & Microbiology (Theory & Practical)	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT / 102/C-2	Biomolecules & Cell Biology (Theory & Practical)	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT / 103/GE-1	Plant Biodiversity [Microbes, Algae, Fungi, Archegoniate (Bryophyta, Pteridophyta & Gymnosperm)]	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A.	4
ACSHP/104/AECC-1	Environmental Studies	4	10	40	50	4	N.A	N.A
Total in Semester - I		22	40	160	200			

N.B. Theory: 1 Credit= 1 hour/Week, Practical: 1 Credit= 2 hours/Week, Tutorial: 1 Credit= 1 hour/Week

SEMESTER –II

Course Code	Course Title	Credit	Marks			No. of Hours / Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
SHBOT / 201/C-3	Mycology & Phytopathology (Theory & Practical)	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT / 202/C-4	Archegoniate (Bryophyta, Pteridophyta, & Gymnosperm) and Palaeobotany (Theory & Practical)	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT / 203/GE-2	Any one from: 2. Plant Ecology, Morphology & Taxonomy 3. Plant Anatomy & Embryology	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
ACSHP/204/AECC-2	English/Hindi/MIL	2	10	40	50	2	N.A	N.A
Total in Semester - II		20	40	160	200			



N.B. Theory:1 Credit= 1hour/Week, Practical:1Credit= 2 hours/Week, Tutorial:- 1 Credit= 1 hour/Week

SEMESTER –III

Course Code	Course Title	Credit	Marks			No. of Hours / Week		
			I.A.	ESE	Total	Lec	Tu.	Pr.
SHBOT / 301/C-5	Morphology & Anatomy of Angiosperms (Theory & Practical)	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT / 302/ C-6	Economic Botany (Theory & Practical)	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT /303/C-7	Genetics (Theory & Practical)	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT / 304/GE-3	Any one from: 4. Genetics and Plant Breeding 5. Cell and Molecular Biology	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT / 305/SEC-1	Any one from :- Biofertilisers / Herbal Technology / Nursery & Gardening / Floriculture	2	10	40	50	2	N.A	N.A
Total in Semester - III		26	50	200	250			

N.B. Theory:1 Credit= 1 hour/Week,Practical:1Credit= 2 hours/Week,Tutorial:- 1 Credit= 1 hour/Week

SEMESTER –IV

Course Code	Course Title	Credit	Marks			No. of Hours / Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
SHBOT /401/C-8	Molecular Biology (Theory & Practical)	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT /402/C-9	Plant Ecology & Phytogeography (Theory & Practical)	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT /403/C-10	Plant Systematics (Theory & Practical)	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT /404/GE-4	Any one from: 6. Plant Physiology & Metabolism 7. Economic Botany & Plant Biotechnology	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT / 405/SEC-2	Any one from:- Medicinal Plant / Plant Biodiversity & Human Welfare / Ethnobotany / Mushroom Culture Technology	2	10	40	50	2	N.A.	N.A.
Total in Semester - IV		26	50	200	250			



N.B. Theory:- 1credit= 1 hour/Week, Practical:1 Credit=2hours/Week, Tutorial:- 1 Credit= 1 hour/Week

SEMESTER – V

Course Code	Course Title	Credit	Marks			No. of Hours / Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
SHBOT / 501/C-11	Reproductive Biology & Angiosperms & Palynology (Theory & Practical)	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT / 502/C-12	Plant Physiology (Theory & Practical)	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT / 503/DSE-1	Any one from:- Stress Biology / Natural Resource Management /	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT / 504/DSE-2	Any one from:- Horticultural Practice & Post Harvest Technology (Theory & Practical)/ Plant Breeding (Theory & Tutorial)	6 (T 6)	10	40 (T 40)	50	6	N.A	
Total in Semester – V		24	40	160	200			

N.B. Theory:- 1 Credit= 1 hour/Week, Practical:- 1 Credit= 2 hours/Week, Tutorial:- 1 Credit= 1 hour/Week

SEMESTER – VI

Course Code	Course Title	Credit	Marks			No. of Hours / Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
SHBOT / 601/C-13	Plant Metabolism (Theory & Practical)	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT / 602/C-14	Plant Biotechnology (Theory & Practical)	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT / 603/DSE-3	Any one from:- Research Methodology / Industrial & Environmental Microbiology / Biostatistics (Theory & Practical)	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
SHBOT / 604/DSE-4	Any one from:- Research Methodology / Industrial & Environmental Microbiology / Biostatistics (Theory & Practical)	6 (T 4+P 2)	10	40 (T 25+P 15)	50	4	N.A	4
Total in Semester – VI		24	40	160	200			

N.B. Theory:- 1 Credit= 1 hour/Week, Practical:- 1 Credit= 2 hours/Week, Tutorial:- 1 Credit= 1 hour/Week



SHBOT=Science Honours Botany, ACSHP= Arts Commerce Science Honours Programme, C= Core Course, AECC= Ability Enhancement Compulsory Course, SEC= Skill Enhancement Course, GE= Generic Elective, DSE= Discipline Specific Elective IA= Internal Assessment, ESE= End-Semester Examination, Lec.=Lecture, Tu.= Tutorial, and Pr.=Practical]

2.3 Choices for Discipline Specific Electives

1) Stress Biology	4) Horticultural Practices & Post Harvest Technology	7) Biostatistics
2) Plant Breeding	5) Research Methodology	
3) Natural Resource Management	6) Industrial & Environmental Microbiology	

2.4 Choices of Skill Enhancement Courses

1) Biofertilizers	4) Floriculture	7) Ethnobotany
2) Herbal Technology	5) Medicinal Botany	8) Mushroom Culture Technology
3) Nursery & Gardening	6) Plant Diversity & Human Welfare	

2.5 Choices for Generic Elective Courses

SEMESTER	CHOICE
SEM-I	1. Plant Biodiversity [Microbes, Algae, Fungi ,Archegoniate (Bryophyta, Pteridophyta & Gymnosperm)]
SEM-II	Any one from: 2. Plant Ecology, Morphology & Taxonomy 3. Plant Anatomy & Embryology
SEM-III	Any one from: 4. Genetics and Plant Breeding 5. Cell and Molecular Biology
SEM-IV	Any one from: 6. Plant Phiosiology & Metabolism 7. Economic Botany & Plant Biotechnology



3. Core Courses



Semester - I

3.1 Core TI: Phycology and Microbiology

(Theory: Credits 4/ Lectures 60 /Marks 25)

Microbiology (10 marks)

Unit 1: Introduction to microbial world (7 lectures)

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

Unit 2: Viruses (7 lectures)

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

Unit 3: Bacteria (9 lectures)

Discovery, general characteristics; Principles and Modern Approaches of Bacterial Taxonomy, Brief Outline classification of Domain Bacteria, Types - archaeobacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure; Nutritional types; Reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction).

Phycology (15 Marks)

Unit 4: Algae (11 lectures)

General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; methods of reproduction; Classification; criteria, system of Fritsch, and evolutionary classification of Lee, 2009 (only upto groups); Significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar). Role of algae in the environment, agriculture, biotechnology and industry

Unit 5: Cyanophyta, Xanthophyta and Bacillariophyta (8 lectures)



Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and asexual reproduction of *Nostoc* and Morphology and life-cycle of *Vaucheria*, Cell Structure and Auxospore formation in Diatoms.

Unit 6: Chlorophyta and Charophyta (8 lectures)

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

Unit 7: Phaeophyta and Rhodophyta (10 lectures)

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

3.2 Core P1: Microbiology and Phycology

List of Practical (Credits 2/15 Marks)

Microbiology (07 marks)

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

Phycology (08 marks)

Study of vegetative and reproductive structures of *Nostoc*, *Zygnema*, *Oedogonium*, *Chara*, *Vaucheria*, *Fucus* and *Polysiphonia*, through electron micrographs, temporary preparations and permanent slides.

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.



3.3 Core T2: Biomolecules and Cell Biology

(Theory: Lectures 60/Credits- 4/Marks 25)

Biomolecules-(12 Marks)

Unit 1: Biomolecules (20 lectures)

Types and significance of chemical bonds; Structure and properties of water; pH and buffers.
Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides.

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

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

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

Unit 2: Bioenergetics (4 lectures)

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

Unit 3: Enzymes (6 lectures)

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

Cell Biology- (13 Marks)

Unit 4: The cell (4 lectures)

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

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

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

Unit 6: Cell organelles (16 lectures)

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



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

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

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

Unit 7: Cell division (6 lectures)

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

3.4 Core P2: Biomolecules and Cell Biology

(Marks 15/Credits 2)

List of Practical (Biomolecules 07 marks & Cell Biology 08 Marks)

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*.
3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
4. Measurement of cell size by the technique of micrometry.
5. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).
6. Study of cell and its organelles with the help of electron micrographs.
7. Cytochemical staining of : DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.
8. Study the phenomenon of plasmolysis and deplasmolysis.
9. Study different stages of mitosis and meiosis (From root tip of *Allium cepa* and Flower Buds of *Allium cepa* and *Rhoeo* sp).

Suggested Readings

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 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

3.5 Core T3: Mycology and Phytopathology

(Theory: Lectures 60/ Credits 4/Marks 25)

Unit 1: Introduction to true fungi (4 lectures)

General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification(Ainsworth, Sparrow, Sussman, 1973).

Unit 2: Chytridiomycota and Zygomycota (5 lecture)

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

Unit 3: Oomycota (4 lectures)

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

Unit 4: Ascomycota (10 lectures)

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

Unit 5: Basidiomycota (8 lectures)

General characteristics; Ecology; Life cycle of *Lycoperdon* and *Agaricus* loose and covered smut (symptoms only), Bioluminescence, Fairy Rings and Mushroom Cultivation.

Unit 6: Deuteromycota (3 lectures)-

General accounts, conidial morphology, conidiomata and Parasexual cycle, Study of *Alternaria* and *Fusarium*

Unit 6: Allied Fungi (2 lectures)

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

Unit 8: Symbiotic associations (4 lectures)

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

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

Terms and concepts; General symptoms; Geographical distribution of diseases; Etiology; Symptomology; Host-Pathogen relationships; Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine. Bacterial diseases – Citrus canker and Bacterial blight of rice. Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Late blight of potato, Black stem rust of wheat, White rust of crucifers, Brown spot of Rice.

3.6 Core P3: Mycology and Phytopathology**List of Practical (Marks 15/Credits 2)****Mycology: 09 marks**

1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, ascocarps & basidiocarps).
2. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
3. *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
4. *Ascobolus*: sectioning through ascocarp.
5. *Alternaria*: Specimens/photographs and temporary mounts.
6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
7. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown.
8. *Albugo*: Study of symptoms of plants infected with *Albugo*; asexual phase study through section/ temporary mounts and sexual structures through permanent slides.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)

Phytopathology: 06 marks

10. Phytopathology: Herbarium specimens of bacterial diseases: Citrus Canker; Viral diseases: TMV, Vein clearing, Fungal diseases: Late blight of potato, Black stem rust of wheat, Brown spot of Rice and White rust of crucifers.



Suggested Readings

1. Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India
6. H. C. L. Gwynne-Vaughan and B. Barnes (2014). Fungi: Their structure and Development, Biotech Books.
7. Gopinath Hait. 2016. A text Book of Mycology, New Central Book Agency (P) Ltd
8. R. S. Mehrotra and A. Aggarwal. 2010. Plant Pathology (Second Edition), Tata Mc Graw Hill Education Pvt Ltd.

3.7 Core T4: Archegoniate (Bryophyta, Pteridophyta, & Gymnosperm) and Palaeobotany

(Theory: Lectures 60/Credits 4/Marks 25)

(Bryophyte-07 marks; Pteridophyte-07 marks; Gymnosperm -07 marks; Palaeobotany-04 marks)

Unit 1: Introduction (4 lectures)

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

Unit 2: Bryophytes (6 lectures)

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

Unit 3: Type Studies- Bryophytes (12 lectures)

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

Unit 4: Pteridophytes (6 lectures)



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

Unit 5: Type Studies- Pteridophytes (14 lectures)

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

Unit 6: Gymnosperms (14 lectures)

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

Unit 7: Palaeobotany (4 Lectures)

Fossils-Definition, Types of Fossils, Importance of fossils, Fossilization Processes, Geological Time-Scale and Megafloral succession

3.8 Core P4: Archegoniate (Bryophyta, Pteridophyta, & Gymnosperm) and Palaeobotany

List of Practicals (Marks 15/Credits 2)

1. *Riccia* – Morphology of thallus.
2. *Marchantia*- Morphology of thallus, whole mount of rhizoids & Scales, vertical section of thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides).
3. *Anthoceros*- Morphology of thallus, dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).
4. *Pellia*, *Porella*- Permanent slides.
5. *Sphagnum*- Morphology of plant, whole mount of leaf (permanent slide only).
6. *Funaria*- Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, longitudinal section of capsule and protonema.
7. *Psilotum*- Identification



8. *Selaginella*- Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll temporary slides), longitudinal section of strobilus (permanent slide).
9. *Equisetum*- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).
10. *Pteris*- Morphology, transverse section of rachis, vertical section of sporophyll, whole mount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).
11. *Cycas*- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll, transverse section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).
12. *Pinus*- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), transverse section of Needle, transverse section of stem, longitudinal section of / transverse section of male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), longitudinal section of female cone, tangential longitudinal section & radial longitudinal sections stem (permanent slide).
13. *Gnetum*- Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (permanent slide)
14. Identification-Petrified Fossil (*Calamites* and *Lyginopteris*), Impression Fossil (*Glossopteris*)
15. Botanical excursions are to be organized in Botanically rich area, Field report and Photographic documents of Plant specimens to be submitted during practical examination (No need to submit any living specimen).

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

3.9 CoreT5: Morphology & Anatomy of Angiosperms

(Theory: Lecture 60/Credits 4/Marks 25)

Morphology: 06 Marks

Unit 1: Leaves (2 Lectures)

Types, phyllotaxy, modifications of leaves.

Unit 2: Flower (5 Lectures)

The flower as a modified shoot; aestivation; Inflorescence: Types and evolution. placentation and its evolution; floral formulae, floral diagram; adhesion and cohesion of floral parts.

Unit 3: Fruits (2 Lectures)

Definition and types

Unit 4: Dispersal of fruits and seeds. (2 Lectures)

Anatomy: 19 marks

Unit 5: Introduction and scope of Plant Anatomy (3 Lectures)

Applications in systematics, forensics and pharmacognosy.

Unit 6: Structure and Development of Plant Body (5 Lectures)

Internal organization of plant body: Types of cells and tissues, The three tissue systems, General idea of Mechanical tissues and its distribution.

Unit 7: 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 8: Apical meristems (12 Lectures)

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

**Unit 9: Vascular Cambium and Wood (12 Lectures)**

Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm, rhytidome and lenticels. Anomalous secondary growth in stems (*Bignonia*, *Boerhaavia*, *Strychnos* & *Dracaena*)

Unit 10: Adaptive and Protective Systems (7 Lectures)

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

3.10 Core P5: Morphology & Anatomy of Angiosperms**List of Practical (Marks 15/Credits 2)**

(Morphology: 4 Marks; Anatomy: 11 Marks)

Morphology: (04 Marks)

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

Anatomy (10 Marks)

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

Suggested Readings**Morphology**

1. Naik, V. N. Taxonomy of Angiosperms. Tata Mc. Graw Hill Publishers Co. 1981. New Delhi



2. Sachdeva, S. K. 1990. Angiosperms, Morphology, Anatomy, Taxonomy, Evolution. Kalyani Publishers, New Delhi.
3. Plant Systematics. Gurucharan Singh. 2005 (2nd Edition). Oxford & IBH.
4. Plant Taxonomy- Nair. Tata Mc. Graw Hill Publisher Company Limited.

Anatomy

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

3.11 Core T6: Economic Botany and Pharmacognosy

(Theory: Lecture 60/ Credits 4/ Marks 25)

Unit 1: Origin of Cultivated Plants (6 lectures)

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

Unit 2: Cereals (6 lectures)

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

Unit 3: Legumes (6 lectures)

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

Unit 4: Sources of sugars and starches (4 lectures)

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

Unit 5: Spices (6 lectures)

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

Unit 6: Beverages (4 lectures)

Tea, Coffee (morphology, processing & uses)

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



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

Unit 8: Natural Rubber (3 lectures)

Para-rubber: tapping, processing and uses.

Unit 9: Drug-yielding plants (8 lectures)

Therapeutic and habit-forming drugs with special reference to *Cinchona*, *Rauwolfia serpentina*, *Strychnos*, *Justicia adhatoda*

Unit 10: Timber plants (3 Lectures)

General account with special reference to teak and pine.

Unit 11: Fibers (4 lectures)

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

3.12 Core P6: Economic Botany and Pharmacognosy

List of Practical (Marks 15/Credits 2)

1. **Cereals:** Wheat (habit sketch, L. S/T.S. grain, starch grains, micro-chemical tests)Rice (Habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2. **Legumes:** Soybean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3. **Sources of sugars and starches:** Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato (habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).
4. **Sources of oils and fats:** Coconut- T.S. nut, Mustard–plant specimen, seeds; tests for fats in crushed seeds.
5. **Essential oil-yielding plants:** Habit sketch of *Rosa* and *Eucalyptus* (Specimen / Photograph)
6. **Rubber:** specimen, photograph/model of tapping, samples of rubber products.
7. **Drug-yielding plants:** Specimens of *Strychnos* seed, *Justicia adhatoda* leaf, Ginger rhizome – Organoleptic study microscopic features.
8. **Wood:** *Tectona*, *Pinus*: Specimen, Section of young stem.
9. **Fibre-yielding plants:** Cotton (specimen, whole mount of seed to show lint and fuzz; whole Mount of fiber and test for cellulose).

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.

3.13 Core T7: Genetics

(Theory: Lecture 60/Credits 4/Marks 25)

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

Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles (ABO blood groups & Rh-alleles), Lethal alleles, Epistasis (Dominant & Recessive), Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance (Kernel colour in wheat & ear size in maize).

Unit 2: Extrachromosomal Inheritance (6 lectures)

Chloroplast inheritance in *Mirabilis jalapa* plant; Mitochondrial inheritance 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; Numerical 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 (UV-ray, X-ray, Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: CIB method. Role of Transposons in mutation, DNA repair mechanisms.

Unit 6: Fine structure of gene (6 lectures)

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

Unit 6. Population and Evolutionary Genetics (6 lectures)

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



3.14 Core P7: Genetics

List of Practical (Marks 15/Credits 2)

1. Meiosis through temporary squash preparation.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
3. Chromosome mapping using point test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex linked traits.
5. Incomplete dominance and gene interaction through seed ratios (9:7, 12:3:1).
6. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
7. Photographs/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.

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.
5. Ajoy, Pal. Text Book of Genetics – from Genes to Genomes, Books And Allied (P) Ltd., Kolkata.



Semester-IV

3.15 Core T8: Molecular Biology

(Theory : Lecture 60/Credits 4/Marks 25)

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

Historical perspective; Nucleic Acids as the carrier of genetic information (DNA -Griffith's, Hershey & Chase, RNA -Fraenkel-Conrat's experiment)

Unit 2: The Structures of DNA and RNA / Genetic Material (10 lectures)

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

Unit 2: The replication of DNA (10 lectures)

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

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

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

Unit 4: Transcription (18 lectures)

Transcription in prokaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli*. Gene silencing.

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

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

Unit 6: Translation (8 lectures)



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

3.16 Core P8: Molecular Biology

List of Practical (Marks 15/Credits 2)

1. Preparation of LB medium and raising *E. Coli*.
2. Demonstration of isolation of genomic DNA from *E. Coli*.
3. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
4. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
5. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
6. Photographs establishing nucleic acid as genetic material (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.
6. Ajoy, Pal. Text Book of Cell and Molecular Biology, Books And Allied (P) Ltd., Kolkata.

3.17 Core T9: Plant Ecology and Phytogeography

(Theory: Lecture 60 /Credits 4/Marks 25)

Unit 1: Introduction (4 lectures)



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

Unit 2: Soil (8 lectures)

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

Unit 3: Water (4 lectures)

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

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

Variations; adaptations of plants to their variation.

Unit 5: Biotic interactions (2 lectures)

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

Unit 6: Population ecology (4 lectures)

Characteristics and Dynamics .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; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.

Unit 9: Functional aspects of ecosystem (8 lectures)

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

Unit 10: Phytogeography (12 lectures)

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

3.18 Core P9: Plant Ecology and Phytogeography

List of Practical (Marks 15/Credits 2)

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 and pH paper)



3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
7. Ecological adaptations of some species: *Ipomoea aquatica* stem, Phyllode of *Acaccia auriculiformis*, *Nerium* leaf and *Vanda* root.
8. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
9. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
10. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
11. Field visit to 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.

3.19 Core T10: Plant Systematics

(Theory: Lecture 60/Credits 4/Marks 25)

Unit 1: Significance of Plant systematics (10 lectures)

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

Unit 2: Taxonomic hierarchy (4 lectures)

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

Unit 3: Botanical nomenclature (8 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 (10 lectures)



Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Takhtajan, 1997; Brief reference of Angiosperm Phylogeny Group (APG III) classification.

Unit 5: Biometrics, numerical taxonomy and cladistics (8 lectures)

Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).

Unit 6: Phylogeny of Angiosperms (10 lectures)

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

Unit 7: Salient features of the following families [Evolutionary trends need to be briefly discussed in case of families marked with astericks] (10 Lectures)

Dicotyledons: Magnoliaceae*, Malvaceae, Brassicaceae, Fabaceae, Euphorbiaceae, Apiaceae, Apocynaceae, Asclepiadaceae, Solanaceae, Scrophulariaceae, Lamiaceae, Verbenaceae, Acanthaceae, Amaranthaceae, Sterculiaceae, Rubiaceae, Cucurbitaceae, Asteraceae*.
Monocotyledons: Alismataceae*, Liliaceae, Poaceae, Musaceae, Orchidaceae*.

3.20 Core P10: Plant Systematics

List of Practical (Marks 15/Credits 2)

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, Section of ovary, floral diagram/s, floral formula/e and identification upto genus following published keys – Bengal Plants by David Prain 1903):

Families: Brassicaceae, Malvaceae, Fabaceae, Apiaceae, Apocynaceae, Asclepiadaceae, Asteraceae, Solanaceae, Scrophulariaceae, Lamiaceae, Verbenaceae, Acanthaceae, Rubiaceae, Cucurbitaceae, Euphorbiaceae, Poaceae, Orchidaceae

2. Field visit (local) – Excursion/Field trips are to be organized in botanically rich areas. A field report with photographic document of plants (atleast 20) and corresponding field record to be submitted during practical examination.

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

Suggested Readings

1. Singh, (2012). *Plant Systematics: Theory and Practice* Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.



2. Jeffrey, C. (1982). An Introduction to *Plant Taxonomy*. Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). *Plant Systematics-A Phylogenetic Approach*. Sinauer Associates Inc., U.S.A. 2nd edition.
4. Maheshwari, J.K. (1963). *Flora of Delhi*. CSIR, New Delhi.
5. Radford, A.E. (1986). *Fundamentals of Plant Systematics*. Harper and Row, New York.

Semester-V

3.21 CoreT11: Reproductive Biology of Angiosperms

(Theory: Lecture 60/Credits 4/Marks 25)

Unit 1: Introduction (4 lectures)

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

Unit 2: Reproductive development (6 lectures)

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

Unit 3: Anther and pollen biology (10 lectures)

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

Unit 4: Ovule (10 lectures)

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

Unit 4: Pollination and fertilization (6 lectures)

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

Unit 5: Self incompatibility (10 lectures)

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

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



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

Units 7: Polyembryony and apomixis (6 lectures)

Introduction; Classification; Causes and applications.

3.22 Core P11: Reproductive Biology of Angiosperms

List of Practical: (Marks 15/Credits 2)

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehiscent anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, pseudomonads, polyads, pollinia (slides/photographs, fresh material), ultrastructure of pollen wall (micrograph); Pollen viability: Tetrazolium test. germination: Calculation of percentage germination in different media using hanging drop method.
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. Intra-ovarian pollination; Test tube pollination through photographs.
6. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
7. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

Suggested Readings

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 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. (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

3.23 Core T12: Plant Physiology



(Theory: Lecture 60/Credits 4/ Marks 25)

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)

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

Unit 6: Physiology of flowering (6 lectures)

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

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

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

3.24 Core P12: Plant Physiology

List of Practical (Marks 15/Credits 2)

1. Determination of isotonic concentration and osmotic pressure 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 humidity and light on the rate of transpiration in excised twig/leaf.
4. Determination of water absorption, retention and transpiration.
5. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
6. To study the phenomenon of seed germination (effect of light).



7. To study the effect of different concentrations of IAA on *Avena* coleoptile elongation (IAA Bioassay).
8. To study the induction of amylase activity in germinating barley grains.

Demonstration experiments

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

3.25 Core T13: Plant Metabolism

(Theory: Lecture 60/Credits 4/Marks 25)

Unit 1: Concept of metabolism (6 lectures)

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

Unit 2: Carbon assimilation (14 lectures)

Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO₂ reduction, photorespiration, C₄ pathways; Crassulacean acid metabolism; Factors affecting CO₂ 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, Boyers conformational model

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; Second messenger concept, Calcium calmodulin, MAP kinase cascade.

3.26 Core P13: Plant Metabolism

List of Practical (Marks 15/Credits 2)

1. Preparation of molar, molal & normal solution.
2. Chromatographic separation of photosynthetic pigments.
3. Experimental demonstration of Hill's reaction.
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. RQ of different respiratory substrate of germinating seeds.
8. Seed Viability Test by TTC.
9. Demonstration of absorption spectrum of photosynthetic pigments.

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 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.

3.27 Core T14 : Plant Biotechnology

(Theory: Lecture 60/Credits 4/Marks 25)

Unit 1: Plant Tissue Culture (16 lectures)

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

Unit 2: Recombinant DNA technology (12 lectures)



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

Unit 3: Gene Cloning (10 lectures)

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

Unit 4: Methods of gene transfer (8 lectures)

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

Unit 5: Applications of Biotechnology (14 lectures)

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

3.28 Core P14: Plant Biotechnology

List of Practical (Marks 15/Credits 2)

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

Suggested Readings

- 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.

4. Discipline Specific Elective Courses



4.1 DSE T1- Stress Biology

(Theory: Lecture 60/Credits 4/Marks 25)

Unit 1: Defining plant stress (2 lectures)

Acclimation and adaptation.

Unit 2: Environmental factors (20 lectures)

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

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

Calcium modulation, Phospholipid signaling

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

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

Unit 5: Reactive oxygen species–Production and scavenging mechanisms. (6 lectures)

4.2 DSE P1 –Stress Biology

(Practical: Marks 15/Credits 2)

List of Practical

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

**Suggested Readings**

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

4.3 DSE T2: Plant Breeding

(Theory: Lecture 60 /Credits 6/Marks 40)

Unit 1: Plant Breeding (10 lectures)

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

Unit 2: Methods of crop improvement (20 lectures)

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

Unit 3: Quantitative inheritance (10 lectures)

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

Unit 4: Inbreeding depression and heterosis (10 lectures)

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

Unit 5: Crop improvement and breeding (10 lectures)

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

Suggested Readings

1. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition. 52
3. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.



4.4 DSE T3: Natural Resource Management

(Theory: Lecture 60/Credits 4/Marks 25)

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.

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

4.5 DSE P3: Natural Resource Management



(Practical: Marks 15/Credits 2)

List of Practical

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

Suggested Readings

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

4.6 DSE T4: Horticultural practices & Post Harvest Technology

(Theory: Lecture 60 /Credits 6/Marks 40)

Unit 1: Introduction (4 lectures)

Scope of Horticulture, Branches of horticulture; Role in economy, Scope of employment generation; Importance in food and nutritional security; Commercial Horticulture: Urban horticulture and ecotourism.

Unit 2: Ornamental plants (4 lectures)

Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental annuals - marigold, carnations, poppies, Petunias, Pansies, Impatiens, Identification and salient features of some ornamental perennials - Rose, Gladiolus, Orchids, Gerberas, Tuberose, Chrysanthemum, Cacti and Succulents (Opuntia, Agave and Spurges), Croton. Identification and salient features of some ornamental flowering climbers – Ipomoeas, *Quisqualis indica*, *Pyrostegia venusta*, *Aganosma caryophyllata*, Bignonias.

Identification and salient features of some ornamental flowering trees - Indian Laburnum (*Cassia fistula*), Gulmohar (*Delonix regia*), Jacaranda, Lagerstroemia, Fishtail (*Caryota urens*) and areca palms, Semul (*Bombax ceiba*), Coraltree (*Erythrina variegata*), Palash (*Butea monosperma*).

**Unit 3: Fruit and vegetable crops (4 lectures)**

Production, origin and distribution of major fruits – Apple, Banana, Orange, Lemon, Grapes, Mango, Watermelon, Litchi, Pomegranate, Pineapple, Guava, Papaya; Production, origin and distribution of major vegetables – Crucifers, Potato, Chillies, Carrot, Radish, Peas, Gourds, Cucumber, Lady's finger, Onion, Tomato, Pumpkin, Beans, Brinjal, Spinach. Description of plants and their economic products of the above mentioned fruits and vegetables. Management and marketing of vegetable and fruit crops; Identification of some fruits and vegetable varieties (citrus, banana, mango, Oranges, Chillies, Crucifers, Beans and Cucurbits).

Unit 4: Horticultural techniques (8 lectures)

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

Unit 5: Landscaping and garden design (6 lectures)

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

Unit 6: Floriculture (6 lectures)

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

Unit 7: Post-harvest technology (10 lectures)

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

Unit 8: Disease control and management (8 lectures)

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

Unit 9: Horticultural crops - conservation and management (10 lectures)

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

Unit 10: Field trip



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

Suggested Readings

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

4.8 DSE T5: Research Methodology

(Theory: Lecture 60 /Credits 4/Marks 25)

Unit 1: Basic concepts of research (10 lectures)

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

Unit 2: General laboratory practices (12 lectures)

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

Unit 3: Data collection and documentation of observations (6 lectures)

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

Unit 4: Overview of Biological Problems (6 lectures)

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

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



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

Unit 6: Plant microtechniques (12 lectures)

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

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

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

4.9 DSE P5: Research Methodology

(Practical: Marks 15/Credits 2)

List of Practical

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

Suggested Readings

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

4.10 DSE T6: Industrial & Environmental Microbiology

(Theory: Lecture 60 /Credits 4/Marks 25)

**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.

4.11 DSE P6: Industrial & Environmental Microbiology**(Practical: Marks 15/Credits 2)****List of 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.

4.12 DSE T7: Biostatistics

(Theory: Lecture 60 /Credits 4/Marks 25)

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.

4.13 DSE P7: Biostatistics

(Practical: Marks 15/Credits 2)

List of Practical

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

Suggested Readings



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

5. Skill Enhancement Courses



5.1 SEC T1: Biofertilisers

(Theory : Lecture 30/ Credits 2/Marks 40)

Unit 1: (4 lectures)

General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

Unit 2: (8 lectures)

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.

Unit 3: (4 lectures)

Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation

Unit 4: (8 lectures)

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.

Unit 5: (6 lectures)

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.

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, NewDelhi.
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

5.2 SEC T2: Herbal Technology

(Theory: Lecture 30/ Credits 2/Marks 40)

Unit 1: (6 Lectures)

Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants.

Unit 2: (6 Lectures)

Pharmacognosy - systematic position m edicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka.

Unit 3: (6 Lectures)

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

Unit 4: (8 Lectures)

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

Unit 5: (4 Lectures)

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

Suggested Readings

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book _Distributors.
3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.



4. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.
5. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
6. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
7. Pharmacognosy, Dr.C.K.Kokate et al. 1999. Nirali Prakashan.

5.3 SEC T3: Nursery & Gardening

(Theory: Lecture 30/ Credits 2/Marks 40)

Unit 1: (4 Lectures)

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

Unit 2: (6 Lectures)

Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion - Seed production technology - seed testing and certification.

Unit 3: (6 Lectures)

Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber, shed root, shade house and glass house.

Unit 4: (8 Lectures)

Gardening: definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components.

Plant materials and design - computer applications in landscaping.

Gardening operations:

Soil preparation and care: soil laying, manuring, watering.

Pest and disease management: Type of pests and disease of garden plants, management of pests and diseases and

Harvesting of crops.

Unit 5: (6 Lectures)

Seed bed: preparation and management. Sowing/raising of seeds and seedlings - Transplanting of seedlings . Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.

Unit 6:

Visit to one local Nursery and one local garden.

**Suggested Readings**

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

5.4 SEC T4: Floriculture

(Theory : Lecture 30/ Credits 2/Marks 40)

Unit 1: (2 Lectures)

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

Unit 2: (8 Lectures)

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

Unit 3: (4 Lectures)

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

Unit 4: (4 Lectures)

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

Unit 5: (4 Lectures)

Landscaping Places of Public Importance: Landscaping highways and Educational institutions.

Unit 6: (6 Lectures)

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

Unit 7: (2 Lectures)

Diseases and Pests of Ornamental Plants.



Suggested Readings

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.
2. S K Bhattacharjee 2010. Advanced Commercial Floriculture. Aavishkar Publishers & Distributors
3. Whale Susan and Follon Mark. 2011. Cut Flowers: A Practical Guide to Their Selection and Care. Jago Publishing Ltd

5.5 SEC T5: Medicinal Botany

(Theory: Lecture 30/ Credits 2/Marks 40)

Unit 1: (8 Lectures)

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.

Unit 2: (8 Lectures)

Definition: endemic and endangered medicinal plants,

Red list criteria; Conservation of endangered and endemic medicinal plants.

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.

Unit 3: (8 Lectures)

Definition; Ethnobotany and Folk medicines.

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.

Unit 4: (6 Lectures)

Study of local medicinal plants with proven medicinal properties: (Parts used and uses only)

1. Neem
2. Tulasi
3. Drumstick (Sorney-Moringa)
4. Fenugreek (Methi)
5. Periwinkle (Vinca)
6. Gooseberry (Amla)
7. Bael (Aegle)
8. Centella (Thankuni)
9. Sweet flag (Bach)
10. Gymnema
11. Cynodon (Durba ghas)
12. Aloe vera
13. Tinospora (Gulanha lata)
14. Ashwagandha



15. Kalmegh 16. Bahera 17. Haritaki

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.

5.6 SEC T6: Plant Diversity & Human Welfare

(Theory: Lecture 30/ Credits 2/Marks 40)

Unit 1: (8 Lectures)

Plant diversity and its scope- Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agrobiodiversity and cultivated plant taxa, wild taxa. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes. Introduction to plant diversity of Bankura district.

Unit 2: (8 Lectures)

Loss of Biodiversity: Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss,

Management of Plant Biodiversity: Organizations associated with biodiversity management- Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations, Biodiversity information management and communication.

Unit 3: (8 Lectures)

Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, *In situ* and *ex situ* conservation, Social approaches to conservation, Biodiversity awareness programmes, Sustainable development.

Unit 4: (6 Lectures)

Role of plants in relation to Human Welfare ; a) Importance of forestry their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. d) Alcoholic beverages through ages. Fruits and nuts: Important fruit crops their commercial importance. Wood and its uses.

Suggested Readings



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

5.7 SEC T7: Ethnobotany

(Theory :Lecture 30/ Credits 2/Marks 40)

Unit 1: Ethnobotany (8 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 (6 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* i) *Solanum surattense*. Role of ethnobotany in modern medicine with special example *Rauwolfia serpentina*, *Trichopus zeylanicus*, *Artemisia*, *Withania*.

Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

Unit 4: Ethnobotany and legal aspects (10 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 ethnobotany. Scientific publishers, Jodhpur.
6. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
7. Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah.
8. Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA – SHREE Publishers, Jaipur-1996
9. Faulks, P.J. 1958. An introduction to Ethnobotany, Moredale pub. Ltd

5.8 SEC T8: Mushroom Culture Technology

(Theory :Lecture 30/ Credits 2/Marks 40)

Unit1: (5 Lectures)

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

Unit2: (12 Lectures)

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. Mushroom weeds and pest and its control.

Unit3: (8 Lectures)

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

Unit4: (5 Lectures)

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

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) Handbook of Mushrooms, II Edition, Vol. I & Vol. II.
5. B. C. Suman and V. P. Sharma (2011): Mushroom cultivation and Uses (Agrobios)
6. V. N. Pathak, N. Yadav and M. Gaur. (2011): Mushroom Production and Processing Technology (Agrobios)
7. Reeti Singh and U. C. Singh (2011): Modern Mushroom cultivation (Agrobios)

6. General Elective Courses



SEMESTER-I

6.1 GE T1: Plant Biodiversity [Microbes, Algae, Fungi, Archegoniate (Bryophyta, Pteridophyta, & Gymnosperm)]

(Theory: Lecture 60/Credits 4/Marks 25)

Unit 1: Microbes (10 lectures, Marks-4)

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, Marks-4)

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, Marks-5)

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, Marks-4)

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, Marks-4)**

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, Marks-4)

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

**6.2 GE P1: Plant Biodiversity [Microbes, Algae, Fungi, Archegoniate
(Bryophyta, Pteridophyta, & Gymnosperm)]**

(Practical: Marks 15/ Credits 2)

List of Practical

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining & simple staining process
4. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), *Oedogonium*, *Oscillatoria*, through temporary preparations and *Fucus* & *Polysiphonia* - Specimen and permanent slides
5. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual Structures through permanent slides.
6. *Alternaria*: Specimens/photographs and tease mounts.
7. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected *Justicia* leaves; section/tease mounts of spores on *Justicia* leaf and permanent slides of different spore forms.
8. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
10. Mycorrhiza: Ecto mycorrhiza and endo mycorrhiza (Photographs)
11. *Marchantia*- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides); v.s. antheridiophore, archegoniophore & l.s. sporophyte (all permanent slides).
12. *Funaria*- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.



13. *Selaginella*- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (from permanent slide).
14. *Pteris*- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
15. *Cycas*- morphology (coralloid roots, bulbil, leaf), t.s. rachis, v.s. leaflet, (temporary slides), l.s. of ovule (permanent slide).
16. *Pinus*- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), t.s. of needle, t.s. stem (temporary slides), l.s./t.s. male cone, w.m. microspores , l.s. female cone, t.l.s. & r.l.s. stem (from 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.

SEMESTER II

6.3 GE T2: Plant Ecology, Morphology & Taxonomy

(Theory: Lecture 60/Credits 4/Marks 25)

Plant Ecology (30 Lectures, Marks-10)

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

Taxonomy (30 Lectures, Marks-15)

Unit 6 Morphology (4 Lectures)

Leaves- Types , Phyllotaxy; Inflorescence – Definition and types; Flower – Different parts; Fruits - Definition and types

Unit 7 Introduction to plant taxonomy (2 lectures)

Identification, Classification, Nomenclature.

Unit 8 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 9: (5 lectures)

Taxonomic evidences from palynology, cytology, phytochemistry and molecular data.

Unit 10 Taxonomic hierarchy (2 lectures)

Ranks, categories and taxonomic groups

Unit 11 Botanical nomenclature (5 lectures)

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

Unit 12 Classification (4 lectures)

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

Unit 13 (4 Lectures)

General characters and economic importance of the following families (range of floral structure excluded): Magnoliaceae, Brassicaceae, Malvaceae, Euphorbiaceae, Fabaceae, Apocynaceae, Lamiaceae, Solanaceae, Rubiaceae, Asteraceae, Poaceae, Orchidaceae



6.4 GE P2: Plant Ecology & Taxonomy

(Practical: Marks 15/Credits 2)

Plant Ecology (Marks-6)

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.
4. Ecological adaptations of some species: *Ipomoea aquatica* stem, *Nerium* leaf and *Vanda* root.
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.

Taxonomy (Marks-9)

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, Asteraceae, Solanaceae, Lamiaceae, Malvaceae, Rubiaceae, Fabaceae, Apocynaceae, Acanthaceae, Verbenaceae.
8. Field visit (local) – Excursion/Field trips are to be organized in Botanically rich areas. A field report with photographic document of plants (atleast 10) and corresponding field record to be submitted during practical examination
9. Mounting of a properly dried and pressed specimen of any one wild plant with herbarium label (to be submitted in the record book).

Suggested Readings



1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 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.

6.5 GE T3: Plant Anatomy & Embryology

(Theory: Lecture 60 /Credits 4/Marks 25)

Plant Anatomy (Marks-13)

Unit 1: Meristematic and permanent tissues (8 lectures)

Root and shoot apical meristems; Simple and complex tissues, Tissue Systems.

Unit 2: Organs (4 lectures)

Structure of dicot and monocot root stem and leaf.

Unit 3: Secondary Growth (8 lectures)

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

Unit 4: Adaptive and protective systems (8 lectures)

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

Embryology (Marks-12)

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

6.6 GE P3: Plant Anatomy & Embryology**(Practical: Marks 15/Credits 2)****List of Practical****Plant Anatomy (Marks-10)**

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).

Embryology (Marks-5)

7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ Campylotropous (from permanent slide).
9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Pollen morphology: Impatiens, Hibiscus (from permanent slide)
11. Dissection of embryo/endosperm from developing seeds.
12. 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.



SEMESTER III

6.7 GE T4: - Genetics and Plant Breeding

(Theory :- Lectures: 60 / Credits 4/ Marks 25)

Unit 1: Heredity (20 Lectures)

1. Brief life history of Mendel
2. Terminologies
3. Laws of Inheritance
4. Modified Mendelian Ratios: 1:2:1- Co- dominance, incomplete dominance; 9:7; 12:3:1.
5. Chi Square
6. Multiple allelism
7. Chromosome theory of Inheritance.

Unit 2: Sex-determination and Sex-linked Inheritance

(4 Lectures)

Unit 3: Linkage and Crossing over (8 Lectures)

Linkage: concept & history, complete & incomplete linkage, bridges experiment, coupling & repulsion, recombination frequency, linkage maps based on two and three factor crosses. Crossing over: concept and significance, cytological proof of crossing over.

Unit 4: Mutations and Chromosomal Aberrations (6 Lectures)

Types of mutations, effects of physical & chemical mutagens. Numerical chromosomal changes: Euploidy, Polyploidy and Aneuploidy ; Structural chromosomal changes: Deletions, Duplications, Inversions & Translocations.

Unit 5: Plant Breeding (4 lectures)

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

**Unit 6: Methods of crop improvement (10 lectures)**

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

Unit 7: Inbreeding depression and heterosis (4 lectures)

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

Unit 8: Crop improvement and breeding (4 lectures)

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

6.8 GE P4: Genetics and Plant Breeding

(Practical :- Credits 2 / Marks 15)

List of Practical

1. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
2. Incomplete dominance and gene interaction through seed ratios (9:7, 12:3:1,).
3. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes through photographs.
4. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
5. Hybridization techniques - Emasculation, Bagging (For demonstration only).
6. Induction of polyploidy conditions in plants (For demonstration only).

Suggested Readings

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley- India.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, 5th edition, John Wiley & Sons Inc., India,
3. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
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.
5. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
6. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
7. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition.
8. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

6.9 GE T5: Cell and Molecular Biology



(Theory :- Lectures: 60 / Credits 4/ Marks 25)

Unit 1: Techniques in Biology (8 Lectures)

Principles of microscopy; Light Microscopy; Phase contrast microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM);

2: Cell as a unit of Life (2 Lectures)

The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components.

Unit 3: Cell Organelles (20 Lectures)

Mitochondria: Structure, Semiautonomous nature; Symbiont hypothesis; mitochondrial DNA. Chloroplast Structure, semiautonomous nature, chloroplast DNA. ER, Golgi body & Lysosomes: Nucleus: Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief).

Unit 4: Cell Membrane and Cell Wall (6 Lectures)

The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall.

Unit 5: Cell Cycle (4 Lectures)

Overview of Cell cycle, Mitosis and Meiosis; Molecular controls.

Unit 6: Genetic material (8 Lectures)

DNA: Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material. DNA replication (Prokaryotes): bidirectional replication, semi-conservative, semi discontinuous, RNA priming, replication of linear, ds- DNA, replicating the 5 end of linear chromosome including replication enzymes.

Unit 7: Transcription (Prokaryotes and Eukaryotes) (8 Lectures)

Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation (Prokaryotes and eukaryotes), genetic code.

Unit 8: Regulation of gene expression (4 Lectures)

Prokaryotes: Lac operon Concept.

6.10 GE P5: Cell and Molecular Biology



(Practical :- Credits 2 / Marks 15)

List of Practical

1. To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs.
2. Study of the photomicrographs of cell organelles
3. To study the structure of plant cell through temporary mounts.
4. Study of mitosis and meiosis (temporary mounts and permanent slides).
5. Study of plasmolysis and deplasmolysis on *Rhoeo* leaf.
6. Study the structure of nuclear pore complex by photograph (from Gerald Karp) Study of special chromosomes (polytene & lampbrush) either by slides or photographs.
7. Study DNA packaging by micrographs.

Suggested Readings

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. 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 IV

6.11 GE T6: Plant Physiology & Metabolism

(Theory: Lecture 60 /Credits 4/Marks 25)

Unit 1: Plant-water relations (8 lectures)

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

Unit 2: Mineral nutrition (8 lectures)

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

Unit 3: Translocation in phloem. (6 lectures)

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

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

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

Unit 5: Respiration (6 lectures)

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

Unit 6: Enzymes (4 lectures)

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

Unit 7: Nitrogen metabolism (4 lectures)

Biological nitrogen fixation; Nitrate and ammonia assimilation.

Unit 8: Plant growth regulators (6 lectures)

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

Unit 9: Plant response to light and temperature (6 lectures)

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

6.12 GE P6: Plant Physiology & Metabolism

(Practical: Marks 15/Credits 2)

Practical

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and humidity) 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. To study the effect of light intensity and bicarbonate concentration on O₂ evolution in photosynthesis.
6. Comparison of the rate of respiration in any two parts of a plant.

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

3. 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.

6.13 GE T7: Economic Botany & Plant Biotechnology

(Theory: Lecture 60 /Credits 4/Marks 25)

Economic Botany (Marks-15)

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

Unit 4: Spices (6 lectures)

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

Unit 5: Beverages (4 lectures)

Tea (morphology, processing, uses)

Unit 6: Oils and Fats (4 lectures)

General description with special reference to groundnut

Unit 7: Fibre Yielding Plants (4 lectures)

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

Plant Biotechnology (Marks-15)

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.

6.14 GE P7: Economic Botany & Plant Biotechnology

(Practical: Marks 15/Credits 2)

List of 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.