

**PUNYASHLOK AHILYADEVJI HOLKAR  
SOLAPUR UNIVERSITY, SOLAPUR.**



**M.Sc. Part- II (Botany)**

**Revised Syllabus (CBCS pattern)**

**To be implemented from June 2021**

**M. Sc. II-Botany C B C S w.e.f.2021 (REVISED) Semester III**

	Code	Title of the paper	Semester Exam			L	P	Credits
<b>Semester III</b>								
<b>BOT</b>		Hard Core	UA	CA	Total			
	HCT 3.1	Plant Embryology and palynology	80	20	100	4		4
	HCT 3.2	Cytogenetics and CropImprovement	80	20	100	4		4
		Soft Core (Any one)						
	SCT 3.1	Advances in Plant metabolism and Biochemistry	80	20	100	4		4
	SCT 3.2	Angiosperm Systematics	80	20	100	4		4
	SCT 3.3	Environmental Biotechnology	80	20	100	4		4
	SCT 3.4	Horticulture practices and Post harvest technology	80	20	100	4		4
		Open Elective (Any one)						
	OET 3.1	Plant growth and Development	80	20	100	4		4
	OET 3.2	Herbal and Drug technology	80	20	100	4		4
	OET 3.3	Herbal Technology	80	20	100	4		4
		HOME ASSIGNMENT			25			1
		Hard Core						
	HCP 3.1	Practical course HCP 3.1	40	10	50		2	2
	HCP 3.2	Practical course HCP 3.2	40	10	50		2	2
		Soft Core (Any one)						
	SCP 3.1	Practical course SCP 3.1	40	10	50		2	2
	SCP 3.2	Practical course SCP 3.2	40	10	50		2	2
	SCP 3.3	Practical course SCP 3.3	40	10	50		2	2
	SCP 3.4	Practical course SCP 3.4	40	10	50		2	2
		Open Elective (Any one)						
	OEP 3.1	Practical course OEP 3.1	40	10	50		2	2
	OEP 3.2	Practical course OEP 3.2	40	10	50		2	2
	OEP 3.3.	Practical course OEP 3.3						
		Add-on /selflearning/MOOC/SWAAM/skill development course run by College/University/internship/ apperntiship						04
		Add on course: Herbal Technology	80	20	100			04
		Ad on Course: Bioinstrumentation	80	20	100			04
		Total for Semester III	480	120	625			29
<b>SEMESTER IV</b>								
<b>BOT</b>		Hard core	UA	CA	Total			
	HCT 4.1	Phytogeography and conservation biology	80	20	100	4		4

	HCT 4.2	Plant tissue culture Greenhouse technology and hydroponics	80	20	100	4		4
	SCT 4.1	Environmental Plant Physiology	80	20	100	4		4
	SCT 4.2	Modern trends in Angiosperm Taxonomy	80	20	100	4		4
	OET 4.1	Crop Physiology	80	20	100	4		4
	OET 4.2	Industrial Botany	80	20	100	4		4
	OET 4.3	Stress Biology	80	20	100	4		4
		Tutorial			25			1
	MP 4.1	Project Work / Industrial Training	140	60	200			8

		Total	460	140	625			25
								104

**M.Sc. II Botany**  
**Semester-III**  
**HCT 3.1 Plant Embryology and Palynology**  
**Lectures-60 (Credits: 4)**

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**Unit-1:** **15L**

**Embryology:**

**Gametophytes in Angiosperms-** Brief outline of development of Male and Female Gametophyte. **Ultra structure of Male Gametophyte-** Vegetative Cell, Generative Cell, Pollen Wall, Pollen Tube; Abnormal Male Gametophytes and their Features.

**Ultra structures of Female Gametophyte-** Synergids, Egg, Antipodals, Central Cell.

**Pollen- Pistil Interaction and Control of Fertilization-** Structure of Stigma and Style, Pollen Tube Growth, Chemotropism, Incompatibility, Pollen Wall Proteins, Stigma Surface Proteins, Post Pollination Events, Fertilization, Methods to Overcome Incompatibility, Significance of Pollen Pistil Interaction.

**Unit-2:** **15L**

**Experimental Embryology-** Techniques for Anther, Ovary, Nucellus, Endosperm, and Embryo Culture and their Significance.

**Apomixis-** Diplospory, Apospory, Causes, Consequences and Significance of Apomixes.

**Polyembryony-** Classification, Causes, Experimental Induction and Practical importance

**Unit-3:**

**Palynology:** **10L**

**Palynology-** Scope and Branches with Special Reference to:-

**Palynotaxonomy-** Pollen Morphology and Plant Taxonomy with reference to Gymnosperms and Angiosperms.

**Melittopalynology-** Bee colony, foraging behavior of bees, unifloral & Multifloral honey, application in crop productivity,

**Applications of palynology** in taxonomy, Pollen banks and their role in agriculture and plant breeding, Methodology in forensic study: potential pollen/spore forensic sample collections pollen preservation and controlling factors, Pollen-expressed and pollen specific genes.

**Unit 4:- Aeropalynology** **10L**

Principles, techniques, pollen analysis, pollen and spore Allergy, plants causing pollen allergy, allergic properties of pollen, pollen calendar and importance

**Unit: 5:-Palaeopalynology** **10L**

Principles, microfossil recovery, theory and techniques, Microfossils and oil exploration.

**Agropalynology-** Pollen storage, viability and pollen germination and their Significance.

### Practical Course HCP 3.1

1. Study of Development and Ultra structure of Male Gametophyte with the help of Slides and Microphotographs.
2. Study of Development and Ultra structure of Female Gametophyte with the help of Slides and Microphotographs.
3. Study of types of styles - Solid, Hollow, Filamentous. Types of Stigmas- Dry and Wet Stigmas and their sub types.
4. Study of new apomicts (any two) and polyembryony.
5. Study of different types of embryos (monophonic, bisporic and tetrasporic).
6. Pollen germination *in situ* condition.
7. Determination of Pollen Germination Percentage in Vitro conditions.
8. Study of Pollen Morphotypes and their significance in Taxonomy. (at least six examples)
9. Honey Analysis. (Unifloral and multifloral).
10. Study of Allergic Plants and their Pollens.
11. Study of Pollen Fertility by TTC or Acetocarmine Methods.
12. Intra –ovarian pollination; Test tube pollination through photographs.

#### Reference:

#### Embryology and Palynology

- Bhojawani, S.S. And S.P. Bhatnagar, 1998. The Embryology of Angiosperms.
- Johri, M.B. 1984. Embryology of Angiosperms.
- Maheshwari, P. 1950. An Introduction to the Embryology of Angiosperms.
- Maheshwari, P. 1963. Recent Advances in the Embryology of Vascular Plants.
- Johri, B.M. 1963. Experimental Embryology of Vascular Plants.
- Shivanna, K.R. And B.M.Johri, 1989. The Angiosperm Pollen; Structure and Function.
- Stanley, R.G & F.L. Linkens, 1974. Pollen; : Biology, Biochemistry Management
- Shivanna K.R. and N. S. Rangaswamy, 1992. Pollen Biology, a Laboratory Manual.
- Cunningham, D.D.1873. Microscopic Examination of Air.
- Erdtman, G. 1988. Pollen Morphology and Plant Taxonomy.
- Fageri, K. And J. Inversen, 1964. Text Book of Pollen Analysis.
- Gregory, P.H. 1973. Microbiology of Atmosphere.
- Heslop-Harrison, Y.1971. Pollen Development and Physiology.
- Moor, P.D. et.al. 1989. Pollen Analysis.
- Nair P.K.K.1996. Essentials of Palynology.
- Nair P.K.K. 1964 Advances In Palynology.
- Tilak, S.T.1989. Airborne Pollen and Fungal Spores.
- Malik C.P Physiology of sexual reproduction in flowering plants.
- Mulcamy D.L. *et.al*, Biotechnology and ecology of pollen.
- Davis, G.L Systematic embryology of angiosperms.
- Nair, P.K. Recent advances in pollen spore research vol I, II and III.
- Raghavan, V. Experimental embryogenesis in vascular plants.

**M.Sc. II Botany Semester-III**  
**HCT 3.2 Cytogenetics and Plant improvement Lectures-60 (Credits: 4)**

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**Unit 1: Genome organization in prokaryotes and eukaryotes**

**15L**

size and structure of genome in viruses, plasmids, bacteria, yeast and higher organisms. Variation in genome size and its organization in prokaryotes, eukaryotes and organelles. Architectural differences of the genome.

**Organization of gene in prokaryotes and eukaryotes-** structure and organization of the gene in plasmid, viruses, bacteria and eukaryotes. Gene conversion, amplification, mobile genetic elements and their significance. Gene families.

**Unit 2: Genetic Recombination and Genetic Mapping-**

**15L**

Independent Assortment and Crossing Over, Recombination, Molecular Mechanism of Recombination, Role of Rec A and Rec B,C,D Enzymes. Proteins Involved in Eukaryotic Recombination, Recombination Nodules, Site Specific Recombination, Chromosome Mapping, Linkage Groups, Genetic Markers-Conventional and Molecular Markers Used in Construction of Molecular Maps. Correlation of Genetic and physical maps, somatic cell genetic-an alternative approach to gene mapping.

**Unit 3: Modern methods of plant breeding**

**10L**

Somaclonal variations, Somatic hybridization-protoplast isolation, fusion and regeneration, hybrids. Hybridoma technology.

**Unit 4: IPR (Intellectual property right)**

**05L**

Domains of IPR Copyright, Trade Mark, Trade Secret, Patent concept, importance, ecological risk and ethical concerns application form for patenting

**Unit 5: Bioinformatics**

**15L**

Introduction to Bioinformatics.

Use of bioinformatics in major research areas

Major Bioinformatics Resources on Internet: National Centre for Biotechnology Information (NCBI)

The knowledge of various databases and bioinformatics tools available at NCBI resource

The major content of the NCBI databases

Purpose and applications in life sciences

Protein data bank (PDB) and Nucleic acid sequence database (Gene Bank)

The Basic Local Alignment Search Tool (BLAST)

## Practical Course HCP 3.2

1. Karyotype analysis in any two plant species.
2. Banding Studies-“O” Banding in *Allium cepa*.
3. Separation of DNA by Gel electrophoresis / Estimation of DNA
4. Meiotic Studies in Structural Hybrids.
- 5&6. Genetic Problems on Mapping of the Genes in Higher Organisms.
7. Study of methods of Genes transfer through photographs – physical, chemical and Biological.
8. Study of steps of genetic engineering for production of BT-Cotton, Golden Rice Flavr savr Tomato through photographs .
9. Practical based on IPR – Procedural information about patenting .
10. Practical based on bioinformatics
- 11&12. Protoplast Isolation, viability testing, Fusion, and Regeneration

### Reference Books

- Benjamin Lewin- Genes -VIII  
James Darnell, Harvey Lodish and David Baltimore- Molecular Cell Biology.  
Albert et.al.-Cell Molecular Biology.  
C.J.Avers-Genetics.  
Strickberger- Genetics.  
E.J.Gardner- Principles of Genetics.  
J. Jahier- Techniques of Plant Cytogenetic.  
Sharma A.K. & Sharma A – Chromosome: Theory and Practice.  
Genetics – P.K.Gupta 2010  
Genetics classical to modern - – P. K. Gupta 2008  
Genetics – Verma and Agrawal -2008  
Cytogenetics evolution biostatistics and Plant Breeding – Shukla and Chandel  
Cell Biology, Genetics, Molecular biology ,evolution and ecology – Verma and Agrawal 2008  
The world of cell – Backer and Klein Smith (Pearson publication)  
Biotechnology - Satyanarayana.  
Biotechnology –R.C.Dubey  
Biotechnology – P. K. Gupta.



**M.Sc. II Botany Semester-III**  
**SCT 3.1 Advanced Plant Physiology and Biochemistry**  
**Lectures-60 (Credits: 4)**

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<b>Unit: 1 Integration of major metabolic pathways in plants, an overview</b>	<b>2L</b>
<b>Unit: 2 Photosynthesis</b>	<b>13L</b>
Ultrastructure of chloroplast and light harvesting complexes, Energy transduction in photosynthesis, photosynthetic electron transport, ATP synthesis, photosynthetic pathway C3, C4 and CAM and their subgroups, C3 & C4 intermediates, regulation of Rubisco, PEP case and PCR cycle, photorespiration and its significance, photosynthetic carbon partitioning regulation of sugar and starch, biosynthesis	
<b>Unit: 3</b>	<b>15L</b>
Respiration – regulation of glycolysis, pentose phosphate pathway and TCA cycle, modern concept of electron transport chain in plant mitochondria, alternate oxidase, respiratory inhibitors, Gluconeogenesis. Organic acid metabolism – metabolism and role of malic acid, oxalic acid and ascorbic acid.	
<b>Unit: 4 Secondary metabolism</b>	<b>15L</b>
Photosynthetic carbon partitioning, overview of Secondary metabolism and Secondary metabolites shikimic acid pathway, biosynthesis of aromatic amino acids.	
<b>Unit: 5 Phosphorus metabolism</b>	<b>15L</b>
Forms of phosphate in soil and plants, mechanism of P uptake, factors controlling P uptake, role of pyrophosphates in plant metabolism. Vam and P nutrition. Sulphur metabolism- Forms of Sulphur in soil and plants, sulphate uptake and reduction, biosynthesis of Sulphur containing amino acids and their role- cysteine, methionine, and glutathione.	

**Practical: SCP 3.1**

- 1 & 2. Estimation of Chlorophylls and Carotenoids, Chl a/ Chl b Ratio and leaf anatomy from C3 and C4 plants.
3. Study of characteristics of CAM plants
4. Measurement of Rate of Respiration (In Germinating Seeds).
5. Study of Enzyme Glycolate Oxidase.
6. Determination of CO<sub>2</sub> Compensation Point.
7. Estimation of Ascorbic Acid.
8. Estimation of Polyphenols.
9. Estimation of Phosphorus in Different Plants Parts.
10. Study of VAM in plants
11. Estimation or detection of Phosphate or Sulphate in Soil
12. Detection and estimation of secondary metabolites.

**References:**

- Sinha S. K. Sane P.V. Bhargava S.C. And Agrawal P.K 1990. Proceedings of International congress of plant physiology vol I & II.
- Smith H. 1975. Phytochrome and Photomorphogenesis.
- Steward F.C. 1976. Growth and Organization in Plants.
- Stumpf P.K. & Conn.E. 1980. The Biochemistry of Plants: A Comprehensive Treatise.
- Tiaz L. And Zieger, F. 1998. Plant Physiology.
- Wilkins M.B. 1976. Physiology of Plant Growth and Development.
- Annual Reviews of Plant Physiology and Molecular Biology.
- Indian Journal of Plant Physiology.
- Journal of Experimental Botany.
- Physiologia Plantarum Sweden.
- Plant Physiology (Bethesda U.S.A)
- Bidwell R.C.S. 1979. Plant physiology.
- Boner J. and Varner J. E. 1976. Plant Biochemistry.
- Edwards G. Walker D.W. 1983. C3-c4 mechanism and cellular environmental regulation of photosynthesis.
- Govindjee 1982. Photosynthesis vol I & II.
- Hopkins W.C. 1995. Introduction to plant physiology.
- Krishnmoorthy H.N. 1992. Physiology of plant growth and development.
- Marschner, H.W. 1986. Mineral nutrition of higher plants.
- Miller P. 1973. Phytochemistry vol I, II & III.
- Moore T.C. 1974. Research experiences in plant physiology, a laboratory manual.
- Mukherjee, S.P. and Ghosh A.N. 1996. Plant physiology.
- Noggle G.R. & G.J. Fritz. 1990. Introductory plant physiology II Ed.
- Randhir Singh & Sawhney S.K. 1988. Advances in frontier areas of Plant Biochemistry. 24 Sadasivan and Manikkam 1996. Plant Biochemical methods.
- 25 Salisbury F.B. & Ross C.W. 1992. Plant physiology IV Ed

**M.Sc. II Botany Semester-III**  
**SCT 3.2 Angiosperm Systematics**  
**Lectures-60 (Credits: 4)**

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**Unit 1:** **15L**

**Systematics:** A key science, important relevance to conservation, sustainable utilization of bio-resources and ecosystem research. Taxonomic structure, Taxonomic hierarchy, species concept category and rank, Evolutionary concept, origin of intra population variation, general biological principles, adaptive radiations.

**Unit 2:** **15L**

Importance and need for classification, hierarchical classification. Criteria used for classification; phases of plant classification. Overview on pre- and post-Darwinian systems of classification.

Artificial systems of classification - Herbalists, Theophrastus, Linnaeus

Natural system of classification - Bentham and Hooker

Phylogenetic systems of classification - Cronquist, Takhtajan

APG system of classification, contributors,

**Unit 3:** **10L**

**Tools of Taxonomy:** Floras, monographs, revisions, websites. Herbarium and Botanical Gardens, their role in teaching, research and conservation, important herbaria and botanic gardens of the World, Botanical Survey of India.

**Floristics:** Need and significance. History of botanical exploration in India and recent works with special emphasis on Maharashtra.

**Morphological** features used in identification. Artificial dichotomous keys

**Biodiversity** types, importance and methods of conservation

**Unit 4:** **10L**

Phytogeographical regions of India, aquatic plants, mangrove plants, terrestrial plants, indigenous plants, exotic plants, resources of wild ornamental plants endemism in Western Ghats, plant exploration, invasion and introduction, seed bank,

**Unit 5:** **10L**

Studies on the following Classes as per Bentham and Hooker's system of classification.

**Dicotyledonae**

Polypetalae: Thalamiflorae, Disciflorae, Calyciflorae

Gamopetalae: Inferae, Heteromerae, bicarpellatae

Monochlamydae: Curvembryae,

**Monocotyledonae**

a. Microspermae b. Epigynae c. Coronariae d. Calycinae e. Nudiflorae f. Apocarrae g. Glumaceae

### **Practicals SCT 3.2:**

1-8. Studies on the following Classes as per Bentham and Hooker's system of classification.

Polypetalae: Thalamiflorae, Disciflorae, Calyciflorae

Gamopetalae: Inferae, Heteromerae, bicarpellatae

Monochlamydae: Curvembryae,

Monocotyledonae

a. Microspermae b. Epigynae c. Coronariae d. Calycinae e. Nudiflorae f. Apocarrae g. Glumaceae

9. Comparative study of morphological and structural adaptations of hydrophytes, mesophytes, xerophytes, halophytes

10. Preparation of key for genus and species

11. Studies on variation between genus of same family

12. Studies on variation between species of same genus

13. Ex-situ conservation methods of biodiversity – through seed, vegetative and micro-propagation methods. (any one plant species per technique)

### **References**

Briggs, David. 2009. Plant microevolution and Conservation in Human-influenced Ecosystems. Cambridge University Press.

Cooke, T. 1903-1908. The Flora of Presidency of Bombay, Vol. I-III.

Cronquist, A. 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York.

Cronquist, A. 1988. The Evolution and Classification of Flowering Plants (2nd ed.) Allen Press, U.S.A.

Hickey, M. and King, C. 2000. The Cambridge Illustrated Glossary of Botanical Terms. Cambridge University Press, UK.

Hutchinson, J. 1959. Families of Flowering plants. Clarendon Press, Oxford.

Jain S.K. and Rao R.R. 1976. Handbook of Field and Herbarium Methods, Today and Tomorrow Publishers, New Delhi.

Jones, S. B. and Luchinger A.E. 1986. Plant Systematics 2nd edn, McGraw Hill Book Co.

Judd Walter S., Campbell, C. S., Kellogg, E. A., Stevens, P.F. and M. J. Donoghue. 2008. Plant Systematics- A Phylogenetic Approach. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.

Kubitzki, K. 1977. Flowering Plants Evolution and Classification of Higher Categories. Plant Systematics – Evolution Supplement I.

Kuijt J. 1969. The biology of parasitic flowering plants. California University Press.

Lawrence, G. H. M. 1951. Taxonomy of Vascular Plants. Oxford and IBH Publ. Co. Pvt. Ltd. New Delhi.

Mabberly, T. J. 2009. The Plant Book 2nd edn Cambridge University Press, Cambridge.

Manilal, K. S. and M. S. Muktesh Kumar [ed.] 1998. A Handbook of Taxonomic Training. DST, New Delhi.

**M.Sc. II Botany Semester-III**  
**SCT 3.3 Environmental Biotechnology**  
**Lectures-60 (Credits: 4)**

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- Unit 1: Environment** **4L**  
Basic concepts and issues, global environmental problems - ozone depletion, UV-B, greenhouse effect and acid rain due to anthropogenic activities, their impact and biotechnological approaches for management.
- Unit 2: Environmental problems** **6L**  
Environmental pollution - types of pollution, sources of pollution, measurement of pollution, methods of measurement of pollution, fate of pollutants in the environment, Bioconcentration, bio/geomagnification.
- Unit 3: Microbiology of waste water treatment** **8L**  
Aerobic process - activated sludge, oxidation ponds, trickling filter, towers, rotating discs, rotating drums, oxidation ditch. Anaerobic process - anaerobic digestion, anaerobic filters, up flow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar and antibiotic industries.
- Unit 4: Xenobiotic compounds** **10L**  
Organic (chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, surfactants) and inorganic (metals, radionuclides, phosphates, nitrates). Bioremediation of xenobiotics in environment - ecological consideration, decay behavior and degradative plasmids, molecular techniques in bioremediation.
- Unit 5: Role of immobilized cells/enzymes in treatment of toxic compounds** **6L**  
Biopesticides, bioreactors, bioleaching, biomining, biosensors, biotechniques for air pollution abatement and odour control.
- Unit 6: Sustainable Development** **8L**  
Economics and Environment: Economic growth, Gross National Productivity and the quality of life, Tragedy of Commons, Economics of Pollution control, Cost-benefit and cost effectiveness analysis, WTO and Environment, Corporate Social Responsibility, Environmental awareness and Education; Environmental Ethics.
- Unit 7: International Legislations, Policies for Environmental Protection** **6L**  
Stockholm Conference (1972) and its declaration, WCED (1983) and Brundtland Report 75 (1987), Rio Earth Summit-UNCED (1992) and its declaration, Montreal Protocol - 1987, Basel Convention (1989), Kyoto Protocol- 1997, Ramsar Convention 1971.
- Unit 8: National Legislations, Policies for Pollution Management** **6L**  
Salient features of Wild life protection act 1972, Water Pollution (Prevention and Control) Act- 1974, Forest conservation act 1980, Air Pollution (Prevention and Control) Act-1981, National Environmental Policy - 2006, Central and State Pollution Control Boards: Constitution and power.
- Unit 9: Public Participation for Environmental Protection** **6L**  
Environmental movement and people's participation with special references to Gandhamardan, Chilika and Narmada Bachao Andolan, Chipko and Silent valley Movement; Women and Environmental Protection, Role of NGO in bringing environmental awareness and education in the society.

**Practical SCT 3.3:**

1-7. Water/Soil analysis - DO, salinity, pH, chloride, total hardness, alkalinity, acidity, nitrate, calcium, Magnesium and phosphorus.

8. Gravimetric analysis-Total solid, dissolved solid, suspended solid in an effluent  
9-12. Microbial assessment of air (open plate and air sample) and water

**References:**

Waste water engineering - treatment, disposal and reuse, Metcalf and Eddy Inc., Tata McGraw Hill, New Delhi.

Environmental Chemistry, A.K. De, Wiley Eastern Ltd, New Delhi.

Introduction to Biodeterioration, D.Allsopp and K.J. Seal, ELBS / Edward Arnold.

Bioremediation, Baker, KH and Herson D.S., 1994. Mc. Graw Hill Inc, New York.

Industrial and Environmental Biotechnology - Nuzhat Ahmed, Fouad M. Qureshi and Obaid Y. Khan, 2006. Horizon Press.

Environmental Molecular Biology, Paul. A, Rochelle, 2001. Horizon Press

Environmental Protection and Laws by Jadhav and Bhosale, V.M. Himalaya publ. House 13.

Biodiversity Assessment and Conservation by PC Trivedi, Agrobios publ.

**M.Sc. II Botany Semester-III**  
**SCT 3.4 Horticultural Practices and Post Harvesting Technology**  
**Lectures-60 (Credits: 4)**

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<b>Unit 1: Introduction</b>	<b>5L</b>
Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism.	
<b>Unit 2: Ornamental plants</b>	<b>10L</b>
Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, <i>Gladiolus</i> , carnations, orchids, poppies, Gerberas, tuberose, sages, cacti and succulents ( <i>Opuntia</i> , <i>Agave</i> and spurge)] Ornamental flowering trees (Indian laburnum, gulmohar, Jacaranda, Lagerstroemia, fishtail and areca palms, semul, coral tree).	
<b>Unit 3: Fruit and vegetable crops</b>	<b>10L</b>
Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops; Identification of some fruits and vegetable varieties (citrus, banana, mango, chillies and cucurbits).	
<b>Unit 4: Horticultural techniques</b>	<b>10L</b>
Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizer, 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.	
<b>Unit 5: Landscaping and garden design</b>	<b>10L</b>
Planning and layout (parks and avenues); gardening traditions-Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.	
<b>Unit 6: Floriculture</b>	<b>10L</b>
Cut flowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions.	

**Practicals: SCP 3.3**

- 1-3. Study of ornamental plants (10 Plants from each group)
- 4-5. Study of fruit and vegetable crop and their varieties
- 6-7. Study of biopesticides and Biofertilizers and their effect on crop plants
- 8-9. Artificial vegetative propagation
10. Study of cut flowers and Bonsai
- 11-12. Visit to Botanical garden, nursery, polyhouse and horticultural plant preservation and processing unit

**References:**

- Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
- Swaminathan, M. S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
- NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
- Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.
- Capon, B. (2010). Botany for Gardeners. 3<sup>rd</sup> Edition. Timber Press, Portland, Oregon.
- Singh S.S. (1988) Crop management under irrigated and Rain fed conditions. Kalyani Publications. New Delhi.
- Swaraj Mandal and Ajit K Basu (2014) Environmental physiology of plants. Campus
- Dwivedi and Dwivedi (2005) Physiology of abiotic stress in plants. AGROBIOS (India)



**M.Sc. II Botany Semester-III**  
**OET 3.1 Plant Growth and development**  
**Lectures-60 (Credits: 4)**

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<b>Unit 1: Growth and Photomorphogenesis</b>	<b>10L</b>
Phytochrome & cryptochrome- discovery, properties, role and mechanism of action.	
<b>Unit 2: Senescence of leaves and petals</b>	<b>10L</b>
Mechanism, biochemical changes and Programmed cell death.	
<b>Unit 3: A brief outline of physiology of seed development &amp; seed germination.</b>	<b>10L</b>
Post harvest physiology- ripening of fruits and its regulation, metabolism of stored seeds and leafy vegetables	
<b>Unit 4: Plant growth regulators-</b>	<b>15L</b>
Plant growth regulators-signalling mechanism of auxin, cytokinin, gibberellin, ABA, ethylene. a brief idea about discovery and possible mechanism of action of triacontanol, Brassinosteroids, salicylic acid, jasmonates, polyamines & morphactins.	
<b>A brief idea about role of growth retardants-</b> CCC, Paclobutrazol, Maleic hydrazide and TIBA	
<b>Unit 5: Secondary messengers and signaling in plants cells.</b>	<b>15L</b>
A brief idea about role of mutants in physiological studies with references to Arabidopsis thaliana .	

**Practicals: OEP 3.1**

1. Comparative growth study of etiolated and light grown seedlings and analysis of Photosynthetic pigments
2. Study of change in nitrate reductase activity during leaf senescence.
- 3 & 4. Hormonal and chemical regulation of leaf and Petal senescence.(Kinetin/ethephon /SA/Kcl/CaCl<sub>2</sub>)
5. Pigment changes during ripening of fruits.
6. Study of enzyme acid phosphates during ripening of fruits.
7. Study of changes in respiration rate during ripening of fruits
8. Effect of different chemical compounds on pollen germination.
9. Effect of various PGRS on seedling growth.
10. Effect of growth retardants on plants.
11. Study of changes in starch & sugars during fruit ripening of Banana / Guava.
12. Study of changes in acidity and TSS (total soluble solids) during grape ripening.

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- Salisbury F.B. & Ross C.W. 1992. Plant physiology IV Ed.
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- Taiz L. And Zieger, F. 1998. Plant Physiology.
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- Annual Reviews of Plant Physiology and Molecular Biology.
- Indian Journal of Plant Physiology.
- Journal of Experimental Botany

**M.Sc. II Botany**  
**Semester-III**  
**Add on Course: Herbal Technology**  
**Lectures-60 (Credits: 4)**

**Total 30L**

**Unit 1: Herbal medicines:** history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; General methods of extraction, isolation and purification of phytoconstituents.

( (10L)

**Unit 2: Pharmacognosy** - systematic position medicinal uses of the following herbs in curing various ailments; tulsi, ginger, fenugreek, Indian Goose berry and ashoka. (10L)

**Unit 3: Phytochemistry** - Phytochemical study Definition, occurrence, chemistry, isolation, estimation and biogenesis of alkaloids, glycosides, plant phenols, resins, terpenes and terpenoids, phospholipids and steroids 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). (15L)

**Unit 4: Methods of Preparation of Extracts:** Principles of extraction and selection of suitable extraction method; Different methods of extraction including maceration, percolation, hot continuous extraction, pilot scale extraction and supercritical fluid extraction with their merits and demerits; Purification and Recovery of Solvents. drug adulteration - types, methods of drug evaluation - biological testing of herbal drugs - phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds) (15)

**Unit 5: Medicinal plant:** micro propagation of important species (*Withania somnifera*, neem and tulsi- herbal foods-future of pharmacognosy) (10 L)

### **Practical**

1. Preparation of Ayurvedic formulation like Asava, Arista
2. General methods of screening of natural products for the following Biological activities. Anti-inflammatory Activity/ Cardiac Activity/ Antibacterial Activity.
3. General methods of screening of natural products In-vitro Antioxidant Activity.
4. Determination of ascorbic acid (vitamin C) by UV spectroscopic method in various herbal formulations.
5. Determination of natural herbal products by UV Spectroscopic method.
6. Preparation of some important extracts by using preliminary Scale Extraction Plant.
7. Isolation and estimation of phytoconstituents by TLC.
8. Phytochemical test for alkaloids, flavonoides, saponines, cardiac glycosides
9. Identification of sugar from plant extracts
10. Industry visits

### **References:**

- Neelesh Malviya, Sapna Malviya Herbal technology 2018, CBS PUB & DIST PVT Limited INDIA  
Shanti Bhushan Mishra 2019, Essentials of Herbal Drug Technology: A Guide of Standardization Quality Control, New Delhi  
Katja Swift, Ryn Midura · 2018 Herbal Medicine for Beginners Callisto Media Incorporated  
Lester Packer, Sissi Wachtel-Galor, Choon Nam Ong · 2004, Herbal & Traditional medicines U.S.A.  
Saikat Sen, Raja Chakraborty · 2019, Herbal Medicine in India: Indigenous Knowledge, Practice, Springer  
M. K. Rai, Geoffrey A. Cordell, Jose L. Martinez · 2012, Medicinal Plants: Biodiversity and Drugs, CRC

Press.New York

C. P. Khare · 2015, Ayurvedic Pharmacopoeial Plant Drugs: Expanded Therapeutics CRC Press.New York

V. V. Sivarajan, Indira Balachandran · 1994, Ayurvedic Drugs and Their Plant Sources,Oxford, IBH publisher

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**M. Sc. II Botany Semester-III**  
**Add-on course Bioinstrumentation**  
**L-60 (Credit-4)**

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<b>Unit I: Introduction, principle, operation and applications of following instruments:</b>	<b>15L</b>
: Colorimeter	
: Spectrophotometer	
: Flame photometry 1.4:	
Unit test on module I	
<b>Unit II: Introduction, principle, operation and applications of Chromatography</b>	<b>15L</b>
2.1: Thin Layer Chromatography	
2.2: HPLC	
: Ion Exchange	
: Unit test on module II	
<b>Unit III: Introduction, principle, operation and applications of following techniques:</b>	<b>15L</b>
: Gel Electrophoresis	
: Polymerase Chain Reaction	
3.3: Gel documentation	
: Unit test on module III	
<b>Unit IV: Introduction, principle, operation and applications of following techniques</b>	<b>15L</b>
: X-ray diffraction	
: Southern blotting	
: Northern Blotting	
: Unit test on module IV	

**Practical's (Add On course Bioinstrumetation)**

- 1) To study working principle of calorimeter and uses in biological analysis.
- 2) To study working principle of spectrophotometer and uses in biological analysis.
- 3) To study working principle of flame photometer and uses in biological analysis.
- 4) To study thin layer chromatography and separate amino acids from plant sample.
- 5) Demonstration of HPLC technique (Virtual mode)
- 6) Demonstration of Ion exchange chromatography (Virtual mode)
- 7) To study principle and demonstration of Gel Electrophoresis.
- 8) Demonstration of PCR technique (Virtual mode)
- 9) Demonstration of Gel documentation ((Virtual mode)
- 10) To study X-ray diffraction.
- 11) Demonstration of Southern blotting technique (Virtual mode)
- 12) Demonstration of Northern blotting technique (Virtual mode).
- 13) Visit at laboratories.

**M.Sc. II Botany Semester- IV**  
**HCT 4.1: Phytogeography and Conservation Biology**  
**Lectures-60 (Credits: 4)**

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**Unit 1: Phytogeography**

**15L**

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

**Unit 2: Biodiversity**

**10L**

Age and area hypothesis, endemism, RET plants, hotspots, Western Ghat vegetation, mangrove vegetation of India

**Unit 3: Ex-situ conservation of biodiversity**

**10L**

Concept, need and methods – polyhouse, seed banks, gene banks, cryopreservation and biotechnology. NBPGR,

**Unit 4: In-situ conservation**

**10L**

Afforestation, Social forestry, Agroforestry, Botanical gardens, Biosphere reserves, National Parks, Sanctuaries, Sacred Groves and Sthalvrikshas.

**Unit 5: Intensification of agriculture and forest policies.**

**15L**

Biological diversity act 2002, forest conservation act, wildlife protection act with recent amendments, international conventions- Washington convention on trade of flora and fauna (1933), international biodiversity year 2010, role of NGO's in conservation of Biodiversity.

**Practicals HCP 4.1**

1. To study field vegetation with respect to stratification, canopy cover and composition.
2. To show hot spots, phytogeographical regions and distribution of endemic plants in the map of India.
3. Study of plants included in agroforestry and social forestry.
4. Study of vegetation analysis by satellite imagery.
5. Visit to NGO's working in the field of conservation.
6. Dispersal of fruits and seeds.
7. Dispersal of seeds.
8. Collection and storage of seeds for seed banks.
9. Mapping of trees with the help of GPS.
10. Study of density of vegetation by quadrat method –agro field.
11. Study of Quantitative estimation of plant biodiversity.
12. Study of wild species suitable for human health and industries.

## References

Nayar M.P.1996. Hot Spots of Endemic Plants of India, Nepal and Bhutan. Tropical Botanical Gardens and Research Institute, Palode, Kerala.

Atmedallah, M. And M.P. Nagar, 1989. Endemic Plants of The Indian Region, Vol I, Botanical Survey of India.

Sunge, Hugh (Ed) 1980. The Biological Aspects of Rare Plant Conservation.

V. P. Agarwal, 1990-Forests in India.

M.P. Singh, S. Chinnamani, R.N. Trivedi-1993-Social Forestry & Environment.

A.P. Dwivedi, 1992. Agroforestry, Principles & Practices.

Mishra & Singh – Flora of India Series- 4, Endemic & Threatened Flowering Plants of Maharashtra.

M.P. Nayar, A.P.R. Sastry (Edited By)- Red Data Book Of India Plants, Vol. 3, BSI Publication

Nayar M.P.1996. Hot Spots of Endemic Plants of India, Nepal and Bhutan. Tropical Botanical Gardens and Research Institute, Palode, Kerala.

Atmedallah, M. And M.P. Nagar, 1989. Endemic Plants of The Indian Region, Vol I, Botanical Survey of India.

Sunge, Hugh (Ed) 1980. The Biological Aspects of Rare Plant Conservation.12 V. P. Agarwal, 1990-Forests in India.

M.P. Singh, S. Chinnamani, R.N. Trivedi-1993-Social Forestry & Environment14 A.P. Dwivedi, 1992. Agroforestry, Principles & Practices.

Mishra & Singh – Flora of India Series- 4, Endemic & Threatened Flowering Plants of Maharashtra.16 M.P. Nayar, A.P.R. Sastry (Edited By) - Red Data Book Of India Plants, Vol. 3, BSI Publication

**M.Sc. II Botany Semester-IV**  
**HCT 4.2 Plant tissue culture, Green house technology and hydroponics**  
**Lectures-60 (Credits: 4)**

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<b>Unit 1:</b>	<b>15L</b>
<b>Plant tissue culture-</b> Objectives and goals of plant tissue culture, laboratory design and development, operation and management.	
<b>Tissue nutrition-</b> Basic principles of in vitro culture, factors influencing morphogenesis	
<b>Media preparation and handling:</b> Sterilization methods, equipment and apparatus, procedures of media preparation and stock solutions.	
<b>Unit 2:</b>	<b>15L</b>
<b>Plant regeneration and plant propagation:</b> Meristem culture / axillary Bud culture, protocols and schedules of observation.	
<b>Callus culture-</b> somatic embryogeny, cell suspension culture, cell line and bioreactors	
<b>Unit 3: Organ culture</b>	<b>10L</b>
Anther culture, Isolation of haploids & its significance. Embryo culture. embryo rescue.	
<b>Synthetic seed-</b> Concept method and applications.	
<b>Unit 4: Greenhouse technology</b>	<b>10L</b>
Construction, operation, maintenance and Management.	
<b>Management-</b> light, temperature, Fertilization, humidity, pest and disease control.	
<b>Unit: 5: Hydroponics-</b> Definition, technique, applications	<b>10L</b>

**Practical's HCP 4.2**

1. Designing of plant tissue culture laboratory.
2. Preparation of culture media.
3. Sterilization techniques.
4. Callus culture, organogenesis and suspension culture.
5. Meristem culture.
6. Somatic embryogenesis.
7. Techniques of hardening.
8. Encapsulation of embryos.
9. Green house design sketching.
10. Demonstration of watering and nutrient supply system in greenhouse.-Drip irrigation sprinklers etc.
- 11& 12. Study of technique of Hydroponics.



**References:**

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Camborg O.L. And Philips G.C. (1996): Plant, Tissue and Organ Culture Fundamental Methods.

Dixon, R.A. (1985): Plant Cell Culture. A Practical Approach.

Narayanaswamy S. (1997): Plant Cell and Tissue Culture.

Evans et. al. (1983): Hand Book of Plant Cell Culture Vol. I, II, III.

VASIL T.K. (1984): Cell Culture and Somatic Cell Genetics of Plant Vol. I. Laboratory Procedures and Their Applications

Bhojwani S.S. And Razdan N.K.(1983): Plant Tissue Culture, Theory And Practice:Elsevier Public

Street H.E. (1974): Tissue Culture.

Reinert J. And Bajaj Y.P.S. (1976): Plant Cell, Tissue and Organ Culture

Thorpe T.A. (1981): Plant Tissue Culture.

Nelson P.V. (1973) Greenhouse, Operation and Management.

Prasad Kumar- Greenhouse Management for Horticultural Crops.

**M.Sc. II Botany Semester-IV**  
**SCT 4.1 Environmental Plant Physiology**

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**Unit 1:** (5L)

**Introduction-** Concept of stress & types of stress, plastic strain & elastic strain, stress injury, avoidance, resistance, endurance, & escape.

**Unit 2:** (20L)

**Water stress-** Effect of water stress on plant metabolism, drought resistance mechanisms in plants, role of pralines and other osmolites, induction of drought resistance.

**Salt stress-** Salinity and sod city, types of salinity, causes of soil salinization, a brief account of distribution of salt affected soils in India, effect of salt stress on plant Metabolism, mechanism of salt tolerance in higher plants, reclamation of saline soils. **Water logging-** Causes of water logging, nature of water logging injury, mechanism of flooding tolerance.

**Unit 3:** (15L)

**Ion stress-** Heavy metal toxicity- iron, manganese and zinc, effects of soil acidity on plants and phytoremediation.

**High and low temperature stress-** Effect of high and low temperatures on plants Metabolism, mechanisms of heat and cold tolerance.

**Radiation stress-** Effect of ultraviolet radiations on plants, photo inhibition and Mechanisms of UV tolerance

**Unit:4: Pollution stress-** Effect of air pollutants (SO<sub>2</sub>, NO<sub>x</sub> and Ozone) on plant metabolism. (15L)

**Oxygen toxicity in plants-** Free radicals and their scavenging  
Effect of elevated CO<sub>2</sub> concentration on plant metabolism & productivity.

**Unit: 5:-Biotic stress (5L)**

Effect of fungal infection on plant metabolism and mechanism of Disease resistance, allelopathy-concept, plant-plant interactions, auto toxicity & allelochemicals.

**Practicals SCP 4.3**

1. Measurement of relative water content and osmotic potential.
2. Determination of chlorophyll stability index.
3. Study of effects of Fe/Zn/Mn toxicity on plant growth and development.
4. Study of protein profile/ amino acid profile in plants under stress.
5. Study of effect of fungal infection on peroxidase activity.
6. Screening of germplasm for biotic and abiotic stresses

7. Effect of UV radiations on anthocyanin production.
8. Study of free radical scavenging enzymes catalase / SOD.
9. Study of free proline accumulation in plants under stress.
10. Study of effect of water logged condition on plants.
11. Study of allelopathic effect on plant growth and development (allelochemicals)
12. Study of chloride and sulphate salinity stress on plant growth and development.

**References:**

Fageria N.K. 1992. Maximizing Crop Yield.

Gupta U.S. 1975. Physiological Aspects of Dry land Farming.

Kozlowski T.T. 1984. Flooding and Plant Growth.

Rice E.L. 1982. Allelopathy (Physiological Ecology)

Sharma S.K. & Gupta I.S. 1986. Physiological Aspects of Dry land Farming.

Turner N.C. & Kramer P. J. 1980. Adaptations of Plants to Water and High Temperature Stress.

Yawalkar & Agrawal, Manures and Fertilizers.

Evans L.T. 1972. Crop Physiology.

Levitt J. 1980. Responses of Plants to Environmental Stresses. Vol. 1 And 2.

Indian Journal of Plant Physiology. New Delhi.

Agros Annual Review of Plant Physiology. Jodhpur.

Environmental Plant Physiology.

Cherry J.H. 1989. Environmental Stress in Plants. Biochemical & Physiological Mechanisms.

Journal of Experimental Botany.

Environmental Plant Physiology.

**M.Sc. II Botany Semester-IV**  
**SCT 4.2: Modern Trends in Angiosperm Taxonomy**

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**UNIT 1:**

**15L**

**Embryology in relation to taxonomy:** Embryological characters of taxonomic importance, utilization of embryological data in solving taxonomic problems at different levels.

**Anatomy in relation to taxonomy:** Vegetative, wood and floral anatomy, anatomical characters of taxonomic importance, use of anatomical data in understanding interrelationship and evolution of angiosperms and solving taxonomic problems.

**Palynotaxonomy:** Pollen morphology-Polarity, symmetry, NPC of pollen, exine stratification, excrescences, L/O pattern, palynogram; pollen characters of taxonomic importance.

**UNIT: 2**

**15L**

**Cytotaxonomy:** Chromosome number, Basic chromosome number, polyploidy, aneuploidy, chromosome morphology, karyotype, chromosome banding, meiotic analysis and plant systematics, scope and limitations.

**Chemotaxonomy:** Origin of chemotaxonomy, classes of compounds and their biological significance, Stages in chemotaxonomic investigations, techniques, Use of chemical criteria in plant taxonomy; Proteins and taxonomy: seed proteins, techniques of protein electrophoresis, protein analysis procedures, analysis of amino acid sequence and its significance in systematics; serology and taxonomy: history, precipitation reaction, techniques, antigen, antisera, antibody, application of serological data in systematics.

**Numerical taxonomy:** Phenetic methods in taxonomy (Taxometrics) Principles, constructions of taxonomic group, OUTs, unit characters, character coing, measurement of resemblances, cluster analysis, phenon and ranks, discriminations, nomenclature and numerical taxonomy, applications, merits, demerits. Cladistics and cladogram, parsimony analysis, cladistics and classification

**UNIT: 3**

**10L**

**Ultrastructural systematics:** SEM and TEM studies and plant systematics; SEM and plant surface structure, TEM and dilated cisternae of endoplasmic reticulum and sieve element plastids, applications of data in the classification of higher taxa.

**Molecular Systematics:** Molecular diagnostic tools, Restriction Fragment Length Polymorphism (RFLPs), Random Amplified Polymorphic DNA (RAPD), Polymerase Chain Reaction (PCR) analysis, specific applications of RAPD, AFLP in molecular systematics. Molecular data and systematic position of Hydatellaceae.

**Plant geography, ecology and systematics:** Patterns of geographic distribution, Disjunction and Vicariance, Vicariance biogeography, Endemism, Centres of diversity, Ecological differentiation, Alien plants, Phenotypic plasticity

**UNIT: 4** GIS, GPS, bar coding, QR coding, plant data base, The plant list

**10L**

**UNIT: 5**

**10L**

Assessment of biodiversity, Deorai, Lead Gardens, PBR, laws and legislations of plant biodiversity, Reddata book, biodiversity awareness programme, sustainable development.

### **Practicals SCT 4.2:**

- 1-4. Microtome technique for study of embryological characters
5. Study of wood characters: vessels, storied and non storied wood
6. Semi permanent pollen preparations by acetolysis and study of different pollen morphotypes.
7. Study of chromosomes and Karyotype analysis.
- 8-9. Interpretation of flavonoid data for taxonomy using PC/TLC/ protein profile analysis.
10. Exercise on numerical taxonomy
11. Study of surface attributes with the help of SEM photograph.
12. Study of sieve tube plastid and dilated cisternae of ER with the help of TEM photograph.

### **Reference Books:**

- Bhojwani, S. S. and Bhatnagar, S. P. 1984. Embryology of Angiosperms. Vikas Publ. House, New Dehli.
- Cronquist, A. 1988. The Evolution and Classification of Flowering Plants (2nd ed.) Allen Press, U.S.A. Cronquist, A. 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York.
- Davis, P. H. and V. H. Heywood 1991. Principles of Angiosperm Taxonomy. Today and Tommorrow Publications, New Delhi.
- Erdtman, G. 1952. Pollen Morphology and Plant Taxonomy. Angiosperms. Almquist and Wiksell. Stockholm.
- Fahn, A. 1979. Plant Anatomy, Pergamon Press, London.
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- Johri, B. M. 1984. Comparative embryology of Angiosperms. Ind. Nat. Sc. Acad. New Delhi. Maheshwari, P. 1985. An Introduction to Embryology of Angiosperms. Tata McGraw Hill, New Delhi. Manilal, K. S. and M. S. Muktesh Kumar [ed.] 1998. A Handbook of Taxonomic Training. DST, New Delhi.
- Naik, V. N. 1984. Taxonomy of Angiosperms Tata McGraw-Hill, New Delhi.
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- Taylor, D. V. and L. J. Hickey 1997. Flowering Plants: Origin, Evolution and Phylogeny. CBS Publishers & Distributers, New Delhi.
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- Simpson, M. G. 2010. Plant Systematics. Elsevier, Amsterdam.
- Stace, C. A. 1989. Plant Taxonomy and Biosystematics. Edward Arnold, London.

**M.Sc. II Botany Semester-IV**  
**OET 4.1: Crop Physiology**

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**Unit 1:** **15L**

**Crop growth-** Crop growth analysis and its applications, crop productivity, harvest Index, water use efficiency and N- use efficiency, plant growth regulators in agriculture and antitranspirants

**Reproductive development-** Photoperiodism and vernalization

**Fertilizers-** Types, application through soil, foliar application, organic farming and its importance.

**Unit: 2:** **10L**

**Crop- weed interactions-** Common weedicides and their mode of action.

**Source- sink relationship-** Phloem transport.-vegetative and reproductive phase and factors affecting source sink relationship.

**UNIT 3:** **10L**

A brief idea of physiological basis of yield in sugar cane, Jowar, cotton, groundnut & wheat

**UNIT 4:** **15L**

**Physiology of crops with reference to following aspects-**

i) Mineral nutrition of groundnut. ii) Nitrogen fixation in chickpea.

Fruit physiology of Ber, Pomegranate, Mango, lemon and grape. [any 2]

Post harvest technology of grapes/ Ber/ and pomegranate w.r.t. market strategy- from

**Unit: 5:** **10L**

A brief idea of crop physiological 5 tions in India ICRISAT, IARIT, CIMAP Luck now, central soilsalinity research lab Karnal, CAZRI Jodhpur, BARC, UAS, Bangalore.

**Practicals OET4.1**

1. Growth analysis of any two crop plants (RGR, NAR, LAR, LAI etc).
2. Study of the effect of antitranspirants on stomatal behavior.
3. Study of the effect of source manipulation on sink capacity in any crop plant.
4. Estimation of acid invertase during ripening of sugarcane stalk.
5. Study of allelopathic effect of weed extract on germination of crop seeds.
6. Estimation of total lipids in oil seeds.
7. Study of effect of weedicide on some aspects of weed metabolism.
8. Study of Crop varities
9. Visit to ware houses to study proper storage conditions for grains, seed and fruits.
10. Study of root nodules in leguminous crops.
11. Study of fertilizers ( Chemical and Biofertilizers )
12. Effect of biofertilizers on growth and development of plant.

**Reference Books:**

- Cherry J.H. 1989. Environmental Stress in Plants. Biochemical & Physiological Mechanisms.2 Fageria N.K. 1992. Maximizing Crop Yield.
- Gupta U.S. 1975. Physiological Aspects of Dry land Farming.4 Kozlowski T.T. 1984. Flooding and Plant Growth.
- Rice E.L. 1982. Allelopathy (Physiological Ecology)
- Sharma S.K. & Gupta I.S. 1986. Physiological Aspects of Dryland Farming.
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- Evans L.T. 1972. Crop Physiology.
- Levitt J. 1980. Responses of Plants to Environmental Stresses. Vol. 1 And 2.12 Indian Journal of Plant Physiology. New Delhi.
- 13 Agros Annual Review of Plant Physiology. Jodhpur.14 Environmental Plant Physiology.
- 15 Journal of Experimental Botany. 16 Environmental Plant Physiology.

**M.Sc. II Botany Semester-IV**  
**OET 4.2: Industrial Botany**

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**Unit 1: Algal and Bio-pesticide Technology**

**15L**

**Algal Technology**

Introduction to Algal Technology

Resource potential of algae, commercial utility of algae- food and feed, pigments, pharmaceuticals and nutraceuticals, fine chemicals, fuel and biofertilizers, seaweeds extracts as biofertilizers, distribution of economically important algae in India

**Algal Products** SCP- *Spirulina* mass cultivation and its applications, biodiesel from algae, advantages over other sources of biodiesel, cultivation and extraction methods, liquid seaweed fertilizers – method of preparation and application

**Biopesticide Technology**

Concept and significance of bio-pesticide; types of biopesticides and their applications,

Herbal- Azadiractine, rotenone and pyrethrins

Insect predators/parasites- Lady bird beetle, Trichogramma

Fungal- Trichoderma, its isolation, mass multiplication and applications

Bacterial- Bacillus thurengensis

Viral- Nuclear Polyhydrosis Virus (NPV), Helicoverpa Nuclear Polyhydrosis Virus (HNPV)

**Unit 2: Biofuel Technology**

**(15 L)**

**Environmental implications** of fossil fuel, concept of biofuel, alternatives for fossil fuels – ethanol, vegetable oil, biodiesel

**Bioethanol Technology**

Sources for bioethanol production- sugar crops, starch crops, cellulosic feed stock bioethanol production- sugar-to-ethanol process, starch-to-ethanol process, cellulose-to ethanol process, bio- ethanol from lignocelluloses, distillation to dehydration process, technology applications of bioethanol, spark ignition engines, compression ignition engines, fuel cells, standardization of bioethanol

**Lipid Derived Biofuels**

Sources - oil seed crops, microalgae, animal fats, waste oils Fuel productions- oil extractions, oil refining, transesterification, properties and use of lipid biofuels, economy of lipid biofuels

**Bio-hydrogen**- Application and future prospects

**Methanogenesis** from agro industrial residues

**Unit 3: -Fermentation Technology**

**15L**

**Introduction:** History, fermentation process, fermenters- design and construction, basic functions, types of fermenters, operation, aseptic operation and use of computer in fermenters, maintenance, types of



fermentation process, batch fermentation, fed-batch fermentation, continuous fermentation, scale up of fermentations, industrial processes- upstream and down-stream processes, strain improvement of microbes, **Alcohol and Beverage Industry**, Sources and methods of production of alcohol, beer and wine

### **Organic Acid Industry**

Sources and methods of production of vinegar, and citric acid

### **Antibiotic Industry**

Sources and methods of production of Penicillin, Cephalosporins, and Griseofulvins

### **Food Industry**

**SCP** - advantages and disadvantages, production of yeast biomass, production of mycoproteins, traditional fungal foods (Shoyu, Miso, Sake, Tempeh), production of Button mushroom, (*Agaricus*) Paddy straw mushroom (*Volvariella*) and Dhingri mushroom (*Pleurotus*)

### **Unit- 4: Entrepreneurship**

**10 L**

Entrepreneur: Concept, characteristics of entrepreneur, types and functions of entrepreneur, difference between entrepreneur and a manager.

Entrepreneurship Development Programmes (EDPs) - Need, objectives, course contents and curriculum, phases and evaluation of EDPs, Project Identification and Selection (PIS) -Meaning of project and report, project identification, project selection, contents of project reports, preparation of project report.

Institutional Finance to Entrepreneurs- Commercial banks, other financial institutions- IDBI, IFSI, ICKI, LIC, UTI, SFC's SIDBI, and EXM Bank Institutional Support to Entrepreneurs -Need of institutional support, institutional support to small entrepreneurs- NSIC, SIDCO, SSIB, SSIDC, SISI's, DICS, Industrial Estates, NABARD

### **Unit 5: Management**

**10 L**

#### **The Business – Its Nature and Scope**

Meaning, characteristics, objectives and scope of business, difference between business and profession, interrelationship between industry, commerce and trade

#### **Fundamentals of Management**

Meaning, characteristics, difference between management and administration, management process, working capital management, inventory management, human resource management, production and operation management, marketing management. Accounting- need, meaning, objectives, journal, ledger, trial balance, final accounts- profits and loss accounts, balance sheet

### **Practicals: OET 4.2**

1-2. Study of any six sea weeds with applications

3. Isolation and culture of *Spirulina*

4-5. Isolation, maintenance and culture establishment of any two nitrogen fixing algae

6. Study of any four bio-pesticides and their market products

7. Extraction of biodiesel from oil seeds/algae by transesterification process
8. Extraction of and estimation of citric acid by titration and spectrophotometric method
- 9-10. Study of any eight fermentation products of commercial importance from local market with reference to source and applications
11. Quality testing of *Trichoderma* (total viability count) Biofertilizer

**Note:**

Visit to management institute and preparation of report is compulsory

Visit to any industry with reference to theory.

**References:**

Biofuel Technologies- Recent Developments, Gupta, Vijay Kumar, Tuohy, Maria G. (Eds) Springer publication

Biofuel technology Handbook, Dominik Rutz, Rainer Janseen, WIP Renewable Energies, Germany

Biopesticides for sustainable agriculture: prospects and constraints, Editor(s): Nutan Kaushik

Entrepreneur Developments, S. S. Khanka, S. Chand., 2005

A Text Book of Microbiology, Dube and Maheshwari

A Text Book of Biotechnology. R C Dube

Insecticide control act 1985 Gazette of India

Fertilizer control act 1985 Gazette of India

**M.Sc. II Botany Semester-IV**  
**OET 4.3: Stress Biology**

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<b>Unit 1: Defining plant stress</b>	<b>5L</b>
Acclimation and adaptation.	
<b>Unit 2: Environmental factors</b>	<b>15L</b>
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.	
<b>Unit 3: Stress sensing mechanisms in plants</b>	<b>15L</b>
Calcium modulation, Phospholipid signaling	
<b>Unit 4: Developmental and physiological mechanisms that protect plants against environmental stress</b>	<b>15L</b>
Adaptation in plants; Changes in root: shoot ratio; Aerenchyma development; Osmotic adjustment; Compatible solute production.	
<b>Unit 5: Reactive oxygen species–Production and scavenging mechanisms.</b>	<b>10L</b>

**Practicals OET 4.3**

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.
8. Study of osmotic potential and water potential.
9. Estimation of proline.
10. Estimation of protein.
11. Structural and physiological adaptations in stressed plants.

**References:**

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