

M.Sc. Botany Syllabus Credit System Course structure

M.Sc. I Botany: (Implemented from 2013-2014)

Semester I:

BO 1.1 Cryptogamic Botany I- Bryophytes and Pteridophytes	(60L)
BO 1.2 Biochemistry and Plant Physiology	(60L)
BO 1.3 Genetics and Plant Breeding	(60L)
BO 1.4 Botanical Techniques	(60L)
BO 1.5 Practical based on BO 1.1 and BO 1.4	
BO 1.6 Practical based on BO 1.2 and BO 1.3	

Semester II:

BO 2.1 Cryptogamic Botany II- Algae and Fungi	(60L)
BO 2.2 Cell Biology and Evolution	(60L)
BO 2.3 Molecular Biology and Genetic Engineering	(60L)
BO 2.4 Plant Ecology and Phytogeography	(60L)
BO 2.5 Practical based on BO 2.1 and BO 2.2	
BO 2.6 Practical based on BO 2.3 and BO 2.4	

M.Sc. II Botany (Implemented from 2014-2015)

Semester III:

BO. 3.1. Spermatophytic Botany	(60L)
BO. 3.2. Developmental and Economic Botany	(60L)
BO. 3.3. Industrial Botany I	(60L)
BO. 3.4. Special Botany Paper (from BO 3.41 to BO. 3.50)	(60L)

- BO 3.41. Advanced Mycology
- BO 3.42. Advanced Angiosperms
- BO 3.43. Advanced Physiology
- BO 3.44. Advanced Genetics and Molecular Biology
- BO 3.45. Advanced Biotechnology
- BO 3.46. Advanced Medicinal Botany
- BO 3.47. Advanced Environmental Botany
- BO 3.48. Advanced Seed Technology
- BO 3.49. Advanced Horticulture and Floriculture
- BO 3.50. Advanced Biodiversity

- BO 3.5. Practicals based on BO 3.1., BO. 3.2. and BO.3.3.
- BO. 3.6. Practicals based on Special Paper BO. 3.41 to BO 3.50

Semester IV:

BO 4.1. Computational Botany	(60L)
BO 4.2. Plant Organism Interaction	(60L)

- BO 4.3. Industrial Botany II (60L)
 BO 4.4. Plant Pathology
 BO 4.5. Practicals Practical based on BO 4.1, BO 4.2., BO 4.3. and BO 4.4.
 BO 4.6. Research Methodology and Summer Training (60L)

M.Sc. Botany Credit System Course Structure and Examination Pattern

1. Each theory course of four credits of 60 Lectures
2. Examination pattern- internal examination 50 Marks and end semester University examination of 50 Marks
3. In each semester four theory and two practical courses
4. M.Sc. Botany syllabus is of 100 credits syllabus
5. Evaluation pattern under credit system will be as below

A. Continuous Assessment (CA)- 50 Marks

Written test (at least two) of 15 Marks each

Assignment of maximum 5 marks

Seminar/ Group Discussion/ Extension work/Report writing/ Study tour 5 marks

An open book test 10 Marks

B. End Semester Examination (ESE) 50 Marks

The setting of question paper for ESE will be as below

Total questions eight from which five have to solve and each question carries 10 marks.

Any six questions with marks for sub questions may be – 4+3+3 or 5+3+2 or 4+4+2.

Any two questions with marks for sub questions 5+5

C. Practical Examination

- I. Internal marks 50** – outline of the distribution of the mark for various aspects for internal marks is as below-

Journal – 10 Marks

Viva voce– at the time of the practical 20 marks

Group discussion of 5-6 students for testing understanding level of students 10 Marks

Attendance – 5 Marks

Additional practical work of interdisciplinary nature – 5marks

- II. End Semester Practical Examination (ESE)- 50 Marks**

Certified journal would be compulsory to appear ESE practical examination

- D. Research Methodology and Summer Training:** It will start in third semester it includes project report, review of literature and summer training report with certificate of completion. The students have to prepare techno-commercial case

study report of any four units mentioned in syllabus. It should be presented at the end of fourth semester practical examination.

E. Passing System for Each Course

A student has to obtain 40% marks in the combined examination of CA and ESE with minimum passing of 30% in both these separately. To pass the degree programme, students have to obtain minimum aggregate of 40% marks in each course.

M.Sc. II Botany Syllabus Credit Based System Draft

BO. 3.1.	Spermatophytic Botany	60 L
	Gymnosperms and Angiosperms (2 Credits each)	
BO. 3.2.	Developmental and Economic botany	60 L
	Developmental Botany (3 Credits)	
	Economic Botany (1 Credit)	
BO. 3.3.	Industrial Botany	60 L
	Algal Technology (1 Credit)	
	Biofuel and Biopesticide (1 Credit)	
	Entrepreneurship and Management (1 Credit)	
	Fermentation Technology (1 Credit)	
BO. 3.4.	Special Botany Paper (from BO 4.41 to BO. 3.50)	
	BO 3.41. Advanced Mycology	
	BO 3.42. Advanced Angiosperms	
	BO 3.43. Advanced Physiology	
	BO 3.44. Advanced Genetics and Molecular Biology	
	BO 3.45. Advanced Biotechnology	
	BO 3.46. Advanced Medicinal Botany	
	BO 3.47. Advanced Environmental Botany	
	BO 3.48. Advanced Seed Technology	
	BO 3.49. Advanced Horticulture and Floriculture	
	BO 3.50. Advanced Biodiversity	
BO 3.5.	Practicals based on BO 3.1., BO. 3.2. and BO.3.3.	
BO. 3.6.	Practicals based on Special Paper BO. 3.41 to BO 3.50	

M.Sc. Botany Semester IV

BO 4.1. Computational Botany (4 Credit) 60 L

Basic Biostatistics (1 Credit)

Experimental Statistics (1 Credit)

Bioinformatics (1 Credit)

Biomathematics (1 Credit)

BO 4.2. Plant Organism Interaction (4 Credit) 60 L

Plant –Plant Interactions (1Credit)

Herbivory and Carnivorous Plants (1 Credit)

Symbiotic Associations (1 Credit)

Pollination and Dispersal Biology (1 Credit)

BO 4.3. Industrial Botany II (4 Credit) 60 L

Herbal Technology (1 Credit)

Post Harvest Technology (1 Credit)

Gardening and Forest Botany (1Credit)

Industrial Plant Tissue Culture (1 Credit)

BO 4.4. Plant Pathology (4 Credit) 60 L

Introduction to Plant Pathology (1 Credit)

Pathogenesis (1 Credit)

Disease Development (1 Credit)

Disease Management and Related Aspects (1 Credit)

BO 4.5. Practicals

Practical based on BO 4.1, BO 4.2., BO 4.3. and BO 4.4.

BO 4.6. Research Methodology and Summer Training (4 Credits)

F. Project (2 Credits)

Projects will be allotted in third semester and students will submit project work having introduction, review of literature, well defined material and methods, discussion, results and conclusions, references

G. Research Methodology and Review of Literature (1 Credit)

Research methodology will be discussed and then review of literature and its presentation based on some advanced techniques in Botany

H. Summer Training and Preparation of Report on Techno-Commercial Case Study on any four aspects (1 Credit)

- I) Summer training Report- Submission based on one summer training in research institutes/ laboratory/industry for atleast one month with certificate from respective authority.

- II) Techno-commercial case study of any four units from the following

Students will visit atleast four units of the following to prepare report for submission

- 1. Biofertilizer unit
- 2. Mushroom cultivation unit
- 3. Greenhouse unit
- 4. Floriculture unit
- 5. Plant nursery unit
- 6. Garden designing and maintenance unit
- 7. Fruit processing unit
- 8. Bio-pesticide unit
- 9. Biomass briquette unit
- 10. Biofuel unit
- 11. Plant tissue culture industries
- 12. Farmhouse management
- 13. Pomoculture unit
- 14. Organic farming
- 15. Fresh vegetables and flower supply unit
- 16. Herbal product industry
- 17. Forest department unit
- 18. Medicinal plant garden
- 19. Effluent treatment plant
- 20. Solid waste management unit

BO 3.1 Spermatophytic Botany 60 L

Credit I - General Aspects and Fossil Gymnosperms (15L)

1. Outline classification of Spermatophyta as per Bessey (1911) and Engler (1936) **1L**
2. Gymnosperm classification as per Sahnii (1920), Chamberlain (1934), Raizda and Sahnii (1960), Sporne (1965) and Bierhorst (1971) **2L**
3. Affinities with pteridophytes and angiosperms **1L**
4. Distribution of gymnosperms- Worldwide and in India. Economic aspects of gymnosperms. **3L**
5. Pteridospermales w.r.t general characters- *Lyngiopteris*, *Heterangium*, *Medullosa*, *Neuropteris*, *Glossopteris*, and *Caytonia*. **4L**
6. Cycadeoidales- General characters, structure of *Cycadeoidea* and *Williamsonia* **1L**
7. Pentoxylales- General characters, *Pentoxylon*, structure of secondary wood, male and female strobili, and contribution of Birbal Sahnii **2L**
8. Cordaitales – General characters, structure of *Cordaites*, and *Cordaitanthus* **1L**

Credit II -Living Gymnosperms (15L)

General characters, affinities, morphology of sporophytes and gametophytes of living gymnosperm orders

1. Cycadales **3L**
2. Ginkgoales **2L**
3. Coniferales **5L**
4. Gnetales, Ephedrales and Welwitschiales **5L**

Credit III - Systematics and Classification of Angiosperms (15L)

1. Systematics: A key science, importance, relevance to conservation, taxonomic structure - taxonomic hierarchy, the species concept, categories and ranks, alpha and omega taxonomy, taxonomy as synthetic discipline. **5L**
2. International Code of Botanical Nomenclature: Salient features-principles, important rules and recommendations, provisions for the governance of the code, appendices **3L**

3. Systems of Angiosperm classification: Brief history of pre-Darwinian and post-Darwinian classification systems, phenetic versus phylogenetic systems, cladistics in taxonomy, angiosperm phylogeny group (APG). **4L**
4. Recent Systems of Classifications: By Armen L. Takhtajan, Arthur Cronquist, R. M. T. Dahlgren and Robert F. Thorne. **3L**

Credit IV -Taxonomic Aspects of Angiosperms (15L)

1. Morphological variations, systematic position, interrelationship, phylogeny and economic importance of following families: Magnoliaceae, Lauraceae, Piperaceae, Aristolochiaceae, Nymphaeaceae, Moraceae, Urticaceae, Casuarinaceae, Alismataceae, Hydrocharitaceae, Najadaceae, and Aponogetonaceae **10L**
2. Phytogeography: Phytogeographic regions of India, endemism, hotspots and hottest hotspots. Endemism in Western Ghats, plant explorations, invasions and introductions. **5L**

References:

1. Bhatnagar S.P and Moitra Alok 1996. Gymnosperms. New Age International Pvt. Ltd. Publishers, New Delhi, 470 pp.
2. Biswas C and Johari B.M 2004. The Gymnosperms Narosa Publishing House, New Delhi. 497 pp.
3. Sporne K.R 1965. The Morphology of Gymnosperms London, pp. 216.
4. Bierhorst D.W. 1971. Morphology of Vascular Plants. New York and London.
5. Chamberlain C.J 1934. Gymnosperms-Structure and Evolution, Chicago.
6. Coulter J.M. and Chamberlain C.J. 1917. Morphology of Gymnosperms, Chicago.
9. Foster A.S and Gifford E.M 1959. Comparative Morphology of Vascular Plants. San Francisco.
10. Maheshwari P. and Vasil, Vimla 1961. Gnetum, Delhi.
11. Blatter E and W.S Millard. 1929. Some Beautiful Indian Trees J.Bom. Nat Hist Soc. 33:624-635.
12. Bor N.L 1943. Manual of Indian Forest Botany. London.
13. Clifford H.T and W. Stephenson. 1975. An Introduction to Numerical Taxonomy. Academic Press, N.Y.

14. Cole A.J (Ed.) 1969. Numerical Taxonomy. Academic Press,N.Y.
15. Cronquist, A. 1968. The Evolution and Classification of Flowering Plants. Thomas Nelson and Sons, Ltd. London.
16. Davis P.H and V.H Heywood 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd London.
17. Heywood V.H 1967. Plant Taxonomy, London.
18. Lawrence, G.H.M 1951. Taxonomy of Vascular Plants. N.Y.
19. Lawrence G.H.M 1955. An Introduction to Plant Taxonomy N.Y.
20. Rendle A.B. 1925. The Classification of flowering plants. 2 Vols. London.
21. Santapau H. 1953. The Flora of Khandala on the Western Ghats of India.
22. Singh V. and D.K Jain, 1981 Taxonomy of Angiosperms. Rastogi Publication, Meerut.
23. Swingle D.B. 1946. A Text book of Systematic Botany. McGraw Hill Book Co. New York.
24. Takhtajan A. 1969. Flowering Plants; Origin and Disposal.
25. Pande B.P 1997. Taxonomy of Angiosperms. S.Chand.
26. Vashishta P.C., A.R. Sinha, Anil Kumar. 2006. Gymnosperms. S.Chand.

BO 3.2 Developmental and Economic Botany (60 L)

Credit I- Process of Plant Development (15L)

1. Plant development- concept, definitions and unique features. **1L**
2. Processes of development, cell growth, division and differentiation, competence, determination, commitment, specification, differentiation, redifferentiation and dedifferentiation. Polarity and symmetry, integration, organization of cells, tissues and tissue system to whole plant. Cell-cell interaction **6L**
3. Factors for development- intrinsic and extrinsic **2L**
4. Vegetative development – structure and organization of seed embryo **1L**
5. Seed germination – Embryonal axis- meristems, establishment of seedling organ **1L**
6. Phenomenon of development, meristems as dynamic centers of cell regeneration, organ development, primordium to organ, juvenility – characteristics, transition to adult phase. Coordinated development **4L**

Credit II -Embryological Aspects of Development (15L)

1. Transition - vegetative to reproductive phase, morphological and histochemical changes in vegetative plant body **2L**
2. Gametophyte development, stamen and microsporogenesis, male gametophyte or male germ unit development, carpel and megasporogenesis, female gametophyte or female germ unit formation **4L**
3. Fertilization – Pollen tube growth and its path, its entry into embryo sac, gametic fusion, significance of double fertilization, abnormalities in fertilization **3L**
4. Embryo development - Development of embryo in dicots and monocot, unclassified or abnormal embryos, unorganized or reduced embryo **3L**
5. Polyembryony, apomictic phenomenon
Polyembryony – concept and classification of polyembryony, special cases and causes of polyembryony, apomixis- concept, categories- agamospermy and vegetative reproduction apospory, parthenogenesis **3L**

Credit III -Physiology and Molecular Basis of Plant Development (15L)

1. Physiology of plant development – totipotency, light mediated development, hormonal control in development, light and hormonal signaling, cell lineages, cell fate mapping, positional informational techniques for studying development, specific gene expression **6L**
2. Case study of organ culture, anther, pollen and protoplast culture and its role in understanding plant development **3L**
1. Molecular basis of plant development - Embryogenesis and seedling development, root, shoot and leaf development, gene expression during transition to flowering and flower development molecular genetics of gametophytes development, expression of cell incompatibility **6L**

Credit IV - Economic Botany (15L)

Source, method of cultivation and economic uses of

1. Cereals- rice, wheat, maize, barley, oat
2. Millets – sorghum, pear millet, finger millet **2L**
3. Legumes and nuts- gram, pigeon pea, soybean, garden pea, black gram, moth bean, cowpea, peanut, almonds, green almonds, cashewnut, walnut **2L**
4. Vegetables- sweet potato, beet, carrot, radish, turnip, potato, brinjal, onion, garlic, cabbage, cauliflower, tomato, jack fruit, cucurbits, bitter gourd **1L**
5. Fruits- mango, citrus, grapes, banana, guava, papaya, anjeer, pineapple, date, apple, pear, plum, peach, strawberry **2L**
6. Plant fibres- cotton, flax, sun-hemp, coir **1L**
7. Wood and Cork – babul, mulberry, willow, deodar, pinewood, red sandalwood, teak, salwood, veneers, plywood cork **2L**
8. Rubber and its products **1L**
9. Fatty oils- linseed oil, safflower oil, soybean oil, sunflower oil, sarson oil, castor oil, peanut oil **1L**
10. Essential oils- camphor oil, eucalyptus oil, jasmine oil, lavender oil, clove oil, rose oil, turpentine oil **1L**
11. (a) Sugar industry and its byproducts **2L**
(b) Spices- *Asafoetida*, turmeric, ginger, cinnamon, saffron, cardamom, nutmeg
Tea and coffee industry

References:

1. P Maheshwari. Embryology of Angiosperms
2. Bhojwani and Bhatnagar. Embryology of Angiosperms
3. K Essau. Plant Anatomy
4. Cutter. Plant Anatomy
5. S N Pandey. Plant Anatomy
6. S N Pandey. Economic Botany
7. V Verma. Economic Botany
8. Bendre. Economic Botany
9. Hill. Economic Botany
10. Razdan. Plant Tissue Culture
11. Vasil. Plant Tissue Culture
12. P K Gupta. Elements of Biotechnology
13. Chawala. Introduction to Plant Biotechnology
14. C B Pawar. Cell Signalling
15. Biology of Plants. American Society of Plant Physiologists Maryland, USA.
16. Galstone A.W. 1989. Life processes in Plants. Scientific American Library, Springer Verlag, New York, USA..

17. Moore T.C. 1989. Biochemistry and Physiology of Plant Hormones Springer –Verlag, New York, USA.
18. Nobel P.S 1999. Physiochemical and Environmental Plant Physiology (Second Edition) Academic Press, San Diego, USA.
19. Salisbury F.B and Ross C.W 1992. Plant physiology (Fourth Edition) Wadsworth Publishing Company, California,USA.

BO 3.3 Industrial Botany I (60 L)

Credit I- Algal and Bio-pesticide Technology (15L)

A. Algal Technology

1. Introduction to Algal Technology 2L

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

2. Algal Products 5L

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

B. Biopesticide Technology 8L

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

1. Herbal- Azadiractine, rotenone and pyrethrins
2. Insect predators/parasites- Lady bird beetle, *Trichogramma*
3. Fungal- *Trichoderma*, its isolation, mass multiplication and applications
4. Bacterial- *Bacillus thurengensis*
5. Viral- Nuclear Polyhydrosis Virus (NPV), Helicoverpa Nuclear Polyhydrosis Virus (HNPV)

Credit II - Biofuel Technology (15 L)

1. Environmental implications of fossil fuel, concept of biofuel, alternatives for fossil fuels – ethanol, vegetable oil, biodiesel 3L

2. Bioethanol Technology 5L

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

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|---|-----------|
| 3. Lipid Derived Biofuels | 3L |
| 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 | |
| 4. Bio-hydrogen- Application and future prospects | 2L |
| 5. Methanogenesis from agro industrial residues | 2L |

Credit III -Fermentation Technology **(15L)**

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|--|-----------|
| 1. Introduction | 5L |
| 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 | |
| 2. Alcohol and Beverage Industry | 2L |
| Sources and methods of production of alcohol, beer and wine | |
| 3. Organic Acid Industry | 1L |
| Sources and methods of production of vinegar, and citric acid | |
| 4. Antibiotic Industry | 2L |
| Sources and methods of production of Penicillin, Cephalosporins, and Griseofulvins | |
| 5. Food Industry | 5L |
| SCP - advantages and disadvantages, production of yeast biomass, production of mycoproteins, traditional fungal foods (Shoyu, Miso, Sake, Tempeh), production of Button mushroom, (<i>Agaricus</i>) Paddy straw mushroom (<i>Volvariella</i>) and Dhingri mushroom (<i>Pleurotus</i>) | |

Credit IV - Entrepreneurship and Management **(15 L)**

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|---|-----------|
| A. Entrepreneurship (8L) | |
| 1. Entrepreneur: Concept, characteristics of entrepreneur, types and functions of entrepreneur, difference between entrepreneur and a manager. | 2L |

2. **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. **4L**
3. **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 **2L**

B. Management (7 L)

1. **The Business – Its Nature and Scope 3L**
Meaning, characteristics, objectives and scope of business, difference between business and profession, interrelationship between industry, commerce and trade
2. **Fundamentals of Management 4L**
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

References-

1. Biofuel Technologies- Recent Developments, Gupta, Vijay Kumar, Tuohy, Maria G. (Eds) Springer publication
2. Biofuel technology Handbook, Dominik Rutz, Rainer Janseen, WIP Renewable Energies, Germany
3. Biopesticides for sustainable agriculture: prospects and constraints, Editor(s): Nutan Kaushik
4. Entrepreneur Developments, S. S. Khanka, S. Chand., 2005
5. A Text Book of Microbiology, Dube and Maheshwari
6. A Text Book of Biotechnology. R C Dube
7. Insecticide control act 1985 Gazette of India
8. Fertilizer control act 1985 Gazette of India

BO 3.4 Optional Paper- Any One Special Paper from BO 3.41 to BO 3.50

BO 3.41 Advanced Mycology and Plant Pathology (Special Paper) (60 L)

Credit I - Fungi as Organism (15L)

1. Fungi and their significance **1L**
2. Relationship of fungi with plants and animals **1L**
3. Milestones in mycological and pathological studies **2L**
4. Fungal cell- structure and composition **1L**
5. Physiology of fungal growth **2L**
6. Ecological groups of Fungi **1L**
7. Fungal spores **1L**
8. Outlineclassification of fungi- **3L**
 - E. A. Bessey System (1950)
 - Alexopoulos System (1962), L. E. Hawkens System (1966),
 - Alexopoulos and Mims System (1979),
 - Webster and Weber System (2007)
9. Molecular method of fungal taxonomy **1L**
10. Fungi as model organism for genetical studies **2L**

Credit II -Allied Fungi (15L)

(With respect to general characters, classification, structure, variation and importance)

1. **Myxomycota**- Acrasiomycetes, Protosteliomycetes, Dictyosteliomycetes, Myxomycetes. **6L**
2. **Plasmodiophoromycota** **2L**
3. **Straminipila**- Hyphochytridiomycota, Labyrinthulomycota, andOomycota **7L**

Credit III -True Fungi (15L)

(With respect to general characters, classification, structural variation and pathological importance, if any)

1. **Chytridiomycota**- Chytridiomycetes **1L**
2. **Zygomycota**- Zygomycetes, and Trichomycetes **2L**

3. **Ascomycota**- Archiascomycetes, Hemiascomycetes, Plectomycetes, Pyrenomycetes, Loculoascomycetes **6L**
4. **Basidiomycota**- Hymenomycetes- Agarics and Polypores
Homobasidiomycetes- Gasteromycetes
Heterobasidiomycetes- Auricularials
Dacrymycetales, Tremellales
5. **Teliomycetes**– Rust and Smut fungi **6L**

Credit IV -Anamorphic Fungi and Allied Aspects (15L)

1. **Deuteromycota**- Classification, structural variations and importance **4L**
2. **Fungal Association**- Lichens, mycorrhizae **3L**
3. **Fungal ecology**- Colonization strategies among fungi **2L**
4. **Ecological services of fungi**- bioremediation, biohydrometallurgy, microbiological sensors **2L**
5. **Fungi as Human pathogens**- Dermatomycosis (*Tinea*), intermediate and systemic mycosis, its symptoms, clinical aspects and control measures **4L**

Practicals Based on Advanced Mycology and Plant Pathology

1. Preparation of culture medium for fungi-PDA medium, CDA medium, Sabourard's medium **2P**
2. Isolation of aquatic and soil fungi by baiting method **2P**
3. Isolation of fungi from rhizosphere and non-rhizosphere soil **2P**
4. Isolation of plant pathogenic fungi from root, stem and fruits **2P**
5. Study of seed borne fungi of any six crops **2P**
6. Study of fungal disease- (any one from each) rots, Downy mildew, wart, ergot, white rust, Anthracnose, rust, smut, leaf spot w.r.t. symptoms, causal organism and control measures **3P**
7. Study of fungi from the following groups- **10P**
Myxomycetes- any four
Chytridiomycetes- any two
Oomycetes- any four

Pyrenomycetes- any four

Loculoascomycetes- any two

Discomycetes- any four

Teliomycetes – any eight

Gasteromycetes- any four

Hymenomycetes- any six

Deuteromycetes- any six

8. Preparation of stains and mounting media for study of fungi

1P

Note:

1. Compulsory visit to Western Ghats for collection and observation of fungi (at least for three days).
2. Visit to any one Mycology Institute/ Laboratory.

References:

1. Ainsworth et al., 1973. The fungi VI –A, VI – B, Academic press.
2. John Webster and Weber, 2007. Introduction to Fungi, Cambridge.
3. Alexopolous C.J. Minms C.W. and Blackwell M., 1999. Introductory Mycology (4th Edition), Willey, New York.
4. Deacon J. W. Fungal Biology (4th Edition) , Blackwell Publishing, ISBN 1405130660
5. Kendrick B., 1994. The Fifth Kingdom, North America, New York Publisher.
6. Kirk et al., 2001. Dictionary of fungi, 9th edition, Wallingford.
7. Mehrotra R.S. and Aneja K.R., 1990. An introduction to mycology, New Age Publication.
8. Miguel U., Richard H., and Samuel A. 2000. Illustrated dictionary of mycology Elvira Aguirre Acosta Publisher.
9. Webster J., and Rpland W. 2007. Introduction to fungi (3rd Edition), Cambridge University Press.
10. Dube H.C. 2010. An Introduction to fungi, Vikas Publication.
11. Vashista B. R. and Sinha A.K. 2008. Botany for Degree students- Fungi, S. Chand's Publication.

BO 3.42 Advanced Angiosperms (60 L)

Credit I- Modern Trends in Angiosperm Taxonomy (15L)

1. **Embryology in relation to taxonomy:** Embryological characters of taxonomic importance, utilization of embryological data in solving taxonomic problems at different levels.
2. **Anatomy in relation to taxonomy:** Wood and floral anatomy, anatomical characters of taxonomic importance, use of anatomical data in understanding the interrelationships, evolution of angiosperms and solving taxonomic problems.
3. **Palynotaxonomy:** Pollen morphology-Polarity, symmetry, NPC of pollen, exine stratification, excrescences, L/O pattern, palynogram; pollen characters of taxonomic importance.

Credit II-Phytogeography, Ecology, Genetics and Taxonomy (15L)

1. Phytogeography and speciation; adaptations, ecological variations, genetic variations and plant systematics.
2. **Numerical Taxonomy:** Phenetic methods in taxonomy [Taxometrics]: Principles, construction of taxonomic groups, OUTs, unit characters, character coding, measurement of resemblances, cluster analysis, phenons and ranks, discrimination, nomenclature and numerical taxonomy, applications, merits and demerits. Cladistics and cladogram, parsimony analysis, cladistics and classification.
3. **Cytotaxonomy:** Chromosome number, (basic, haploid and diploid chromosome number) polyploidy, aneuploidy, chromosome morphology, karyotype, chromosome banding, meiotic analysis and plant systematics, scope and limitations.

Credit III-Chemotaxonomy and Allied Aspects (15 L)

1. **Chemotaxonomy:** Origin of chemotaxonomy, classes of compounds and their biological significance, stages in chemotaxonomic investigations. Techniques-Criteria for use of chemical in plant taxonomy; Proteins and taxonomy- seed proteins, techniques of protein electrophoresis, chemical 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.

2. **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.
3. **Molecular Systematics:** Molecular diagnostic tools, restriction fragment length polymorphism (RFLPs), Random Amplified Polymorphic DNA (RAPD), Polymerase Chain Reaction (PCR) analysis, specific applications of RAPD in molecular systematics. Molecular data and systematic position of Hydatellaceae.

Credit IV- Taxonomic Aspects

(15 L)

Morphological, variations, systematic position, interrelationships, phylogeny and economic importance of following families: Dilleniaceae, Tiliaceae, Bigoniaceae, Passifloraceae, Salicaceae, Gentianaceae, Cuscutaceae, Boraginaceae, Plantaginaceae, Lobeliaceae, Asteraceae, Costaceae, Pontederiaceae, Dioscoriaceae, Arecaeae, Pandanaceae, and Orchidaceae.

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- Paech, K. and M. V. Tracey. 1956. Modern Methods of Plant Analysis. Vol-I & II. Springer-Verlag.
- Shivanna, K. R. and N. S. Rangaswamy. 1992. Pollen Biology- A Laboratory Manual. Springer-Verla
- Sharma Arunkumar and ArchanaSharm. 1980. Chromosome Technique: Theory and Practices (3rd ed.) Butterworths, London.
- Judd Walter S., Cmpbell C. S., Kollogg, E. A., Stevens P.F. and M. J. Donoghue 2008. Plant Systematics. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.
- Davis, P. H. and V. H. Heywood 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi
- Grnquist, A. 1981. An Integrated system of Classifications of flowering plants. Columbia University Press, New York
- Gurcharan Singh. 2004. Plant Systematics : Theory and practice Oxford and YBH Publishing Co. Pvt. Ltd., New Delhi.
- Hutchison, J. 1959. Families of flowering plants

- Lawrence George H. M. 1951. Taxonomy of vascular plants Oxford and IBH Publ. Co. Pvt.Ltd., New Delhi
- Manilal, K. S. and M. S. Muktesh Kumar (ed.) 1998. A Hand book of Taxonomy Training, DST, New Delhi
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- Quicke, Donald, L. J. 1993. Principles and Techniques of Commemorative Taxonomy. Blakie Academic and Professional, London
- Stace, C. A. 1989. Plant Taxonomy and Biosystematics Edward Arnold, London.
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- Taylor, D. V. and L. J. Hickey 1997. Flowering plants : Origin, evolution and phylogeny CBS Publishers and Distributors New Delhi.

BO 3.6 Practicals Based on Special Paper BO 3.42 -Advanced Angiosperms

1. Microtome technique for study of embryological characters (3P)
2. Study of wood character, vessels, storied and nonstoried wood (3P)
3. Pollen preparations by Acetolysis method (Semi-permanent) and study of different pollen morphotypes. (2P)
3. Study of chromosomes, chromosome banding and Karyotype analysis (Any two species) (3P)
4. Analyses and interpretation of data of any two species for taxonomic characterization (4P)
 - (a) flavonoid data based on PC/TLC
 - (b) Seed protein by SDS-PAGE and interpretation of protein profiles
5. Study of plant surface attributes with the help of SEM photographs and sieve tube plastid and dilated cisternae of endoplasmic reticulum with the help of TEM photographs (1P)
- 6-13. Descriptions, Sketching, classification and identification of families: (7P)
Gentianaceae, Cuscutaceae, Boraginaceae, Plantaginaceae, Lentibulariaceae, Lobeliaceae, Asteraceae, Costaceae, Pontederiaceae, Dioscoriaceae, Burmanniaceae, Orchidaceae and identification of wild and cultivated plants represented in local flora.
14. Two local excursions to study vegetation, ecology and flowering pattern of the region. (2P)

Note:

Student should submit minimum 10 conventional herbarium specimens and 50 electronic herbarium specimens. Minimum 5 permanent slides of wood anatomy and 5 slides of floral anatomy (microtomy cut sections of flower specimens).

BO 3.43 Advanced Plant Physiology

Credit- I Plant Nutrition (15L)

Soil type and properties, absorption and assimilation of mineral nutrients and transport of water and solutes.	3L
Role of microbes in availability of mineral nutrients.	2L
Chemical fertilizers, conventional and recent methods of applications	1L
Transporter, energizing transporter, role of ATPase and PPase	3L
Water potential and factor influencing transport of water	3L
Transpiration ratio and water conservation strategies in plants	3L

Credit- II Photosynthesis (15L)

Photosynthetic ETS in pro and eukaryotic organism	03
Chlorophyll fluorescence kinetics and determination of PSI and PSII efficiency	03
Light saturation curve, CO ₂ response curve and CO ₂ compensation point	02
Evolution of RUBISCO and PEPcase	01
C ₃ and C ₄ Intermediate	01
CO ₂ concentrating mechanism and increase of CO ₂ fixation efficiency, Signal cell C ₄ Photosynthesis	03
CAM pathway in desert and aquatic plants	01
Partitioning of photosynthetic assimilate and feedback regulation of photosynthesis	01

Credit- III Respiration (15L)

The role of respiration in plant carbon balance	
Diverse nature of mitochondrial electron transport system	3L
Comparative account of normal respiration and cyanide resistance respiration, significance of cyanide resistance respiration, alternate oxidase and overall regulation of respiration	3L
Respiration in response to anoxia, acidosis metabolism during fruit development and seed	

germination	4L
Biosynthesis of secondary metabolites, role of secondary metabolites in plants, plant growth regulator	5L

Credit- IV Stress Physiology and Allied Aspects (15L)

Developmental and physiological mechanism that protect plant against environmental extremes/stress	2L
Role of natural and synthetic growth regulators in growth and development.	2L
Crop growth, relative growth rate and net assimilation rate.	2L
Metabolism and allocation of resource during vegetative and reproductive growth	2L
Source and sink relationship	1L
Physiology of flowering, circadian Rhythms, photoperiodism, vernalisation	2L
Post harvest physiology of fruits, seed maturation and dormancy.	2L
Physiological traits for improvement of crop.	2L

References:

1. Buchanan B.B, Grissem W. and Jones R.L 2000. Biochemistry and Molecular
2. Biology of Plants. American Society of Plant Physiologists Maryland, USA.
3. Dennis D.T., Turpin, D.H. Lefebvre D.D. and Layzell D.B. (eds) 1997. Plant
4. Metabolism (Second Edition) Longman, Essex, England.
5. Galstone A.W. 1989. Life processes in Plants. Scientific American Library, Springer Verlag, New York, USA..
6. Moore T.C. 1989. Biochemistry and Physiology of Plant Hormones Springer –Verlag, New York, USA.
7. Nobel P.S 1999. Physiochemical and Environmental Plant Physiology (Second Edition) Academic Press, San Diego, USA.
8. Salisbury F.B and Ross C.W 1992. Plant physiology (Fourth Edition) Wadsworth Publishing Company, California, USA.
9. Singhal G.S., Renger G., Sopory, S.K. Irrgang K.D and Govindjee 1999.
10. Concept in Photobiology; Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
11. Taiz L. and Zeiger E. 1998. Plant Physiology (Second Edition). Sinauer Associates, Inc. Publishes, Massachusetts, USA.
12. Thomas B. and Vince-Prue D. 1997. Photoperiodism in Plants (Second Edition) Academic Press, San Diego, USA.
13. Verma S.K. and Verma Mohit 2007. A.T.B of Plant Physiology, Biochemistry and Biotechnology, S.Chand Publications.
14. Leninger A.C 1987. Principles of Biochemistry, CBS Publishers and Distributers (Indian Reprint)

BO 3.6 Practicals based on Special paper BO 3.43 Plant Physiology

1. Induction of deficiency symptoms and growth analysis in crop plants **2P**
2. Determination of activity of nitrate reductase and assimilation of nitrogen **2P**
3. Study of transpiration and stomatal physiology under abiotic stress **1P**
4. Determination of rate of photosynthesis using IRGA/Oxygen measurement system **2P**
5. Study of effect of abiotic factors on activity of RuBisco and PEPcase enzyme **2P**
6. Separation and identification of stress related proteins **1P**
7. Demonstration of study of respiration under stress condition using oxygen measurement system **2P**
8. Effects of auxins and cytokinins or gibberellins on growth/enzyme activity **2P**
9. Effect of nutrient constituents/ growth regulators / environmental factors on *in vitro* growth and differentiation **2P**
10. Development of biotic and abiotic stress tolerance using *in vitro* techniques **1P**
11. Screening of cultivars for biotic and abiotic stress tolerance using *in vitro* technique **1P**
12. Comparative physiological studies of non transgenic and transgenic (Bt. Brinjal) plant **2P**
13. Determination of secondary metabolite **1P**
14. Estimation of Na/K/Mg/Ca and P **2P**
15. Effect of mycorrhizae on phosphorus assimilation **2P**
16. Effect of biofertilizers on crop growth **2P**

Note: Visit to advanced plant physiology laboratory and submission of report

M.Sc. Botany Semester III

BO 3.44 Advanced Genetics and Molecular Biology

Credit I- Genetics

1. Chromosome Packaging

7L

Genome size and evolutionary complexity, structure of the prokaryotic chromosome, structure of eukaryotic chromosomes, structure of nucleosome, arrangement of chromatin fibers in a chromosome, polytene chromosomes, lampbrush chromosomes, satellite chromosome, d chromosomes, molecular structure of centromere and telomere

2. Transposable Elements

8L

General characteristics, mechanisms of transpositions, mutagenic effects of transposition, structure of prokaryotic transposable elements – insertion sequences, Tn 10 transposon in bacteria, eukaryotic transposable elements – Ac and Ds elements in maize, *Copia* transposable element in *Drosophila*

Credit II- Molecular Biology

1. Molecular Biology of Plasmids

8L

Plasmid DNA Replication, interactions between plasmid and host, DNA replication processes, control of copy number, partitioning incompatibility, conjugal Functions, pilus production, transfer DNA replication, broad host range plasmids

2. Molecular Biology of T4 Bacteriophage

7L

Morphology and composition, experimental methods used to study phage infection, one-step growth experiment, single burst experiment, premature lysis experiment, genetic organization of T4, types of mutations observed in the T4 genome, structure of rII locus, molecular biology of T4 phage infection, initial stages of infection, regulation of infection, morphogenesis and maturation

Credit III- Genetics and Evolution

1. Genetics of Wheat

8L

Introduction, genetics of the wheat plant, wheat gluten proteins, classification and nomenclature, isolation, characterization, and expression of gluten protein genes, structure and evolution of high molecular weight subunit genes, structure and evolution of low molecular weight subunit and gliadin genes, gene expression and regulatory sequences, gene silencing

2. Population Genetics and Evolution

7L

Hardy Weinberg principle, allele frequencies and genotype frequencies, allele frequency calculations, enzyme polymorphisms, DNA polymorphisms, systems of mating, random mating and the Hardy-Weinberg principle, implications of the Hardy-Weinberg principle, DNA typing and population substructure

Credit IV-Genetical and Molecular Analysis

1. Site-Specific Recombination

4L

Introduction, double site-specific recombination, phage lambda integration, circular chromosome segregation, inversion systems, integrons, transposons: single site-specific recombination, phage Mu transposition

2. Molecular Analysis of Inherited Diseases

5L

Introduction, direct detection of gene mutation, detection of deletions, duplications and inversions, expansion mutations, point mutations, indirect diagnosis with linked genetic markers.

3. Genome Sequencing Projects

6L

Genomic mapping, genetic mapping, single-nucleotide polymorphisms, VNTRs, microsatellites, physical mapping, restriction maps, radiation hybrid maps, nucleotide sequencing, manual DNA sequencing, automated DNA sequencing, genome sequencing

References:

1. Advances in Genetics (Vol. 49). J C Hall, J C Dunlap and Theodore Friedman (Eds), Academic Press.
2. Genetics- Principles and Analysis (4 Ed.) D H Hartl and E W Jones. Jones and Bartlett Publishers, Massachusetts.
3. A Primer of Conservation Genetics. Richard Frankham, J D Ballou and D A Briscoe. Cambridge University Press.
4. Genetics – A conceptual approach – Benjamin Pierce
5. Bacterial and Bacteriophage Genetics. Edward Birge, Springer Publications
6. Molecular Biology of the Cell (2e). AB Bray, D Lewis, J Raff, M Robert and Walter. Garland Publishing Inc., New York
7. The Science of Genetics. A G Atherly, J R Girton and J F McDonald. Saunders College Publishing, Fort Worth, USA.
8. Cell and Molecular Biology- Concept and Experiments. G Karp. John Wiley and Sons Inc., USA.
9. Principles of Genetics. D P Snustad and M J Simmons, John Wiley and Sons Inc., USA
10. Principles of Genetics. Gardner and Snustad. John Wiley and Sons Inc., USA.

BO 3.6 Practical based on Special Paper (24 practicals)

1. Isolation and SDS PAGE separation of wheat proteins 3P
2. Study of polytene chromosome 1P
3. C-Metaphase and the morphology of chromosomes 1P
4. Study of Effects of transposable elements in suitable plant material 1P
5. Culturing of suitable bacteriophage and observation on plaque morphology 2P
6. Computational analysis of transposable element sequences 1P
7. Determination of allelic frequencies of suitable morphological/biochemical trait 1P

8. Genome analysis in wheat	2P
9. Germplasm collection, cataloging, data storage and retrieval	2P
10. Determination of chiasma frequency in the given material	1P
11. To search literature of different organisms and genes from NCBI.	1P
12. Use of various tools to retrieve information available from NCBI	1P
13. To retrieve gene and protein sequences of various organisms from NCBI.	1P
14. To locate gene(s) on chromosomes for a given disease/disorder	1P
15. Separation of isozymes by using native gel electrophoresis	1P
16. Isolation of nuclei, separation and identification of histones by SDS-PAGE	2P
17. Separation of chloroplast proteins on SDS-PAGE	2P
18. Chromosomal banding: O banding in <i>Allium cepa</i>	2P
19. Genetic problems on mapping of the genes in higher organisms	2P

Note:

1. Practical No.1 is mandatory.
2. Select any 15 practicals from practical no.2 to 15.
3. Select any 3practicals from practical no. 16 to 19.
4. Visit to a reputed molecular biology laboratory and submission of report is mandatory.

BO3.45Advanced Plant Biotechnology

Credit I-Fundamental Biotechnology (15L)

1. Concept of plant biotechnology **1L**
2. Methods of gene cloning –*invivo* gene cloning - vectors used in gene cloning (Plasmid vectors, lamda (λ) phage vectors, cosmids and expression vectors), selection of vectors **3L**
3. *In vitro* gene cloning – polymerase chain reaction (PCR), methods of PCR, applications of PCR **3L**
4. DNA polymorphism, Use of various enzymes in recombinant DNATEchnology **3L**
5. Techniques in restriction mapping, Southern, Northern, Western, Blotting techniques and applications **3 L**
6. DNA libraries, chromosome walking and jumping,DNA sequencing, Gene synthesis machines, Molecular markers SNPs, ISSR, SCAR **2L**

Credit II- Gene Expression (15L)

1. Techniques used to study gene expression at transcription level: **5L**
 - Northern hybridization,
 - reverse Northern hybridization,
 - differential screeningand subtractive hybridization,
 - differential display of mRNA, ESTs, SAGE,cDNA-AFLP,
 - DNA microarrays
2. Gene-tagging and plasmid rescue, promoter and enhancer traps **2L**
3. Alterations in gene expression:Site-directed mutagenesis, insertional mutagenesis, knock out mutants, targeting induced local lesions in genomes (TILLING) **3L**
4. Gene silencing - Gene inhibition at RNA level - antisense, co-suppression, miRNAs and siRNAs,silencing mechanisms **5L**

Credit III-Agriculture Biotechnology(15 L)

1. Herbicide resistance (phosphinothricine glyphosate, Sulphonyl urea, astrazin) **3L**
2. Insect resistance (Bt gene, non Bt like protease inhibitor) **3L**
3. Virus resistance (Coat protein mediated nucleocapsid gene) **2L**
4. Disease resistance (Chitinase, 1-3 beta glucanase, RIP) **2L**
5. Nematode resistance **1L**
6. Abiotic stress tolerance (Salt tolerant and drought stress resistance) **3L**
7. Post-harvest losses (Long shelf life of fruits and flowers) **2L**

Credit IV – Plant Tissue Culture for Secondary Metabolite Production (15 L)

1. Scope and applications of *in vitro* secondary metabolite production. **1L**
2. Types of culture systems used for secondary metabolite production **3L**
3. Improving secondary metabolite production in culture **5L**
 - a. Regulation of secondary metabolite pathways and compartmentalization
 - b. Manipulation of nutrient media, precursor additions
 - c. Immobilization of cells
 - d. Elicitation using biotic and abiotic elicitors
 - e. Biotransformation
 - f. Screening and selection of high secondary metabolite producing cell lines.
4. Bioreactors- Types of bioreactors, growth, product analysis and scaling up **3L**
5. Pathway engineering - Enhancing secondary metabolite production through genetic manipulation of biosynthetic pathways **3L**

References:

1. Chawla HC (2004) – Introduction to plant biotechnology (Science Publ)
2. Davies K (Ed) (2004) – Plant pigments and their manipulation – Annual plant reviews, vol 14 (Blackwell Publ)
3. Altman A, Hasegawa PM (Ed) (2012) – Plant Biotechnology and agriculture. Prospects for the 21st century (Academic press).
4. Bhojwani SS. & Razdan MK (1996). - Plant Tissue Culture : Theory & Practice (Elsevier)
5. Hou CT, Shaw JF (2009) – Biocatalysis and agricultural biotechnology (CRC Press)
6. Slater A, Scott NW, Fowler MR (2008) – Plant Biotechnology: the genetic manipulation of plants (Oxford Press)
7. Rai M (2009) – Fungal Biotechnology (IK International)
8. Vasil IK, Thorpe TA (1994) – Plant cell and tissue culture (Springer)
9. H K Das Textbook of Biotechnology 4th edition

BO 3.6 Practicals based on BO 3.45 Advanced Plant Biotechnology

1. DIG – labelling of DNA fragment for use as probe in Southern hybridization **3P**
2. Restriction digestion and electrophoresis of plant genomic DNA, Southern blotting and Southern hybridization **3P**
3. RNA isolation from plant tissues and electrophoresis of RNA **3P**
4. RT-PCR and comparing gene expression in two treatments **3P**
5. Immobilization of cells and comparative analysis of secondary metabolite production in immobilized and suspension cultures. **3P**
6. Manipulating cultures using elicitors for enhanced production of secondary metabolites **3P**
7. Use of PCR-based molecular markers- RAPDs, ISSR markers for scoring polymorphism. Construction of phylogenetic trees using given data **2P**

8. Making linkage maps from given data using mapmaking software. QTL analysis using given data **2P**
9. Separation and detection of specific proteins using Western blotting **3P**

Note-

1. Compulsory visit to Plant Biotechnology Laboratory/ Institute/Agriculture University and submission of report during practical examination.
2. Visit to Plant tissue culture unit and genetic engineering laboratory for knowing advanced techniques in Plant Biotechnology. Preparation of report with photographs of important instruments with descriptions.

BO 3.46 Advanced Medicinal Botany

Credit I- General Pharmacognosy(15L)

1. History, definition, scope of Pharmacognosy 1L
2. Traditional and alternative system of medicine 1L
3. Classification of crude drugs 2L
4. Scheme for pharmacognostic studies of crude drugs 1L
5. Cultivation, collection and processing of herbal drugs 3L
6. Cultivation and utilization of medicinal and aromatic plants in India 3L
7. Indian trade in medicinal and aromatic plants 1L
8. Case study of any two Ayurvedic medicinal products industries from India 3L

Credit II-Analytical Pharmacognosy(15L)

1. Drug adulteration 1L
2. Drug evaluation –Morphological, microscopical, chemical, physical and biological methods 6L
3. Quality control of herbal drugs 1L
4. Case study of any two Ayurvedic drugs by chemical, physical and biological methods 2L
5. Plant tissue culture for phytopharmaceuticals 1L
6. Biosynthesis of glycosides and alkaloids 2L
7. Biogenesis of phytopharmaceuticals 2L

Credit III- Plant Drugs(15L)

Detailed pharmacognostic study of the following drugs w.r.t. source, cultivation, collection, macroscopic characters, and application - Isabgol, Indian Gum, Honey, Indian Senna, Aloes, *Digitalis*, *Dioscorea*, SafedMusli, Shatavari, Liquorice, Brahmi, Henna, Arjuna, Amla, Karanj, Neem, Camphor, *Eucalyptus*, Peppermint, Garlic, Tulsi, Clove, Hops, Papain, Belladonna, Ashwagandha, *Vinca*, Vasaka, Turmeric, Tobacco, *Santalum*, etc. 15L

Credit IV-Industrial Aspects(15L)

1. Phytopharmaceuticals prospects 2L
2. Marine drugs 2L
3. Nutraceuticals and cosmeceuticals 4L
4. Ayurvedic pharmacy- principles, formulations, Ayurvedic profile of drugs- Shatavari, Neem, punarnanva, guggul, bhringraj, amla, tulsi, arjuna, behra, haritaki, ginger, curcuma, gulvel, hirda, *Aloe* 2L
5. Natural pesticides- Pyrethrum, neem, Deris, tobacco 2L
6. Immunomodulatory medicinal plants 1L
7. Natural excipients 2L

References:

1. Pharmacognosy. Tylor and Brady
2. Pharmacognosy. Wallis
3. Pharmacognosy. Trees and Evans
4. Pharmacognosy. Kokate, Gokhale, and Purohit
5. Economic Botany. Hill
6. Economic Botany. Panday
7. Economic Botany. V Verma
8. Medicinal Plants of India and Pakistan. Kirtikar and Basu
9. Medicinal Plants. S K Jain
10. Phytochemistry of Plants. McDaniels
11. Plant Physiology. Salisbury and Ross

Practicals based on BO 3.46 Advanced Medicinal Botany

1. Identification of drug with the help of organoleptic and microscopic evaluation techniques **2P**
2. Percentage extractives and fluorescence analysis of drugs **2P**
3. Determination of ash values of drugs **2P**
4. Histochemical studies of drugs **2P**
5. Chemotaxonomic studies of drug belonging to any five families **4P**
6. Biological activity and chemical constituents of any two drugs **2P**
7. Estimation of alkaloids from suitable medicinal plants **1P**
8. Estimation of glycosides from suitable medicinal plants **1P**
9. Extraction of essential oils from suitable medicinal plants **2P**
10. Estimation of oleoresin from suitable medicinal plants **1P**
11. Preparation of herbal foods **2P**
12. Preparation of herbal cosmetics **2P**
13. Visit to any two pharmaceutical industries and submission of report **1P**
14. Field visit to study ethnobotany and preparation of report **1P**

Note:

1. At least one short and one long study tour be arranged for studying medicinal plants and to explore ethnobotanical data. Students must submit the tour report and ethnobotanical data during practical examination.
2. Student must carry out detailed pharmacognostic investigation of at least one drug and should submit a report at the time of practical examination as a project.

BO 3.47 Advanced Environmental Botany

Credit I-Environmental Botany and Conservation Biology (15L)

1. Definition, scope and importance of environmental studies, interdisciplinary nature of Environmental Science, principles background and scope of Environmental Science, environmental science and technology, media and people, decision making and applications of environmental science. **4L**
2. The environment: Physical environment; biotic environment; biotic and abiotic interactions. **1L**
3. Environmental Botany:
Present concern: Conservation of genetic resources, gene pools land races, global warming and costal ecosystems. Depletion of forest cover, threats to mangrooves. Urbanization and plant cover. **4L**
4. Environmental Ethics:
Nature and origin of environmental ethics, ecological consciousness, views of developed and developing countries, environment community and equity, integrating ethical values and knowledge, self centered development and environment. **1L**
5. Global and national environmental issues
Social issues and environment, ozone depletion, greenhouse effect, acid rain, global warming, carbon credits, climate change, deforestation, biodiversity loss, desertification. **3L**
6. Modern tools in the study of environmental science – GIS, GPS, RS Data, aerial photography, and its data interpretations **2L**

Credit II-Environmental Impact Assessment (15L)

1. EIA: Concept, scope, process and necessity with case studies such as Thermal, Irrigation project, mining etc. EMP. **2L**
2. Human impact on environment and its consequences- Agriculture societies, industrial societies, impact of cultural change on environment, population explosion, degradation of natural resources **3L**
3. Types and sources of environmental pollution, physical, chemical and biological parameters used in monitoring of air, water and soil pollution **3L**
4. Radiation pollution -Types, sources, measurement and detection of radiation intensity, effects of radioactive pollution, control of radiation pollution **2L**
5. Thermal pollution - Definition; sources, effects of thermal pollution; control of thermal pollution **1L**
6. Fertilizers, pesticides and their impact on environment **1L**

7. Bio-indicators of environmental degradation- Concept of Bioindicators, bio-indicators as plants, animals, role of bioindicators in pollution control **2L**
8. Threats to the earth: Greenhouse gases and possible effect of global warming **1L**

Credit III-Environmental Biotechnology (15L)

1. Significance of Environmental Biotechnology in agriculture, food security, climate change mitigation, and Environmental Biotechnology for handling pollution **3L**
2. Waste treatment: biological methods used in treatment of sewage **3L**
3. Sludge treatment and its application **2L**
4. Phytoremediation: Concept, process and application in decontaminating soils and water, phyto-extraction, phyto-filtration, phyto-accumulation in remediation of wastewater and degraded soils with examples. **4L**
5. Genetic improvement for bioremediation **1L**
6. Designing bioremediation protocol- Treatments to heavy metal containing wastes **2L**

Credit IV-Conservation Biology, Sustainable Development and Biodiversity (15L)

Conservation Biology and Sustainable Development:

1. *In situ* and *ex situ* conservation strategies, sustainability of wetland and forests, sustainable agriculture; urban planning and sustainable cities **2L**
2. Reviews of various national and international obligations in the environmental protection such as CITIES, RAMSAR, Montreal, Basal, CBD, Koyoto protocol, CDM, carbon sequestration, clean technology and its importance, concept and role of green belt **3L**
3. Environmental legislation in India: Environmental (Protection) Act, Air and water pollution acts **1L**
4. Renewable energy resources: solar energy, geothermal energy, wind energy, wave energy, tidal energy, hydroelectric energy and energy from biomass, Nuclear fuel **2L**

Biodiversity:

1. Biodiversity: Concept and definitions, types of biodiversity- genetic diversity, species diversity,ecosystem diversity **1L**
2. Major ecosystems of the world, phytogeographic regions of world (vegetation belts), Biogeographical zones of India, flora and fauna of India **2L**

3. Loss of biodiversity: Factors affecting diversity, natural versus anthropogenic, present and past rate of loss of biodiversity and its consequences on the human life. **2L**
4. Value and use of biodiversity- Ethical, aesthetic, food, fodder, ornamentals, medicinal, economical and socio-ecological approach etc. **2L**

References:

1. J. S. Singh, S. P. Singh and S. R. Gupta, Ecology, environment and resource conservation by Anamyapublication , New Delhi.
2. K. V. Krishnamurthy, An advanced Text book on Biodiversity, Principles and practices – Oxford IBH , New Delhi.
3. Begon and Harper 1986, Population ecology
4. Kormondy 1996, Concept of ecology
5. Kumar H.D. Concept of ecology
6. Odum, E. P. 1971. Fundamentals of Ecology, Saunders, Philadelphia
7. Odum, E. P. 1983. Basic Ecology, Saunders, Philadelphia.
8. Chapman, J. L. and Reiss, M. J. 1988, Ecology, principles and Applications, Cambridge University Press, Cambridge, U. K.
9. Heywood, V. H. and Watson, R. T. 1985. Global Biodiversity Assessment, Cambridge University Press, Cambridge, U. K.
10. Treshow, M. 1985. Air pollution and plant life, Wiley Interscience.
11. Das. Concept of ecology
12. Nebel, B. J & Wright, R. T. 1981, Environmental Science – the way the world work Prentice Hall.

BO 3.6 Practicals based on BO 3.47 Advanced Environmental Botany

1. Studying pollution indicator plants in terms of morphology and anatomy **2P**
2. Comparison of stomatal index of any six plants from polluted and non polluted areas **2P**
3. Comparison of pollen fertility of any six plants from polluted and non polluted areas **2P**
4. Studying the effect of radiation on plants **2P**
5. Effect of chemical mutagen on plant growth **2P**
6. Estimation of CO₂, DO and BOD of the water samples **2P**
7. Estimation of chlorides and alkalinity of the water sample **2P**
8. Exercise on carbon sequestration **2P**
9. Studying plant community using transect and quadrat method **2P**
10. Interpretation of any six aerial photographs of vegetation **2P**
11. Treatment of wastes by microbes and plants **2P**

Note:

1. Visit to the site of social forestry/agroforestry
2. Visit to water treatment plant and polluted water body and preparation of report

BO 3.48 Advanced Seed Technology (60 Lectures)

Credit I- Introduction to Seed Technology (15L)

- 1. Introduction: 2 L**
 - a. Definition, difference between seed and grain
 - b. Seed quality characteristics
 - c. Important seed industries in India.
- 2. Seed Development, Structure and Chemical Composition: 5 L**
 - a. Floral biology and mode of pollination (autogamy and allogamy)
 - b. Development and structure of megasporangium, microsporangium, male and female gametophyte
 - c. Fertilization and embryo development
 - d. Seed structure (embryo, endosperm and seed coat)
 - e. Chemical composition of seed (carbohydrates, proteins, oils, fats and other)
- 3. Seed Dormancy: 3 L**
 - a. Definition
 - b. Types of dormancy
 - c. Causes of seed dormancy
 - d. Methods of breaking dormancy
- 4. Seed Germination: 5 L**
 - a. Definition
 - b. Types of germination
 - c. Factors affecting seed germination
 - d. Seed vigour and seed ageing
 - e. Seed viability, orthodox and recalcitrant seed

Credit II- Seed Production (15L)

- 1. Seed Production in Field Crops: 5 L**
 - a. Classes of seed
 - b. General principles of seed production
 - c. Maintenance of breeders seed in self and cross pollinated crops
 - d. Seed production techniques in hybrids (use of male sterility, self incompatibility and gametocides)
 - e. Procedure of seed production in cotton and maize (Land requirements, isolation requirements, brief cultural practices, plant protection, rouging, harvesting and threshing)
 - f. Seed village concept

- 2. Vegetable Seed Production: 4 L**
- a. Production and maintenance of nucleus, breeders and foundation seeds in self and cross pollinated vegetable crops
 - b. Brief account of seed production of tomato, brinjal, chilly, okra, onion, cucurbitaceous, fenugreek/coriander, collection, multiplication and storage of clones in potato, true potato seed (TPS) production.
- 3. Seed Processing: 6 L**
- a. Objectives of seed processing
 - b. General layout of seed processing plants
 - c. Pre-cleaners - construction and working
 - d. Preparation of seed for processing - scalper - debearder and huller - construction and working
 - e. Seed drying - optimum temperature range, dryers - construction and working
 - f. Air screen cleaner - construction and working
 - g. Specific gravity separator - principles of operation, construction and working
 - h. Seed treatment - importance - seed treating equipment - slurry treater - principles and working
 - i. Packaging and handling of seeds - weighing platforms - scales - bagging machine - lifting arrangement - screw conveyor, bucket elevator and belt conveyor - construction and working

Credit III- Seed Testing and Allied Aspects (15L)

- 1. Seed Testing: 4 L**
- a. Objectives
 - b. ISTA
 - c. Seed sampling
 - d. Sampling, dividing and mixing equipments
 - e. Procedure of sampling, (kinds- primary, composite, submitted and working)
 - f. Types of seed samples (service, official and certification sample)
- 2. Genetic purity and quality testing- 5 L**
- a. GOT (grow out test).
 - b. Germination test: preparation, apparatus, germination material, Methods-paper, sand and soil, evaluation-normal, abnormal seedlings and ungerminated seeds.
 - c. Moisture testing: Moisture Meter and Air Oven Method as per ISTA rules.
 - d. Physical purity analysis
 - e. Quick viability test (Tz).
 - f. Aids for varietal identification: PCR, RAPD, RFLP, DNA finger printing, ELISA test.
- 3. Seed Certification and Quality Control: 3 L**
- a. General procedure for seed certification
 - b. Genetic purity maintenance

- c. Seed Certification Board, Central Seed Committee and their functions.
 - d. Minimum seed certification standards (field and seed)
- 4. Field Inspection: 3 L**
- a. Seed inspector, powers and duties
 - b. Number of inspection with reference to stage of crop
 - c. Procedure and observations during field inspection

Credit IV- Seed Legislation and Seed Pathology (15L)

- 1. Seed legislation: 2 L**
- a. Seed legislation in India
 - b. Types of seed legislation.
- 2. Artificial Seed Production: Introduction, concept, procedure. 1 L**
- 3. Seed Pathology: 4 L**
- a. Scope and economic importance of seed borne diseases
 - b. Significance of seed transmission (soil, air, insect, and nematodes)
 - c. Entry point, mechanism of seed transmission
 - d. Impact of seed infection on seed, quarantine for seed
 - e. Seed crop management-disease free seed production, integrated management of seed borne diseases
 - f. Seed health testing methods
- 4. Seed entomology: 4 L**
- a. Relation of insects and plants
 - b. Fibre crop pests, pests of pulses, vegetable pests-any one from each
 - c. Seed store grain pests (any two) with respect to their life cycle, way of infestation and control measures.
- 5. Seed Deterioration and Seed Storage: 4 L**
- a. Definition, manifestation and causes of seed deterioration.
 - b. Prevention measures of seed deterioration.
 - c. Definition of seed storage
 - d. General principles of seed storage
 - e. Constructional features for good seed warehouse, other measures for pest and disease control, sanitation, seed treatment, fumigation, dehumidification, refrigeration (cold storage).

Reference:

1. Anonmyous. 1997. Seed Technology in Tropics. ISTA Zurich.
2. Agrawal, R.L. 1996. Seed Technology, IBH publishing Co., New Delhi.
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5. Thompson, J.R. 1977. Advances in Research and Technology of Seeds. Part - 1, 3 & 4. Centre for Agrl. Publishing and Documentation, Washington.
6. Desai. B.B., P.M Kotecha and D.K. Salunkha. 1997. Seeds Hand Book - Biology Production, Processing and Storage. Marcel Dekker. New York.
7. Khairwal. P.S., C. Ram and A.K. Chabra. 1997. Pearl millet Seed Production and Technology. Manohar book service, New Delhi.
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9. Rai. M. and S. Mauria. 1995. Hybrid Research and Development. Indian Society of Seed Technology. IARI. New Delhi.
10. Jaima Kigel, J. and G. Galili. 1997. Seed Development and Germination. Marcel Dekker, New York.
11. Khan, A.A. 1977. The Physiology and Bio-chemistry of seed Dormancy and Germination. North Holland Publishing Co., Amsterdam, New York.
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13. Purseglove, J.W. 1977. Tropical crops of Monocotyledons, Longmans, Green and Co., Ltd., London.
14. Bewley, J.D. and M. Black. 1982. Physiology and Biochemistry of Seeds in relation to Germination, Vol. I & II. Springer Verlag, Berlin, Heidelberg, New York.
15. Justice, O.L. and L.N. Basu. 1978. Principles and Practices of Seed Storage. Castle House Publications Ltd, Great Britain.

BO- 3.6 PRACTICALS BASED ON SPECIAL PAPER

BO 3.48 ADVANCED SEED TECHNOLOGY

(Any 24 Practicals)

1. Study of floral biology of crops- cotton/okra, chilly/tomato, soybean/chick pea/ground nut, maize/wheat, sorghum/bajra **(4P)**
2. Grow Out Test **(1P)**
3. Study of seed germination (epigeal, hypogeal and viviparous types). **(1P)**
4. Study of seed germination testing methods (paper, soil and sand). **(1P)**
5. Preparation of artificial seed- demonstration **(1P)**
6. Study of physical purity test **(1P)**
7. Quick viability test (Tz). **(1P)**
8. Moisture testing by moisture meter and oven method **(1P)**
9. Sampling, dividing and mixing equipments **(1P)**
10. Analysis of seed samples for discolouration, abnormalities, fungal structures. **(2P)**
11. Detection and identification of important seed borne fungi by various detection methods- washing, agar and blotter method (*Alternaria*, *Colletotrichum*, *Fusarium*, *Phoma*, *Microphomina* and *Mucor*). **(2P)**
12. Detection and identification of seed borne bacteria **(1P)**
13. Study of important pests of Kharif (rainy) and Rabi (winter) cereals, their life cycle, damage and control measures (any two pests from each). **(2P)**
14. Study of the life cycle of store grain pests, damage and control measures (any two from each). **(2P)**
15. Visit to warehouse, storage godown and nearby seed industry. **(1P)**
16. Compulsory industrial visit to study processing sequences, TPS production (True Potato Seed), R & D fields (PCR, RAPD, RFLP and DNA finger printing) **(1P)**
17. Collection, submission of crops and storage pests, different seed varieties of any three-crop plants **(1P)**

BO 3.49 Advances in Horticulture and Floriculture

Credit I -Introduction to Horticulture (15L)

1. Importance and classification:- definition, branches of horticulture, importance of horticultural crops, nutritive value of fruits and vegetables in human nutrition, classification of horticultural crops **3L**
2. Soil and climate requirements of fruit crops:- climate and its influence on fruit crops, fruit growing zones in india, soil and its relation to fruit growing **2L**
3. Planning, lay-out and planting of fruit crops:- selection of site, preliminary operations, planning of orchards, systems of planting orchards, lay-outs for planting trees, spacing, digging of pits, selection of plant material, windbreaks **5L**
4. Propagation methods of fruit plants:- medium of propagation, sexual methods: seed propagation, seed storage, pre-germination treatments, sowing of seeds, apomixis, asexual or vegetative methods of propagation, micropropagation **3L**
5. Manuring, irrigation and cultural practices:- essential plant nutrients, principles of manuring, water requirements of fruit plants, methods of irrigation, orchard soil management **2L**

Credit II-Pomoculture(15L)

1. Present status and scope of fruit growing in India and Maharashtra, importance of fruit growing **3L**
2. Growth and fruiting habits: growth and fruiting habits, fruit bud differentiation, fruit setting, fruit drop, seedlessness, cracking of fruits, problems of fruiting, Bahar treatment, Unfruitfulness, pruning and training, role of plant growth substances **3L**
3. Harvesting and marketing: harvesting and marketing of fruits, care after picking, packing of fruits, systems of marketing, export potential, air transport, transport by sea, cold storage of fruits **3L**
4. Dryland horticulture:- importance of dryland fruits, selection of dry land fruits, rainwater management **3L**
5. Organic horticulture: definition, synonyms and misnomers, principles, methods, merits and demerits, organic farming systems, components of organic horticulture systems, different organic inputs, role of biofertilizers in organic horticulture **3L**

Credit III- Olericulture(15L)

1. Olericulture:concept, definition, classification of vegetable crops, present status and prospects of vegetable cultivation, nutritional and medicinal value, **2L**
2. Origin, history, evolution and distribution of vegetable crops, botanical distribution of families, genera and species covering tropical, subtropical and temperate vegetables **3L**
3. Production technology of vegetables: introduction, soil and climate requirements, commercial varieties, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigational requirements, intercultural operations, weed control, mulching physiological disorders, harvesting and post-harvest management , plant protection methods of following vegetables- a) tomato b) cabbage c) bhindi d) peas and beans. **8L**
4. Protected cultivation of vegetables: importance and scope of protected vegetable production **1L**
5. Post-harvest / processing of vegetables: major value added products from vegetables **1L**

Credit IV- Floriculture(15L)

1. Floriculture : Concept, definition, Scope and Importance of floriculture, global scenario of flowers, scope of floriculture in India **2L**
2. Pre-requisites of commercial floriculture: soil and climate requirements, field preparation, systems of planting, water and nutrient management, weed management, rationing, training and pruning, pinching and disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies **3L**
3. Harvesting and processing of flowers: harvesting indices, harvesting techniques, post-harvest handling and grading, pre cooling, packing and storage, value addition, concrete and essential oil extraction, transportation and marketing, export potential, agri-export zones **5L**
4. Commercial production of flowers: varietal wealth and diversity, climate, soil preparation, aftercare and mairing, pruning and training, harvesting, yield, important pests and diseases, control measures, harvesting, grading, packing and marketing , storage and transport, export potential of cut flowers: *Chrysanthemum*, *Gerbera*, Tuberose, *Anthurium*;Loose flowers- Scented Rose and Jasmine **5L**

Reference Books:

1. Principles of Horticulture and Fruit Growing by Y. N Kunte, M.P Kawathalkar and K.S Yawalkar (Agri- Horticultural Publication House, Nagpur)
2. Arora J. S *Introductory Ornamental Horticulture* Kalyani Publications
3. Bose T. K and Yadav L. P *Commercial Flowers* Naya Prokash
4. Singh B. D *Plant Breeding* Kalyani Publications
5. Chadha K. L and Pareek O. P *Advances in Horticulture* Vol. IV, Malhotra Publications
6. Sudheer K. P and Indira V *Post Harvest Technology of Horticultural Crops* New Delhi.

BO 3.6 Practicals Based on BO 3.49 Advanced Horticulture and Floriculture

1. Study of garden tools and implements **1P**
2. Study of different media, containers and potting and repotting **1P**
3. Preparation of nursery beds and raising of nursery seedlings **1P**
4. Study of different methods of cutting and layering **1P**
5. Study of different methods of budding and grafting **1P**
6. Methods of training and Pruning **1P**
7. study of different Bahar treatments used in fruit plants **1P**
8. Identification and description of species/ varieties of any two fruit plants with respect to propagation, cultural practices and irrigation **1P**
9. Identification and description of species/ varieties of any two vegetables with respect to propagation, cultural practices and irrigation **1P**
10. Identification and description of species/ varieties of any two flowering plants with respect to propagation, cultural practices and irrigation. **1P**
11. Study of pests and diseases (any two) of fruits, vegetables, and flowers and their control measures **2P**
12. Study of methods of postharvest technology for fruits and vegetables. **1P**
13. Study of methods of postharvest technology for flowers (cut flowers) **1P**
14. Study of different protective structures with respect to design, components, orientation and construction **1P**
15. Study of special cultural practices for flower crops under protected structure **1P**
16. Gerbera–identification and description of species/varieties – propagation and planting –pruning management **1P**
17. Study of response of micronutrients and macronutrients on growth of cut flowers. **1P**
18. Diseases and Pests of Roses and Gerbera in nurseries **1P**
19. Preparation of project, Cut flower production, **1P**
20. Project preparation of protected cultivation of important horticultural crops **1P**

Note:

1. Visit to flower growing areas – Cut flowers/Floriculture industry
2. Visit to plant Horticulture Nursery/Greenhouse/Polyhouse
3. Visit to agriculture university to see Pomoculture, Olericulture and floriculture practices

BO 3.50 Advanced Biodiversity

Credit I- Introduction to Diversity (15L)

	<p>1. Biodiversity</p> <p>Definition, perspective, scope and importance.</p>	1L
	<p>2. Genetic Diversity</p> <p>Introduction, Nature and origin of genetic variations, Measurement of genetic diversity. Methods based on DNA and chromosome: - allozymes. DNA based Marker technique:- RFLP, PCR and RAPD</p>	2L
	<p>3. Species Diversity</p> <p>Species inventory, origin of species diversities, diversity indices, species richness and species abundance, alpha, beta and gamma diversity.</p>	2L
	<p>4. Ecosystem Diversity</p> <p>Classification of ecosystems, Major ecosystems of the world: 1. Tropical Forest 2. Grasslands 3. Temperate Forest 4. Arid and Semiarid lands 5. Arctic and Alpine, 6. Wet land a. Fresh water b. Marine water 7. Agro ecosystems 8. Boreal Forest, 8. Agro ecosystems: - Urban and Peri-urban Diversity.</p>	3L
	<p>5. Diversity At Taxonomic Level</p> <p>Diversity at taxonomic level with reference to species, habit, habitat, distribution and evolutionary success.</p> <ol style="list-style-type: none"> 1. Algal Diversity. 2. Lichen Diversity. 3. Bryophytes Diversity. 4. Pteridophytes Diversity. 5. Gymnosperms Diversity. 6. Angiosperms Diversity. 	7L
	<p>Credit II- Assessment and Loss of Biodiversity (15L)</p> <p>1. Assessment and Monitoring of Biodiversity</p> <p>Introduction, Methods of assessing and measuring biodiversity:-</p>	4L

	<p>Diversity indices based on species:-</p> <ol style="list-style-type: none"> 1. Species richness 2. Species abundance 3. Taxic diversity <p>Comparison of different sampling techniques for monitoring plant, bird, insect, mammals, reptiles and fish biodiversity.</p>	
	<p>2. Magnitude and Distribution of Biodiversity</p> <p>Current status of plant diversity, Global distribution of biodiversity, Identification of diversity hotspots, Biodiversity of India, Endemism and biodiversity</p>	4L
	<p>3. Loss of Biodiversity</p> <p>Introduction</p> <p>Loss of Genetic Diversity</p> <p>Factors affecting genetic diversity</p> <ol style="list-style-type: none"> 1. Founder effects 2. Demographic bottle necks 3. Genetic drift 4. Inbreeding depression <p>Loss of Species diversity</p> <p>Introduction Habitat fragmentation Population size as a critical factor in species extinction MVP and population viability analysis Meta population concept</p> <p>Threatened Species</p> <p>IUCN threatened categories and unknown categories Census of threatened species Common features of threatened species</p> <p>Loss of Ecosystem diversity</p> <p>Loss of ecosystem diversity. Factors affecting ecosystems degradations and loss.</p> <p>Loss of Agrobiodiversity</p>	7L

<p>Credit III - Conservation of Biodiversity (15L)</p>	
<p>1. Introduction and Concept Conservation of genetic diversity, species diversity, and ecosystem diversity.</p> <p>2. In-situ and ex-situ conservation In-situ conservation methods :- protected areas, biosphere reserves, national parks, on farm and home garden conservation Ex-situ conservation methods: - germplasm collection, botanic gardens, seed banks, test tube gene banks, , pollen bank, field gene banks, DNA banks.</p> <p>3. Ecosystem restoration. Social approach to conservation and indigenous knowledge systems :- Sacred groves and Sthalavrikshas. People’s movement for Biodiversity conservation Chipko movement, Chico River dam and Tribal Campaign. Role of educational institutes in biodiversity conservation.</p>	
<p>Credit IV -Management of Plant Biodiversity (15L)</p> <p>1. Management of Plant Biodiversity Current magnitude of plant diversity, an overview of the variety of life forms; global distribution of biodiversity, factors affecting species distribution, number of species worldwide, estimates and examples of recently discovered communities, abundance of species in different ecosystems of the world; abundance of species in different ecosystems of the world: identification of diversity hot-spots; biodiversity of India; endemism and biodiversity.</p>	8L
<p>2. Values and Uses of Biodiversity Ethical values, aesthetic values, food, fodder, ornamentals, medicinal, economical and sociological approach</p>	3L
<p>3. Biodiversity and Biotechnology Biotechnology and its role in assessment of biodiversity and bio-resources. Biotechnology and its role in conservation and utilization Adverse impact of biotechnology on biodiversity: direct and indirect.</p>	4L

BO 3.6 Practicals based on BO 3.50 Advanced Biodiversity		
1.	Analysis of aquatic vegetation studies - algae and fungi	02
1.	Estimation of algal and fungal species diversity in soil sample	02
2.	Study of vegetation including lower groups by belt transect along slope gradient.	02
3.	Study the biomass profile of the plants in an herbaceous ecosystem.	01
4.	Prepare shoot/canopy profile of tree stand along the line transect.	02
5.	Find out various diversity indices with the help of computer software.	02
6.	Remote sensing techniques for vegetation/ plant diversity assessment using satellite imagery and aerial photographs.	02
7.	Construction of quadrat- To study the percentage of frequency, density, abundance and their relative values of forest communities. Prepare their frequency class diagram and compare them with Raunkiaers normal frequency diagram and also find out the Simpson's index of dominance.	04
8.	Methods for estimating above-ground biomass for carbon pool assessment.	02
9.	Methods for estimating below-ground biomass for carbon pool assessment.	02
10.	<i>Ex-Situ</i> conservation methods of biodiversity- Micro propagation.	01
11.	Map of Phytogeographical regions of India	01
12.	Study of any three endangered plant species	01
Note:	Field trip to places for study of vegetation type(including any one plant diversity hotspot/national park/wild life sanctuary/Sacred groove) prescribed in the syllabus for 2 to 5 days under the guidance of teachers. Preparation and submission of field visit report. (Compulsory)	

References:

1. Textbook of Biodiversity- K V Krishnamurthy, *Science Publishers, Inc, USA*, 2003.
2. Plant Conservation and Biodiversity, Series: Topics in Biodiversity and Conservation, Vol. 6, Hawksworth, David L.; Bull, Alan T. (Eds.) Reprinted from Biodiversity and Conservation, 20073.
3. Plant Biodiversity and Taxonomy, M.P.Singh, B.S. Singh and Soma Day, *Daya Books*, 2002.
4. Restoration and endangered species (1996) ed. Bowles M.L. and Whelan C.J. Cambridge University press.
5. Preservation and valuation of Biological resources (1990) orians G.H, Brown G.M., Kunin. W.E. and Swierbinski J.E. University Washington Press.
6. Paradise Lost? The ecological economics of Biodiversity 1994, Barbier E.B., Burgess J.C. and Folke C., Earthscan London.

7. Molecular Markers, Natural history and Evolution (1994) Avise JC, Chapman and Hall London
8. Forest Genetic Resources: Status, Threats and Conservation strategies (2001), Umashaanker, R Ganeshiah K.N and Bawa K.S, Oxford and IBH, New Delhi.
9. Global biodiversity strategy: Guidelines for action to save, study and use Earth's biotic wealth sustainably and equitably (1992). WIR/IUCN/UNEP;WRI Publ, Baltimore, MD.
10. Plant Biodiversity hot spots in India: An overview (1997) Etd. Hajra P.K and V Mudgal, BSI.
11. Biomass studies- Field methods for monitoring Biomass (1997) Shaileja Ravindranath and Sudha Premnath,Oxford and IBH, New Delhi.
12. Ecological census techniques- A hand book (1997) William J. Sutherland. Cambridge university Press.
13. Status, Conservation and management of Wetlands (2002) T.V. Ramchandra, R. Kiran, N Ahalya,. Allied Publication New Delhi.
14. Statistical Ecology (1988). John A. Ludwig and James F. Reynolds.John Wiley & sons.
15. Ecological diversity and its measurement (1988) Magurran Anne. Chapman and Hall India.
16. Ecological methods for Field and laboratory investigation (1984) Michael P, TMH Company Ltd. Bombay.

BO 3.5 Practicals Based on BO 3.1, BO 3.2 and BO 3.3

Gymnosperms

1. Study of external, internal and reproductive morphology of *Cycas* and *Zamia* **1P**
2. Study of external, internal and reproductive morphology of *Pinus*, *Cupressus*, *Araucaria*, *Agathis* and *Podocarpus* **1P**
3. Study of external, internal and reproductive morphology of *Gnetum* and *Ephedra* **1P**
4. Study of fossil specimens of gymnosperm (any six) from order Pteridospermales, Cycadeoidales and Pentoxylales **1P**

Angiosperms

1. Study of plant families (at least 8 locally available families- Six of Dicotyledons and two of Monocotyledons. **2P**
2. Identification of genus and species of locally available wild plants (any four) **1P**
3. Preparation of vegetative and reproductive botanical keys of any six plants from different families **1P**

Note:

1. Field trips of atleast two days for collection and preparation of field notes and its submission.
2. Submission of report of at least 50 plant species from medicinal plants, endemic plants and exotic weeds from local area.

Practicals - Developmental Botany

1. Isolation of shoot apical meristems from seedling, young and mature vegetative plant and tracing the course of stomatal development and observations on stomatal types. **1P**
2. Histochemical analysis of secondary growth (primary to secondary axis) and comparison between vegetative SA and reproductively induced SA **1P**
3. Observations on **1P**
 - a. Microsporogenesis and development of male gametophyte (pollen)
 - b. Megasporogenesis and development of female gametophyte
 - c. Types of endosperm, dissection and isolation of endosperm **2P**
4. Observations on stages of embryo development, dissection and isolation of developing embryo (3 stages) and *in vitro* germination of spore/pollen **1P**
5. Organogenesis in *in vitro* cultured tissues and somatic embryogenesis in *in vitro* cultured tissues

2P

Economic Botany

1. Study of any four cereals, legumes oil seeds, vegetables, fruits, fibres, wood, essential oils w.r.t. botanical name, common name and applications. **2P**

Industrial Botany I

1. Study of any six sea weeds with applications **1P**
2. Isolation and culture of *Spirulina* **1P**
3. Isolation, maintenance and culture establishment of any two nitrogen fixing algae **2P**
4. Study of any four bio-pesticides and their market products **1P**
5. Extraction of biodiesel from oil seeds/algae by transesterification process **1P**
6. Extraction of and estimation of citric acid by titration and spectrophotometric method **2P**
7. Study of any eight fermentation products of commercial importance from local market with reference to source and applications **1P**
8. Quality testing of *Trichoderma* (total viability count) biofertilizer **1P**

Note:1. Visit to management institute and preparation of report is compulsory

2. Visit to any industry with reference to BO 3.3 (Industrial Botany I)

BO 4.1 Computational Botany (60 L)

Credit I- Basic Biostatistics (15 L)

1. Introduction to Statistics

9L

Measures of central tendency – mean, mode, median and their properties

Measures of dispersion – variance, standard deviation, coefficient of variance

Symmetry and skewness, measures of skewness, kurtosis

Sampling and sampling distributions – concept of sample and population, statistic, standard error, methods of sampling

2. Correlation and regression

6L

Bivariate correlation, positive correlation, negative correlation

Measures of correlation – Scatter diagram, Karl-Pearson's coefficient of correlation, Spearman's rank correlation coefficient

Regression – Equations of regression lines using least square method, regression estimate and its standard error

Credit II- Experimental Statistics (15 L)

1. Design of experiments and analysis of variance

8L

Principles of design – randomization, replication, local control, treatment group and control group

Guidelines for designing the experiments, size of plot, number of replications

Completely randomized design (CDR), randomized block design (RBD)

Analysis of variance table (ANOVA), standard error, critical difference for pairs of treatments

Tukey's test for pairwise comparison of treatments

Dunnet's test for comparison of treatment means with control

Duncan's multiple range test

Mann-Whitney U test

2. Testing of hypothesis

7L

Hypothesis, statistical hypothesis, critical region, level of significance, p-value, normal distribution

T-test: t-test for mean, equality of two means, paired t-test, unpaired t-test, chi-square test: chi-square test for goodness of fit, independence of attributes, non-parametric test

NOTE – Emphasis be given on methodology and numerical problem solving rather than derivations and proofs.

Credit III - Bioinformatics (15 L)

1. Bioinformatics- Introduction to databases and retrieving information from databases: NCBI, EMBEL etc. **1L**
2. Molecular tools in protein and nucleotide sequence analysis; origin of new genes and Proteins, gene duplication and divergence **3L**
3. Sequence similarities:
 - a. Pair wise comparison of DNA and protein sequences, dynamic programming algorithms, FASTA and BLAST. **3L**
 - b. Multiple sequence alignments, progressive methods, iterative methods, localized alignments **3L**
 - c. Determining phylogenetic relationships using DNA and protein sequences **3L**
 - d. Protein structure prediction, motifs and domains **2L**

Credit IV-Biomathematics (15L)

1. Types of measurement and their units **1L**
2. Making solutions – moles and molarity, stock solutions and dilutions, making media and reaction mixtures **4L**
3. Ions and electrical potentials – Nerst and Goldman equations **1L**
4. Osmolarity and osmotic pressure measurements **1L**
5. Quantification of chemical reactions – equilibrium constant, reaction rates **1L**
6. pH measurements and preparation of buffers **2L**
7. Measuring concentrations using spectrophotometry **1L**
8. Measurement of enzyme activity **2L**
9. Specific activity of radioisotopes, making radioisotope solutions **1L**
10. Cell counting using serial dilutions, haemocytometry **1L**

Reference :

1. Lab Math – Adams, D.S. I.K. InternationsPvt Ltd. New Delhi, 2004
2. Statistical Methods – Snedecor G.W. and Cochran W.G. Affiliated East-West Press Pvt. Ltd. 1989
3. Statistical methods in Agriculture and Experimental Biology – Mead, R. and Curnow, R.N. Chapman and Hall, 1983
4. Practical statistics and experimental design for plant and crop science – Clewer, A.G. and Scarisbrick, A.H. , John Wiley, New York, 2001

5. Bioinformatics - Westhead, DR, Parish JH and Twyman, RM, BIOS Scientific Publishers Ltd., Oxford, 2003
6. Bioinformatics – Sequence and genome analysis. D.W. Mount, CBS Publishers, New Delhi, 2003
7. Bioinformatics and Molecular Evolution – Higgs PG and Attwood, TK

BO 4.2 Plant–Organism Interactions (60 L)

Credit I – Plant –Plant interactions (15 L)

- | | |
|-------------------------------------|-----------|
| 1. Introduction, | 1L |
| 2. Allelopathy in plants | 4L |
| 3. Parasitic association in plants | 3L |
| 4. Competitive mechanisms in plants | 4L |
| 5. Epiphytic plants | 3L |

Credit II- Herbivory and Carnivorous Plants

- | | |
|--|-----------|
| 1. Herbivores–insect-plant interaction, grazing animals–physical and biochemical interactions | 4L |
| 2. Plant signaling and defense against herbivores | 4L |
| 3. Genetic engineering in plants for improved tolerance against herbivores | 3L |
| 4. Carnivorous plants – morphological features, specialized biochemical mechanisms for nutrient processing | 4L |

Credit III Symbiotic Associations

- | | |
|--|-----------|
| 1. Lichens | 3L |
| 2. Endophytic association of plants – algae, bacteria, fungi | 3L |
| 3. Mycorrhizae | 3L |
| 4. Nodulating bacteria | 2L |
| 7. Algae and coral relationships | 2L |
| 8. Fungal-insect relationships | 2L |

Credit IV Pollination and Dispersal Biology

- | | |
|---|-----------|
| 1. Pollination types and mechanisms – flower structure with reference to pollination mechanisms, mimicry, thermogenesis | 4L |
| 2. Pollinators – bees, beetles, butterflies, birds, mammals | 4L |
| 3. Co-evolution of pollinators and plants, fig-fig wasps interaction, humming bird-plant interaction, etc | 3L |
| 4. Seed dispersal mechanisms –fruit and seed morphology relevant to seed dispersal | 4L |

References:

Walter Larcher 1995 “Physiological Plant Ecology”. 3rdEds. Springer – Verlag, New York Berlin Heidelberg

Zdenek Lastuvka, Barbara Politycka, S. S. Narwal, Jana Kalinova 2007, "Coactions and Competition in Higher Plants", Scientific Publisher (India).

Malcolm C. Press, Jonathan D. Graves 1995, "Parasitic Plants", Chapman & Hall, 2-6 Boundary Row, London.

Peter Scott 2008, "Physiology and Behaviour of Plants". John Wiley & Sons Ltd.

R.S. Mehrotra. Introduction to Mycology. Wiley Eastern.

Hans Lamberts and Thijs L. Pons Plant Physiological Ecology, Springer Publication.

BO 4.3 Industrial Botany Part II (60L)

Credit I- Herbal Technology (15L)

1. Introduction, concepts and prospects **2L**
2. Phyto-technology- value addition to biodiversity through chemo prospection **3L**
3. Medicinal plants mentioned in Atharva-Veda with their application **2L**
4. Medicinal mushrooms for healthy life **2L**
5. Natural dyes for cotton and silk industry –*Tecomella* leaves, Katha and Ravenchi wood, Seeds of *Bixa*, Babul flowers **2L**
6. Medicinal herbs for dying hair and in cosmetics **2L**
7. Aromatic plants as important sources of essence **2L**

Credit II- Gardening and Forest Botany (15 L)

1. Floriculture- significance, importance, scope, prospects and role of floriculture in developing country, its scope for domestic and export market, factors affecting flower production, production of cut flowers and maintaining its quality, prolonging of vase life, packaging of cut flowers, cultivation of carnation, Gerbera, gladiolus, jasmines, orchids **5L**
2. Principles of garden design **1L**
3. Styles of gardening **1L**
4. Indoor gardening **1L**
5. Landscape gardening- Bio-aesthetic planning, landscaping of highways, railway stations and railway lines, bank of rivers and canal, city, town and country sides, educational institutes and factories **2L**
6. Forest Botany- Forest, forestry and man, forest resources, forest organization, forest industries, social forestry, forest management, forests economics **5L**

Credit III - Industrial Plant Tissue culture (15 L)

1. Laboratory design, maintenance of plant tissue culture laboratory, sterilization practices in plant tissue culture laboratory. **3L**
2. Case studies of micro propagation of banana, sugarcane, *Lilium*, orchids and Gerbera with respect to:
 - a. Selection of elite plants
 - b. Preparation of explants
 - c. Surface sterilization
 - d. Initiation of cultures

- e. Subculture
- f. *In-vitro* rooting/ *In-vivo* rooting
- g. Acclimatization of tissue cultured raised plants
- h. Market potential (National, International) **7 L**
- 3. Transporting of ex-agar plantlet, rooting of ex-agar plantlet **1L**
- 4. Economics of micropropagation of banana, sugarcane, *Lilium*, orchids and Gerbera **2L**
- 5. Preparation of bankable techno-commercial reports of micropropagation of banana, sugarcane and *Lilium* **2L**

Credit IV - Post-Harvest Technology of Fruits (15 L)

1. General account of tropical and subtropical fruits **2L**

- a) Introduction
- b) World fruit production and contribution to gross domestic product (GDP)
- c) Global consumption of tropical and subtropical fruits
- d) International trade in tropical and subtropical fruit

2. Postharvest biology of tropical and subtropical fruits **4L**

- a) Introduction
- b) Diversity in fruit characteristics
- c) Maturation and ripening
- d) Quality attributes
- e) Environmental factors affecting deterioration
- f) Biological factors affecting deterioration
- g) Pathological disorders and insect infestation
- h) Biotechnological approaches for improving quality and postharvest life

3. Postharvest technologies of fruits **4L**

- a) Introduction
- b) Maturity and harvesting indices- harvesting, conditioning, quality, the cold chain, centralized packing operations, ripening, processing

4. Preservation and processing of fruits **5L**

- a) Principles of conventional methods of preservation
- b) Fruit preparation for preservation purposes
- c) Refrigeration and freezing
- d) Drying
- e) Manufacturing and canning of fruit beverages and purees
- f) Manufacturing of jams and jellies

Reference Books

1. Post-harvest handling of tropical fruit, B R Champ, E Highley& G I Johnson (eds), Australian Centre for International Agricultural Research

2. Post-harvest technology of fruits and vegetables: Handling, processing, fermentation and waste management, L R Verma and V K Joshi, Indus Publishing Company.
3. Postharvest biology and technology of tropical and subtropical fruits: Volume 1: Fundamental issues, Edited by E Yahia, Universidad Autónoma de Querétaro, Mexico, Woodhead Publishing Series in Food Science, Technology and Nutrition No. 206
4. Processing of Fruits and Vegetables for Value Addition, Vijay Sethi, B.C. Dekka, Vijay Sethi, ShrutiSethai, ShrutiSethi, Indus Publishing.
5. Handbook of Fruits and Fruit Processing, Y.H. Hui, John Wiley & Sons.
6. Advances in Fruit Processing Technologies, Sueli Rodrigues, Fabiano Andre NarcisoFernandes, CRC Press.
7. Quality Control in Fruit and Vegetable Processing, Issue 39, Food & Agriculture Org.
8. Small Scale Food Processing: A Guide to Appropriate Equipment, Peter Fellows, Ann Hampton, Intermediate Technology Publications.
9. Hand book of horticulture, ICAR, New Delhi
10. Floriculture in India, Randhawa and Mukhopaddhay
11. Gardening in India, Bose and Mukherjee, Oxford
12. Introductory ornamental horticulture, Arora, Kalyani publishers
13. Forest Management in India, Vasant Desai, Himalaya Publications
14. Forest and Forestry, K P. Sagreiya, National Book Trust

BO 4.4 Plant Pathology (60 L)

CreditI - Introduction to Plant Pathology (15L)

1. Plant Pathology- Milestones in plant pathology **1L**
2. Plant pathology and its objectives **1L**
3. Nature and concept of plant disease, classification of plant diseases **2L**
4. Causes of plant diseases, symptoms of plant diseases, disease cycle **2L**
5. Bacterial and mollicutes diseases of plants. **2L**
6. Viral diseases of plants Diseases caused by viruses. **2L**
4. Nematodal diseases of plants **2L**
5. Plant disease epidemiology and forecasting of plant disease epidemics. **2L**
6. Effect of plant diseases on human affairs **1L**

CreditII - Pathogenesis (15L)

1. Pathogenesis: Penetration, infection and spread of diseases **4L**
2. Effect of pathogen on plant physiological functions **4L**
3. Enzymes and toxins in plant disease **4L**
4. Pathogenicity of biotrophic and necrotrophic pathogens **3L**

Credit III–Disease Development (15 L)

1. **Environmental factors and disease development**- effect of temperature, humidity, soil pH, soil texture, light, CO₂ and O₂ levels, nutrients and disease development **4L**
2. **Genetics of plant pathogen interactions**- genetics of host parasitic interactions, phytoalexin and antigenhypothesis, vertical and horizontal resistance, physiological specialization, adaptation of fungi to different hosts **3L**
3. **Plant defense mechanism**- morphological and biochemical defense, defense through induced synthesis of proteins and enzymes, detoxification of pathogen toxins and hypersensitivity of defense reactions, concept of phytoncides **3L**

4. **Molecular biology** of host pathogen interactions, pathogenesis genes, avirulence genes, host-R genes, effector molecules, miRNA **3L**
5. **Concept of post-harvest diseases of fruits, vegetables and seeds** **2L**

Credit IV-Disease Management and Related Aspects (15 L)

1. Diagnostic methods for detecting pathogens **2L**
2. Breeding methods for improving resistance in plants **3L**
3. Control of disease using fungicides and other chemicals **2L**
4. Bio-control agents for controlling disease **2L**
5. Disease control using biological and chemical activators of resistance **2L**
6. Plant disease assessment **2L**
7. Biotechnology and its role in plant pathology **2L**

References:

1. Plant Pathology by R. S. Mehrotra, first edition, McGraw-Hill Education publication, 1982.
2. Plant Pathology by George N Agrios, fifth edition, Academic Press, London, 2005.
3. Plant Nematode: Morphology, Systematics, Biology and Ecology by M. R. Khan, first edition, Science Publishers, 2008.
4. Plant Pathogenesis and Resistance by Jeng-Sheng Huang, first edition, Springer, Netherlands, 2001.
5. Plant Pathology by R. S. Mehrotra and Ashok Agarwal, second edition, Tata McGrawHill Education, 2003.
6. Biocontrol of Plant Diseases by P. C. Trivedi, first edition, Aavishkar Publishers and Distributors, 2007.
7. Concise Encyclopedia of Plant pathology by P. Vidhyasekaran, first edition, CRC Press, 2004.
8. Topics in Mycology and Pathology by L. N. Nair, first edition, New Central Book Agency Kolkata, 2007.
9. Fundamentals of plant pathology by A.K. Sinha, Kalyani Publishers
10. Disease of crops plants of India by Rangswami and Mahadevan, Prentice Hall Publication

BO 4.5 Practicals based on BO 4.1,BO 4.2, BO 4. 3 and BO 4.4

Biostatistics (eight practicals)

1. Measurement of central tendency (mean, mode and median), variance, standard deviation, coefficient of variance and standard error from the given grouped and ungrouped data. **1P**
2. Measures of skewness and measures of Kurtosis (grouped and ungrouped data). **1P**
3. Determination of regression lines and calculation of correlation coefficient – grouped and ungrouped data. **1P**
4. Examples based on t – test **1P**
5. Drawing a simple random sample with the help of table of random numbers. **1P**
6. Chi-square test for goodness of fit and independent attributes. **1P**
7. Analysis of variance on the given data (ANOVA) **1P**
8. Tukey's test for pairwise comparison of treatments **1P**
9. Dunnet's test for comparison of treatment means with control **1P**
10. Duncan's multiple range test for comparing treatment means **1P**
11. Determination of Karl-Pearson's coefficient of correlation from the given grouped and ungrouped data. **1P**
12. Determination of Spearman's rank correlation coefficient from the given grouped and ungrouped data. **1P**

Note: Any four practicals from practical number 1 to 6 and any four practicals from practical number 7 to 12

Bioinformatics (any two practicals)

1. Databases and database searching and DNA and protein sequence comparisons **1P**
2. Pairwise comparison of DNA and protein sequences – BLAST **1P**
3. Multiple sequence alignments, progressive methods, CLUSTAL **1P**
4. Determining phylogenetic relationships using DNA and protein sequences **1P**

Plant-Organism Interaction

1. Study of parasitic plants, epiphytic plants, carnivorous and lichens any two plants from each **1P**
2. Study of seed dispersal mechanism in plants with any six examples **1P**
3. *In vitro* allelopathic studies **1P**
4. Study of nodulating bacteria (*Invitro* and *invivo*) **1P**

Industrial Botany II(Any FivePracticals)

1. Extraction of essential oil by Soxhlet apparatusand preparation of dyes from any five flowering plants **1P**
2. Qualitative tests for carbohydrates, starch, proteins, lipids, alkaloids and tannins **1P**

3. Study of any 10 herbals used in medicine and preparation of reports of herbal products from local Market **1P**
4. Micropropagation of banana, sugarcane and *Lilium* **1P**
5. Study of any four post harvest diseases of fruits and submission of report on general post-harvest technology methods followed by farmers **1P**

Plant Pathology

1. Study of any two each- bacterial, nematodal and viral diseases **1P**
2. Study of any six fungal diseases **1P**
3. Isolation of fungal pathogens from leaves, stem and roots by cultural methods **1P**
4. Demonstration of Koch's postulates for fungal pathogens **1P**
5. Study of pure culture of fungi by streak plate and pour plate method **1P**

BO 4.6 Research Methodology and Summer Training Report

I. Project (2 Credits)

Projects will be allotted in third semester and students will submit project work having introduction, review of literature, well defined material and methods, results and discussion, conclusions and references. The project should be presented at the end of fourth semester.

J. Review (1 Credit)

Based on review of literature on some advanced techniques in Botany and its presentation during practical examination

K. Summer Training (1 Credit)

1. Report submission based on one summer training in research institutes/ laboratory/industry for atleast one month with certificate from respective authority.
2. Techno-commercial case study of any four units from the following

Students will visit at least four units of the following to prepare a report for submission

1. Biofertilizer Unit
2. Mushroom cultivation unit
3. Green house unit
4. Floriculture unit
5. Plant nursery unit
6. Garden designing and maintenance unit
7. Fruit processing unit
8. Bio-pesticide unit
9. Biomass briquette unit
10. Biofuel units
11. Plant tissue culture industries
12. Farmhouse management
13. Pomoculture units
14. Organic farming
15. Fresh vegetables and flower supply unit

16. Herbal product industry
17. Forest department unit
18. Medicinal plant garden
19. Effluent treatment plant
20. Solid waste management unit