

**UNIVERSITY OF CALICUT**  
**M.Sc. Plant Science**  
**Distribution of Working hours and Marks**  
**(2005 Admission onwards)**

Semester No	Course No.	Subjects for paper Theory/practical	Working hours		External marks	Internal Marks	Total	
			Per Sem	Per Week				
I	T.P.1.1 P.P.1.1	Phycology, Bryology and Pteridology.	90	5 3	80 80	20 20	200	650
	T.P.1.2 P.P.1.2	Mycology, General Microbiology and Plant Pathology.	90	5 3	80 80	20 20	200	
	T.P.1.3 P.P.1.3	Gymnosperms, Anatomy of Angiosperms and Microtechnique Viva voce	90	5 3	80 80 50	20 20	200 50	
II	T.P.2.1 P.P.2.1	Angiosperm embryology, Plant tissue culture and Biometrics.	90	5 3	80 80	20 20	200	650
	T.P.2.2 P.P.2.2	Plant physiology, Biochemistry and Environmental biology	90	5 3	80 80	20 20	200	
	T.P.2.3 P.P.2.3	Cell biology, Biophysics, Immunotechnique Viva voce	90	5 3	80 80 50	20 20	200 50	
III	T.P.3.1 P.P.3.1	Angiosperm morphology and Systematics, Ethnobotany	90	5 3	80 80	20 20	200	650
	T.P.3.2 P.P.3.2	Genetics, Plant breeding and Horticulture	90	5 3	80 80	20 20	200	
	T.P.3.3 P.P.3.3	Molecular biology, Genetic engineering and Bioinformatics Viva voce	90	5 3	80 80 50	20 20	200 50	
IV	T.P.4.1 P.P.4.1	Specialisation subject and Research Methodology	90	5 3	80 80	20 20	200	200
	<del> </del>	Dissertation Viva voce	180	16	160 50	40	250	
<b>Grand total</b>								<b>2400</b>

T.P.: Theory Paper; P.P.: Practical Paper

Practical Exam: 60 marks    Record: 20 marks (including other submissions if any)

Chairman, BoS  
Plant Science

### Mark distribution for Internal Assessment

		Theory/Practicals	Dissertation
<b>a</b>	Attendance	6	12
<b>b</b>	Performance in class/lab/class tests etc.	10	20
<b>c</b>	Seminar/Quiz/Assignment	4	8
	<b>Total</b>	<b>20</b>	<b>40</b>

### Marks for Attendance

95% and above	6
90-94.99 %	5
85-89.99 %	4
80-84.99 %	3
75-79.99 %	2
70-74.99 %	1

### XI. Specialisations:

1. Environmental Science
2. Tissue Culture & Biotechnology
3. Biofertilizer Technology
4. Principles and Practices of Horticulture and Garden Management.
5. Conservation of Medicinal Plants, Museology and Herbarium Techniques.

### Viva Voce

In each semester, on the next day after the last practical examination, there shall be a comprehensive viva voce of about 30 minutes duration for each student. One full day (9 am to 5pm) shall be utilized for this.

### Study Tour

There shall be a study tour of five days duration, for field study or visit to research institutes, in the first and third semesters. At the time of the practical examination each student should submit a tour report certified by the head of the department.

### **Periodic Evaluation**

During the course of the semester, continuous internal evaluation may be carried out based on seminars, written tests, practical tests, viva voce, submissions and quiz. The marks may be intimated to the students and the mark list and answer papers kept by the teacher concerned. The student should be given a chance to see their answer scripts after valuation. The marks should be submitted to the Departmental Council for finalising the internal marks. Finalized and approved internal assessment marks should be exhibited on the departmental notice board.

### **Grievance Redressal**

Any complaint about the award of marks in the continuous evaluations may be brought to the notice of the teacher concerned. If not settled, the matter may be brought to the notice of the head of the department. The head of the department if necessary, may appoint a committee consisting of the Head of the Department, Departmental Council Secretary, the concerned teacher, and the student for redressal measures. The decision of the committee will prevail. The Head of the Department will be the Chairman of the Committee.

### **Grading**

Pass minimum: 40% of the total marks for each theory and practical papers separately. There shall be no minimum marks for internal assessment, records, viva voce and dissertation.

Third class: 40-49%; Second class: 50-59%; First class: 60% and above.

Students who fail in any paper in any semester can reappear for that paper along with students of that particular semester of the next batch as per the studied syllabus. For improvement of marks in any paper there will be one chance after the completion of the course and within one year after the completion of the course as per the studied syllabus.

### **Examiners**

The Examinations will be conducted by the Board of Examiners constituted by the University

### **Plan of Question Papers**

#### **Theory:**

Part A: Two essay-type questions of 10 marks each out of three questions

(2x10 = 20 marks).

Part B: Six short answer questions of 5 marks each out of eight questions

(6x5 = 30 marks).

Part C: Ten short answer questions of 3 marks each out of twelve questions

(10x3 = 30 marks).

#### **Practicals:**

The Board of Examiners for practical examinations of I to III semesters shall decide the plan of question papers.

### T.P. 1.1 PHYCOLOGY, BRYOLOGY AND PTERIDOLOGY PHYCOLOGY

1. General considerations: Criteria for algal classifications and modern trends. Comparison of systems of classification of F.E. Fritsch and F.F. Round, on the basis of Phylogenetic consideration.
2. Reproduction: Different types of reproduction, Life history patterns, parallelism in evolution, origin of higher plant groups from algae.
3. General characteristics of Cyanophyta, Chlorophyta, Xanthophyta, Bacillariophyta, Phaeophyta, Rhodophyta, Euglenophyta, Dinophytes, Chrysophyta and Cryptophyta.
4. Ecology: Ecology of fresh water forms and marine forms.
5. Economic importance of Algae with special reference to seaweeds.
6. Fossil algae: A general account.

#### Practical

1. Collection and study of Algae mentioned below. Identification upto generic level.
2. Collection, preservation and preparation of algal herbarium (10 specimens).
3. Staining Techniques for permanent mounts.

#### Genera for the Practicals

**Cyanophyta** : Gloeocapsa, Oscillatoria, Microcoleus, Anabaena, Nostoc, Scytonema, Stigonema.

**Chlorophyta** : Chlamydomonas, Volvox, Chlorella, Hydrodictyon, Scenedesmus, Enteromorpha, Ulva, Cladophora, Pithophora, Bulbochaete, Cephaleuros, Chaetophora, Draparnaldiopsis, Strigeoclonium, Trentepohlia, Oedogonium, Acetabularia, Bryopsis, Codium, Caulerpa, Halimeda, Desmids (Closterium, Cosmarium), Mougetia, Zygnema, Chara and Nitella.

**Xanthophyta** : Botrydium, Vaucheria. **Bacillariophyta** : Coscinodiscus, Pinnularia. **Phaeophyta** : Ectocarpus, Dictyota, Padina, Sargassum, Porphyra.

**Phodophyta** : Gracilaria, Polysiphonia, Gelidium, Amphiroa

#### References :

1. Fritsch, F.E. 1945. The structure and Reproduction of Algae. Vol. I and III.
2. Smith, G.M. 1950. Manual of Phycology.
3. Round, F.E. 1965. The biology of Algae.
4. Pold and Wyane. 1978. Introduction of Algae.

#### Journals :

1. Journal of Indian Botanical Society.
2. Proceedings of Indian Academy of Science.
3. Acta Botanica Indica.

### BRYOLOGY

#### Theory

1. General characters and systems of classification of Bryophytes. Contribution of Indian bryologist.
2. A general account of the Anatomy, Reproduction, Life history and Phylogeny of Sphero carpales, Marchantiales, Jungermanniales, Anthocerotales, Funariales, Polytrichales.
3. Origin and evolution of Bryophytes.
4. A general account of fossil Bryophytes and their affinities.

#### Practicals

Morphological and structural study of representation members of following groups using cleared wholemount preparations, dissections and sections: Riccia, Targionia, Fimbriaria, Cyathodium, Marchantia, Riccardia, Fossombronia, Porella, Anthoceros, Sphagnum, Funaria and Polytrichum.

#### Reference

1. Watson E.V. The structure and life of Bryophytes, Hutchinson Univ. Press London.
2. Cavers F. The interrelationship of Bryophytes. New Phytologist.
3. Kashyap, S.R. The Liverworts of Western Himalaya and the Punjab Plains, Vol. I & II. Chronica Botanica.
4. Smith G.M. Cryptogamic Botany Vol. II. McGraw Hill. Book Co. N.Y.
5. Parihar N.S. An introduction of Embryophyt: Bryophyta, General Book House, Allahabad.
6. Verdoon, F.M. Annual of Bryology. Ashor & Co. Amsterdam.

## PTERIDOLOGY

### Theory

1. General characters, Classification and life cycle of Pteridophytes, Contribution of Indian Pteridologists.
2. Diversity of forms among Pteridophytes – club mosses, quill worts., mosquito ferns, braken ferns, bird's nest fern, maiden hair fern and tree ferns general morphology with special reference to South Indian species.
3. Fossil Pteridophytes, Psitophytales, Lepidodendrales Calamitales, and Primofilicales – morpho anatomical features.
4. Habitat ecology of Pteridophytes, epiphytes, lithophytes, Climbers, halophytes, Sciophytes, Xerophytes, rheophytes, hydrophytes.
5. History in relation to ecology of Pteridophytes, Structure and evolution of stele in Pteridophytes vessels in Pteridophytes.
6. Origin and evolution of sporangium – Heterospory and seed habit.
7. The fern gametophytes, types of development, morphology of mature gametophytes, ultra structure of gametophytes, Biochemical and physiological aspects of gametophyte development. Photomorphogenesis. Development of sex organs, antheridiogen, gametangium and fertilization.
8. Cytology of Pteridophytes, Chromosome number, polyploidy, origin of polyploids., apospory, apogamy, agamospory, vegetative reproduction and hybridization.
9. Applied Pteridology, Biofertilizer production from Azolla, Azolla Anabaena symbiosis – Biochemistry of nitrogen fixation – nif genes.  
Pteridophytes as weeds – Salvinia (Aquatic) Pteridium (Terrestrial) Weed  
problem, weed control – impact and management- Biological control.  
Ornamental and medicinal Pteridophytes.  
Pteridophytes as ecological indicators.

### Practicals

1. Morphological anatomical and reproductive features of Ophioglossum, Angiopteris, Osmunda, Lygodium, Ceratopteris, Pteris, Blechnum, Asplenium, Trichomanes, Pteridium, Acrostichum, Salvinia and Azolla.
2. Fossils – Rhynia, Lepidodendron, Calamites, Botryopteris.
3. Spore germination and development of prothallus in knop's agar medium.
4. Habitat study of Lycopodium, Gleichenia, Actiniopteris, Pyrrosia, Drynaria, Acrostichum, Salvinia.
5. Submission of field study report of 10 herbarium of common local Pteridophytes.

### Reference

1. Bierhost, D.W. 1971. Morphology of Vascular Plants, Mac. Millan Co., New York.
2. Dyer, A.C. 1979. The experimental Biology of Ferns. Academic Press, London.
3. Jermy, A.C. 1973 (Ed.). The Phylogeny and Classification of Ferns.
4. Kramer, K.U. & Green, P.S. 1991. The Families and Genera of Vascular Plants, Narosa, New Delhi.

**T.P. 1.2 MYCOLOGY, GENERAL MICROBIOLOGY  
AND PLANT PATHOLOGY  
MYCOLOGY**

**Theory**

1. Introduction to mycology – History, Contribution of Indian mycologists.
2. General characters, fungal systematics- traditional and modern systems of fungal classifications with a special reference to Bessey and Ainsworth 1983 Alexopoulose *et al* 1996.
3. Characters used in fungal classification.
4. Phylogeny of fungi.
5. Ecology of fungi- fungi as saprophytes, decomposer, Symbionts, Mycorrhize
6. Biology, general characteristics and classification of the following phyla:- Myxomycota, Oomycota, Chytridiomycota, Zygomycota, Ascomycota and Basidiomycota.
7. Asexual fungi (Deuteriomycetes): General characters, habit and importance of asexual fungi, somatic structures, structures associated with asexual reproduction, conidomata, conida and conidium ontogeny, other asexual propagules, teliomorph – anamorph connections, Nomenclature and classification.
8. Significance of fungi to human.
9. Ecological significance of Lichens.

**Practicals**

Using appropriate mycological methods and techniques the students shall collect/isolate and study the morphology and anatomy of the reproductive structures of the following genera of fungi : Stemonites, Synchytrium, Saprolegnia, Pythium, Albugo, Pilobolus, Mucor, Saccharomyces, Taphrina Ascobolus, Xylaria, Geoglossum, Phomopsis, Drechslera, Aspergillus, Alternaria, Cercospora, Fusarium, Tremelle, Auricularia, Puccinia, Ustilago, Ganoderma, Lycoperdon, Geastrum, Dictyophora, Cyathus, Parmelia and Usnea.

**References**

1. Ainsworth, G.C. et al. (Eds). 1965-1973. The Fungi- An advanced Treatise. Vols. 1-4, Academic Press.

2. Alexopoulose, C.J. et. al. 1996. Introductory Mycology. 4<sup>th</sup> Edition, Wiley.
3. Burnet, H.H. 1976. Fundamentals of Mycology, E. Arnolds.
4. Deacon, J.W. 1988. Introduction to Modern mycology, Blackwell.
5. Moore-Landecker. 1996. Fundamentals of Fungi, Cambridge University Press.

**GENERAL MICROBIOLOGY**

**Theory**

1. Introduction – History and scope of microbiology – Development of microbiology in 20<sup>th</sup> century, branches of microbiology.
2. Bacteria – Classification based on Bergey's manual, Archaeobacteria and Eubacteria. Morphology and ultra structure, nutrition, genetics, plasmids and their characterisation. Cyanobacteria – salient features, and biological importance, General account of actinomycetes and mycoplasma.
3. Viruses – general account of plant and animal viruses, bacteriophages and their classification. Isolation, purification, infection, replication and transmission of plant viruses. Detailed study of TMV, RSV, Hepatic B, HIV, T4 Phage
4. Microbial ecology: Role of microbes in ecosystem, microbiology of rhizosphere, phylloplane, sewage disposal, bioremediation and water purification detection of microbes in air and water.
5. Agricultural microbiology: Management of agricultural soils, biofertilizer and biopesticides.
6. Industrial microbiology – industrial microorganisms and products, Primary and secondary metabolites, Production of alcohol, vinegar, antibiotics, vitamins, steroids, vaccines, organic acids, enzymes.
7. Food microbiology:- Food spoilage and preservation methods- microbiology of fermented food – dairy products – bread and other fermented food products. Microorganisms

as source of food – Single cell protein – production and application.

#### Practicals

1. Test for the presence of coliform bacteria in contaminated water.
2. Isolation of bacteria from soil by dilution plate method.
3. Isolation of pure bacterial culture by streak plate method.
4. Staining of bacteria and their spores.
5. Demonstration of bacterial motility by hanging drop method.

#### References

1. T.D. Brock (1996). *Biology of Micro-Organisms* : Prentice Hall.
2. Friefielder (1997). *Molecular Biology*
3. R.Y. Stanier et. al. (1990). *The Microbial World*. Prentice Hall.
4. R.E.F. Mathew (1981). *Plant Virology*: Academic Press.
5. M. Goodfellow et. al (1953). *The Biology of Actinomycetes*. Academic Press.
6. Pelzar, M.G., Chan E.C.S. and Krieg N.R. (1986) *Microbiology*, Tata McGraw Hill.
7. Dubey. R.C. & Maheswari, D.K. (2000). *A text book of Microbiology*. S. Chand & Comp.

### PLANT PATHOLOGY

#### Theory

1. Diagnosis by symptoms.
2. Casual agents (fungi, bacteria, viruses, mycoplasma, parasitic plants), Abiotic causes.
3. Importance of plant diseases.
4. Koch's postulates – brief history.
5. Disease development - infection, progress of disease, role of enzymes and toxins (fusarin and Victorin)
6. Defense mechanisms – structural, chemical (phytoalexins)
7. Effect of environment on disease development.
8. Disease management: Exclusion, eradication, protection, quarentine, IPM, Biocides.

#### Practicals

The following genera of plant pathogens are to be studied in the laboratory.

*Hemileia vastatrix*, *Pyricularia oryzae*, *Colletotrichum falcatum*, *Cercospora arachidicola*, *Erysiphe* sp., *Puccinia graminis* or other *Puccinia* spp., *Exobasidium*, banana virus, cassava mosaic.

#### References

1. Agrios G.N. 1997. *Plant pathology*, 3<sup>rd</sup> ed. Academic Press.
2. Tarr S.A.J. 1972. *The principles of plant pathology*, Winchester Press.
3. Wood R.K.S. *Physiological Plant Pathology*. Blackwell
4. Wheeler I. 1975. *Principles of plant infection*.
5. Wheeler H. 1975. *Plant pathogenesis*. Springer – Verlag.
6. Van der Plank J.E. 1975. *Principles of plant infection*. Academic Press..
7. Mehrothra R.S. 1980. *Plant Pathology*. Tata-Mcgraw Hill
8. Smith K.M. 1973. *A text book of plant virus diseases*, 3<sup>rd</sup> ed. Academic Press.
9. Horsfall J.G & Diamond A.E. (eds). 1960. *Plant pathology- an advanced treatise*, 3 vols. Academic Press.
10. Rangaswami G. 1988. *Diseases of crop plant of India*, 3<sup>rd</sup> ed. Prentise Hall, India.
11. *Annual Review of Phytopathology*, annual Reviews inc. Polo Alto.

**T.P. 1.3 GYMNOSPERMS, ANATOMY OF ANGIOSPERMS AND  
MICROTECHNIQUE  
GYMNOSPERMS**

**Theory**

1. General characters: Phylogeny, Classification.
2. Geological horizons, distribution, general account including morphology, anatomy, phylogeny and interrelationship of the following orders with special emphasis on the genera specified.
  - a) Pteridospermales : Lyginopteris, Heterangium, Sphenopteris, Sphaerostoma, Lagenostoma, Medullosa, Trigonocarpus, Pachytesta, Codonotheca.
  - b) Glossopteridales : Glossopteris
  - c) Caytoniales: Caytonia
  - d) Cycadoideales: Williamsonia
  - e) Pentoxylales: Pentoxylon
  - f) Cycadales: Cycas, Zamia
  - g) Ginkgoales: Ginkgo
  - h) Coniferales: Cedrus, Cryptomeria, Cupressus, Agathis, Podocarpus.
  - i) Taxales: Taxus
  - j) Ephedrales : Ephedra
  - k) Welwitschiales: Welwitschia
  - l) Gnetales: Gnetum
3. Evolution of Gymnosperms
4. Distribution of living and fossil gymnosperms in India.
5. Economic importance of Gymnosperms.

**Practicals**

1. Identification of petrifications, compressions, impressions, slides of fossil types include in groups mentioned above.
2. Comparative study of vegetative and reproductive structures of all living genera mentioned above.
3. Morphological and anatomical studies of above mentioned taxa.

**Reference**

1. Andrews, H.N. 1961. Studies in Paleobotany, Wiley, N.Y.

2. Banks, H.P. 1970 Evolution and plants of the past. Wadsworth.
3. Bierhost, D.W. 1971. Morphology of Vascular plants, Macmillan.
4. Bower F.O. 1935. Primitive plants. Macmillan .
5. Chamberlain, C.J. 1935. Gymnosperms Structure and Evolution. Univ. of Chicago Press.
6. Foster, A.S. & E.M. Gifford. 1974. Comparative morphology of vascular plants. Freeman.
7. Maheshwari, P & V. Vasil. Gnetum. CSIR, New Delhi.
8. Ramanujam, C.G.K. 1976. Indian Gymnosperms in time and Space. Today & Tomorrow, Dehra Dun.
9. Sewart, W.N. 1983. Paleobotany and the Evolution of Plants. Cambridge Univ. Press.
10. Stockey, R.S. 1981. Some comments on the origin and evolution of conifers. Canadian J. Bot. 59: 75-82.
11. Taylor, T.N. 1982. Reproductive biology in early seed plants. Bioscience 32: 23-28.
12. Walton, 1951. An introduction to the Study of Fossil Plants.

**ANGIOSPERM ANATOMY**

**Theory**

1. Differentiation: Concept, its significance in developmental studies, totipotency, phylogenetic perspectives of differentiation – general idea of entropy.
2. Meristems: Recent theories on organization of root and shoot apical meristems. Origin of lateral root. Leaf and bud development. Plastochnronic stage, experimental studies on meristems, vegetative to reproductive apex. Reversion from reproductive to vegetative apex.
3. Tissue systems: Differentiation and functions of different tissue systems such as epidermis, parenchyma, chlorenchyma, sclerenchyma, laticifers, glands, transfer cells. Environmental factors influencing differentiation of the divergent tissue systems, experimental studies, their economic importance.
4. Secondary cambium: Concept, classification, origin and constitution of cambium, cambial activity, cambium in wound

healing and grafting, factors influencing cambial differentiation and activity, cork-cambium, different types, origin and function.

5. Abnormal Cambium: Classification, origin and function, experimental studies.
6. Seedling and nodal anatomy, rootcot vascular connection, pattern of nodal anatomy, controversies on phylogenetic trends in nodel anatomy.
7. Xylem: Origin, Structural features and function of fibres, fibre trachieds, trachieds, vessel elements, xylem parenchyma, the trends of specialization, taxonomic significance, factors affecting xylem differentiation, elements of wood anatomy.
8. Phloem: Origin, structure and function of sieve cells, sieve tubes companion cells and fibres, trends of specialization, taxonomic significance, factors affecting phloem differentiation.
9. Leaf: Origin and development of lamina –general pattern.
10. Fruit and seeds: general anatomy of fleshy and dry fruits- anatomy of seeds in general, development dormancy and drought resistance from anatomical point of view.
11. Roots: Initiation and development of specialized roots.
12. Anatomy in relation to ecology and taxonomy.

#### Practicals

1. Diversity in cells and tissue in a monocot and dicot plant with respect to position, distribution, structure and function.
2. Epidermis – Trichomes, stomatal types, stomatal index.
3. Clearing shoot apical meristems – different patterns.
4. Clearing and staining of leaf, young twigs, roots, floral parts etc.
5. Nodal anatomy.
6. Vascular cambium and cork cambium.
7. Xylem and its constituents by sectioning and macerating the tissues.
8. Phloem and its components.
9. Abnormal secondary growth – different patterns : Dracaena, Bignonia, Aristolochia, Amaranthus, Nyctanthes, Aerva, Beetroot, Mirabilis, Pisonia, Bougainvillea

10. Submission of slides – 30 Nos.

#### Reference

1. Easu, K. 1983. Plant Anatomy – Wiley Eastern Limited.
2. Fahn, A. 1977. Plant Anatomy Pergamon Press.
3. Cutter, E.G. & Edward, E. 1978. Plant Anatomy : Experiment and Interpretations Part I and II.
4. Mauseth, J.D. 1988. Plant Anatomy – The Nenjamin Cumming Publishing Co.
5. Forester, A.S. 1960 Practical Plant Anatomy – D. Van Nostrand Company. Inc.
6. Roberts, L.W. 1976. Cytodifferentiation in Plants – Cambridge University Press, Cambridge.

#### MICROTECHNIQUE

#### Theory

1. Basic instruments and equipments used in Microtechnique, their uses and principles involved.
  - a) Microscopes; Ordinary L.M., Phase contrast, Electron Microscope.
  - b) Microscopic measurements.
  - c) Use of camera lucida.
  - d) Microtomes: Rotary and sledge and their uses.
  - e) Embedding oven.
  - f) Couplin jars.
2. Killing, fixing and staining plant tissues.
  - a) Principles and purposes.
  - b) Important chemicals and reagents used in the preparation of fixatives and their properties.
  - c) Common chemical fixatives, their composition, preparation, specific uses-FAA, Carnoy's fluid, Chrome acetic, Nawaschin's Fluid. Craf, Zircles's fluid, Fleming's fluid.
3. Important dehydrating agents. Clearing agents and mounting media used in microtechnique and their properties: Ethyle alcohol, chloroform, glycerin, isopropyle alcohol, butyle alcohol.
4. Staines used in microtechnique:
  - a) Principles and purpose of staining.

- b) Classification of important biological stains.
  - i) Natural dyes – Hematoxylin, Carmine, Orcein.
  - ii) Coal tar dyes
    - Basic dyes: Safranin, Crystal violet, basic Fuchsin, cotton blue
    - Acid dyes: Fast green, Light green, Orange-G, Erythrosin, Eosin.
  - c) Technique of staining.
- 5. Preparation of whole mounts, macerations and smears;
  - a) Glycerin – xylene method for whole mounts.
  - b) Tertiary butyl alcohol method for whole mounts.
  - c) Maceration fluid, preparation of maceration slides of plant tissues.
- 6. Methods of double staining of free hand sections using the following combinations:
  - a) Safranin – Fast green, Safranin – aniline blue
  - b) Crystal violet – Orange G.
- 7. Methods of embedding plant materials in paraffin wax using:
  - a) Alcohol – xylene method
  - b) Tertiary butyl alcohol method
  - c) Alcohol – chloroform method.
- 8. Technique of sectioning materials embedded in paraffin wax using rotary microtome and fixing paraffin ribbons on slides:
  - a) Fixing blocks on microtome
  - b) Cutting sections
  - c) Adhesives and their preparation.
  - d) Mounting and spreading ribbons on slides
- 9. Methods of staining paraffin sections using the following combinations
  - a) Iron alum-haematoxyline – Safranin/fast green.
  - b) Safranin – Fast green/aniline blue
  - c) Crystal violet – Orange G/Erythrosin
- 10. Technique of mounting, clearing labeling and storing permanent preparations.
- 11. Vital staining : Methods and significance.
- 12. Histochemistry – A general introduction.

### Practical

1. Students are expected to familiarise with preparation of stained permanent slides of the following. Whole mounts, free hand sections, maceration and serial microtome sections following double and triple staining procedure. At least twenty permanent slides representing whole mounts, free hand sections and serial sections should be submitted for evaluation.

### Reference

1. Johanson D.A. 1940. Plant Microtechnique. McGraw Hill, New York.
2. Sass J.E. 1958. Botanical Microtechnique (Ed.) Constable & Co. Ltd. London.
3. Lacker J.R. 1966. Cytological techniques. Chapman & Hall, London.
4. Berlyn G.P. and Mikshe J.P. 1976. Botanical Microtechnique and cytochemistry, Iowa State University Press. Iowa.
5. Gray P. 1964. Handbook of basic Microtechnique (Ed.3) Edward Arnold Ltd. London.
6. Gahan P.B. 1984. Plant Histochemistry and Cytochemistry – An Introduction, Academic Press.
7. Dwivedi J.N., and Singh R.B. 1990. Essentials of Plant techniques, 2<sup>nd</sup> Edn. Scientific Publ. Jodhpur.
8. Krishnamoorthy K.V. 1988. Methods in Plant Histochemistry. Viswanath Publishers, Trichi.
9. Sanderson J.B. 1994. Biological Microtechnique, Scientific Publishers, U.K.

**T.P. 2.1 ANGIOSPERM EMBRYOLOGY, PLANT TISSUE  
CULTURE AND BIOMETRICS  
EMBRYOLOGY**

**Theory**

1. History and development of angiosperm embryology.
2. Microsporogenesis – Structure and function of wall layers, ultrastructural changes in tapetum in pollen development.
3. Male gametophyte – microspore/pollen mitosis, division of generative cells, heterogeneity in sperms, pollen fertility and sterility, pollen storage, viability and germination.
4. Ovule – ontogeny, types and evolution, reduction, nutrition.
5. Megasporogenesis – subcellular features of archesporial and megaspore mother cells, megaspore tread, dyad and coenomegaspore, termination of functional megaspore.
6. Embryosac – Classification and types, ultrastructure of components; synergid and antipodal haustoria, nutrition of embryosac.
7. Pollination: Ultrastructural histochemical details of style and stigma, significance of pollen-pistil interaction, role of pollen wall proteins and stigma surface proteins, intra-ovarian pollination and in vitro fertilization.
8. Fertilization: Role of synergids, filiform apparatus, heterospermy, differential behavior of male gametes, syngamy and triple fusion, post fertilization metabolic and structural change in embryosac.
9. Endosperm – Classification and types, ultrastructure, cellularisation in nuclear endosperm, endosperm haustoria, their extension and persistence, function, storage metabolites.
10. Embryo – Polarity in relation to development, classification and types, Histo and organogenesis of mono- and dicot embryos, delayed differentiation of embryo structure, cytology and function of suspensor, physiological and morphogenetic relationship of endosperm and embryo.
11. Polyembryony – Classification and types.
12. Apomixis – diplospory – apospory, parthenogenesis of embryos.

13. Fruit and seed – parthenocarpy – induction of seedless fruits.
14. Experimental embryology – embryology in relation to taxonomy, embryo culture, anther culture, ovary culture.

**Practicals**

1. Preparation of dissected whole mounts of endothecium, tapetum, ovule, endosperm, embryo and haustoria. Squash preparations of tapetum, microspore mother cells, dyads, tetrads, pollinia and massulae.
2. Study from permanent preparations – Development and structure of anther, pollen, ovule, megasporogenesis, embryosac, endosperm and embryo. The comparative study of the typical monocot and grass embryo.
3. Pollen germination – viability tests.
4. Study of election micrographs listed in the theory part.
5. Experiments of intra-ovarian pollination.

**References**

1. Bouman F. 1978. Ovule initiation, ovule development and seed coat structure in angiosperms. Today and tomorrow publishers, New Delhi.
2. Bhojwani S.S. and Bhatnagar S.S. 1974. The embryology of angiosperms. Vikas publication, New Delhi.
3. Davis C.L. 1965. Systematic embryology of angiosperms. John Wiley, New York.
4. Eames A.J. 1960. Morphology of angiosperms. McGraw Hill. New York.
5. Johanson D. 1950. Plant embryology, Waltham, Massachusetts.
6. Johri B.D. (ed) 1984. Embryology of angiosperms Springer Verlag, Berlin.
7. Maheswari P. 1950. An introduction to the embryology of angiosperms. McGraw Hill, New York.
8. .... (ed.) 1963. Recent advances in the embryology of angiosperms. Intl. Soc. Plant. Morphologists, New Delhi.
9. Reghavan V. 1976. Experimental embryogenesis in plants, Academic Press, New York.

10. Wardlaw C.W. 1976. Embryogenesis in plants. Methusen, London.
11. Guha S. and S.C. Maheswari. 1964. In vitro production of embryos from anthers of *Datura*. Nature (London).

#### PLANT TISSUE CULTURE

1. Basic concepts of plant morphogenesis and its importance.
2. Comparative morphology and plant morphogenesis, experimental works on root, leaf and flower.
3. Plant tissue culture : History; Definition; basic aspects; Different media, components, growth regulators; explants, sterilization, inoculation, subculturing etc. Totipotency.
4. Different types of cultures : Callus and Organ cultures, Cell culture; Suspension culture – different types- application. Significance of ovary, ovule, endosperm and embryo culture.
5. In vitro morphogenesis : Organogenesis; Factors affecting. Different stages of Micropropagation applications. Somaclonal variation and its significance in crop improvement. Somatic embryogenesis : Factors affecting – significance. Synseeds – applications.
6. Production of pathogen free plants – Meristem culture and its application; Shoot and root tip culture of orchids.
7. Protoplasts – Isolation and culture methods : Somatic Hybridization. Different types and fusion methods; application in crop improvement.
8. Haploids – Anther and pollen culture; Factors affecting, significance in crop improvement. In vitro fertilization and its significance.
9. Brief account of germplasm storage : long and short term. Cryopreservation and its applications.
10. Brief account of secondary metabolites; production in vitro Biosensors, Biochips Brief account.
11. Brief account of applied aspects of tissue culture with special reference to Kerala – Spices, Medicinal Plants and fruit crops.

#### Practicals

1. Preparation of stock solutions: Different media.

2. Preparation of solid and liquid media.
3. Inoculation technique: Culture of different explants
4. Introduction of callus and organogenesis
5. Anther and ovary, embryo culture; Meristem culture.

#### Reference

1. Bhojwani, S.S. and Razdan, M.K. 1983. Plant Tissue Culture : Theory and Practice. Elsevier, Amsterdam.
2. Doods, J.H. and Roberts L.W. 1985 Experiments in plant tissue culture Cambridge Press.
3. George, E.F. 1993/96. Plant propagation By Tissue Culture – 2 vols. Exegetics Ltd.
4. Narayanaswamy. S. 1994. Plant cell and tissue culture. Tata McGraw Hill Ltd.
5. Pierrik, R.L.M. In Vitro Culture of Higher Plants.

#### BIOMETRY

##### Theory

1. Statistical methods – Numerical distribution and their graphical representation.
2. Sampling – Theory and methods.
3. Measures of central tendency – mean, median, mode, ogive, skewness, kurtosis.
4. Measures of dispersion – range quartile deviation, mean deviation, variance and standard deviation.
5. Frequency distribution – normal, binomial and position distribution.
6. Test of significance and Chi square test and estimation of linkage.
7. Design of experiments – randomized blocks, latin square and factorial.
8. Analysis of variance.
9. Theories of probabilities, correlation and regression.

##### Practicals

Practical skills to solve and work out problems in biometry.

##### References

1. Panse and Sukhatme, Statistical methods of Agricultural workers, ICAR Publ.
2. Mather, Measures of linkage in heredity.

3. Kempthorne, Introduction to Genetic statistics.
4. Steel and Torrie, Principles and procedures of statistics with special reference to the biological science.

**T.P. 2.2 PLANT PHYSIOLOGY, BIOCHEMISTRY AND ENVIRONMENTAL BIOLOGY**  
**PLANT PHYSIOLOGY**

1. Water relations in plants : Physical and chemical properties of water chemical potential of water - concept and terminology – Gibb's free energy concept – water movement in cells and tissues through cell membranes –water absorption by root – Apoplast and symplast pathway – The ascent of water through xylem – water relations of the whole plant – soil water atmosphere continuum (SPAC) – Transpiration \_ Stomatal regulation of transpiration.
2. Mineral nutrition : Microelements, beneficial elements – requirements and deficiency symptoms in plants. Calcium and metabolic regulation in plants – nutrient culture techniques for plant growth – Absorption of minerals by roots – Diffusion and facilitated diffusion – Apparent free space – radial path of ion through roots – root microbe interactions – bacteria and micorrhiza – Transport of ions across biological membrane – passive and active transport – Transport proteins or carrier proteins – channel proteins – Nernst's equation, electrochemical gradient and ion distribution across the membrane – Active transport and electrogenic pumps – patch and clump studies – role of ATPase – Transcellular transport – Apoplast and symplast pathways and active pumps.
3. Phloem transport : Transport in phloem – pathways of transport of organic solutes pattern of translocation – sink – source relationship – phloem loading, phloem unloading and sink – source transport – passive, active and pressure flow models – sink – source association and assimilate allocation and partitioning between different parts and plants.
4. Photosynthesis : Carbon metabolism – C3 photosynthetic carbon reduction cycle – activation and regulation – C4

photosynthetic carbon assimilation cycle – C4 syndrome – C2 photorespiratory carbon oxidation cycle – CAM metabolism.

5. Respiration : Energetics of glycolysis – Krebs cycle and electron transport system- Regulation of respiration by energy demand and concentration of key metabolites – Alternate electron pathways in plants – External NADPH dehydrogenase – Rotenone insensitive NADH dehydrogenase – Cyanide resistant respiration.
6. Nitrogen Metabolism : Nitrate assimilate pathway – Biological Nitrogen Fixation – Dinitrogenase activity – Nitrogen cycling – Nitrogen incorporation into amino acids – transamination – export forms of nitrogen amides and ureides – Nitrogen nutrition – Agricultural and ecological aspects.
7. Growth and morphogenesis : Growth regulations and their effect on growth – photomorphogenesis – phytochrome.
8. Physiology of flowering : Physiological and Biochemical changes associated with flowering – theories of flowering – controlling factors – photoperiodism and vernalization.
9. Physiology of fruit development and ripening.
10. Physiology of seed development and germination.
11. Growth and differentiation : Pattern of growth, Growth kinetics, principles of differentiation.
12. Biological clock : Measuring time, Rhythmic phenomena.
13. Stress physiology : Physiology of plant under stress – water temperature, salt, environmental pollution – heavy metals and air pollution.
14. Plant movements: Phototropism, Gravitropism, nastic movements.

**References**

1. Hopkins, W.G. 1995. Introduction to Plant Physiology, John Wiley & Sons Inc.
2. Salisbury F.B. and Ross C.W. 1992. Plant physiology. 4<sup>th</sup> Edn. Wordsworth Publ. Co.
3. Bidwell R.G.S. 1979. Plant Physiology. 2<sup>nd</sup> Edn. Macmillan Publ. Co. Inc.

4. Anderson J.W. and Boardall J. 1991. Molecular activation of plant cells – An introduction to Plant Biochemistry. Blackwell Scientific Publications.
5. Devlin R.M. and Witham F.H. 1986. Plant Physiology. 4<sup>th</sup> Edn. CBS Publishers & Distributors, New Delhi.
6. Karp G. 1996. Cell and Molecular Biology – Concepts and Experiments. Jhon Wiley & Sons, Inc.
7. Noggle G.R. and Fritz G.J. 1992. Introductory Plant Physiology, Prentice Hall of India Pvt. Ltd. New Delhi.
8. Steward F.C. Plant Physiology – A treatise Vol. I to X. Acad. Press.
9. Taiz L. and Zeiger E. 1991. Plant Physiology. The Benjamin Cummings Publ. Co. Inc.
10. Wilkins M.B. 1984. Advanced Plant Physiology, Longman Scientific & Technical.

#### Journals

1. Annual Review of Plant physiology.
2. Encyclopedia of Plant Physiology.

#### Practicals

1. Preparation of molal, molar, normal and percentage solutions and their dilutions.
2. Dry Weight/moisture content determination of plant materials.
3. Factors affecting membrane permeability.
4. Measurement of water potential of plant tissues.
5. Solute potential of sap by density gradient method.
6. Plasmolysis – Deplasmolysis method.
7. Histochemical localization of potassium in the guard cells under different conditions of transpiration.
8. Pottassium uptake by excised roots chloride.
9. Separation of plant pigments by paper chromatography/ thin layer chromatography and absorption spectre of each pigment separated.
10. Quantitative estimation of chlorophyll content using spectrophotometry.
11. Light compensation points pertaining to photosynthesis – anatomical study.

12. pH changes in root surfaces.
13. Role of phytochrome in the germination of light sensitive seeds.
14. Measurement of growth rate using various parameters.
15. Amylase activity and gibberellic acid effect in germinating cereal seeds.

#### References

1. Green N.P.O et.al. 1990. Biological Science, 2<sup>nd</sup> Edn. Vol. I & II Cambridge University Press, New York.
2. Meidner H. 1984. Class Experiments in Plant Physiology, George Allen and Unwin, London.
3. Moore T.C. 1981. Research Experience in Plant Physiology – A laboratory Mannual. 2<sup>nd</sup> Edn. Springer Verlag.

#### BIOCHEMISTRY

#### Theory

1. Introduction – History, Scope and significance of Biochemistry – The molecular logic of life.
2. Biomolecules: Micromolecules and Macromolecules.
  - a) Carbohydrates: Classification, structure and function of simple sugar and compound carbohydrates, starch and sucrose synthesis, Metabolism of carbohydrates.
  - b) Amino acids and proteins – Classification and structure – Primary, secondary, tertiary, and quarternary structure of proteins Amino acid metabolism, Biosynthesis of Proteins, general functions of proteins.
  - c) Lipids: Classifications, Storage and structural lipids, lipids in membranes Lipid metabolism.
  - d) Nucleotides and nucleic acids: Chemistry, Structure of nucleotides, other functions – Biosynthesis of purines and pyrimidines.
3. Enzymes: Classification and nomenclature, Mechanism of enzyme action, Co. enzymes, Michaelis Merton equation and its significance. Enzyme inhibition and types. Allosteric inhibition and regulations. Various factors affecting enzyme action.

- Secondary metabolites.  
A brief survey of secondary metabolites physiological roles. Significance ecological and phylogenetic importance.

#### Practicals

- General qualitative colour reaction for carbohydrates, amino acids, protein and lipids.
- Quantitative estimation of reducing sugar from plant tissue by any suitable method.
- Estimation of protein by Biuret method/Lowry et al. method.
- Quantitative estimation of amino acids.
- Quantitative estimation of DNA and RNA. Colorimetric/spectro photometric.
- Quantitative estimation of total phenolics.
- Extraction of enzyme: Any enzyme.
- Effect of substrate on enzyme and determination of its  $K_m$  value.

#### References

- Stryer. (1995). Biochemistry : Toppas Company Ltd., Japan.
- J. Darnell, H. Lodish, D. Baltimore (1994) Molecular Cell Biology: Scientific American Books Inc, USA.
- J.D. Watson, H. Hopkins, J.W. Roberts, J.A. Steitz, A.M. Weiner (1996). Molecular Biology of Genes. The Benjamin Cunnings Pub. Co. USA.
- K.M. Prescott, J.P. Harley, D.A. Klein (1996) Microbiology : Wm. C. Brown Publishers, USA.
- R. Ananthanarayan, C.K. Jayaram Panicker (1992) Test book of Microbiology : Orient Longman Ltd. Madras.
- C.B. Powar, H.F. Danganawala (1997) General Microbiology (Vol. II) : Himalaya Publishing House, Bombay.
- David L., Nelson and Michael M Cox (2000). Lehninger. Principles of Biochemistry. 3<sup>rd</sup> edition. Macmillan U.K.
- Geoffrey Zubay Biochemistry Macmillan Publishing Company, New York.
- Sadasivam and Manickam, Biochemical methods. New Age International Publishers. New Delhi.

- David T. Plummer, An Introduction to Practical Biochemistry. Tata McGraw Hill.

#### ENVIRONMENTAL BIOLOGY

#### Theory

- Ecosystem – Structural components, relationship between structural and function ; trophic structures – Ecological awareness.
- Productivity and energy flow – concept, limits and processes of primary production; methods of productivity measurement; efficiency with regard to energy capture and transfer.
- Biogeochemical cycling – basic types; the global water, Carbon and Nitrogen cycles.
- Succession, climax and stability – concepts, characteristics of pioneer and climax species; climax concept and stability.
- Population characteristics – density, diversity indices, alpha, beta and gamma diversity, natality, mortality, age distribution, biotic potential, carrying capacity, aggregation, dispersal, ecotone and edge effect.
- Genecology – basic concepts, ecotype, ecophenes, ecads.
- Environmental pollution – types : Land, air, and water : Minamata and Love Canal episode; pesticides, radiation, noise and automobile pollution; effect on plant; control with emphasis on biological methods, cumulative effect on global environment – El nino, La nina, green house effect, Ozone depletion, Ozone day.
- Biodiversity: Concepts – centers of diversity, phytogeographic zones, vegetation types of India, Kerala and endemism. Importance of conservation, agrobiodiversity, conservation strategy, Organizations-history and development. IUCN, WWF, CITES, TRAFFIC, Species Survival Commission. Conservation programmes – UNEP, MAB, Ramsar convention, Convention on Biodiversity, Rio +10, Eco-development programme, environment day, Conservation movements in India and Kerala. IUCN Hot spots. Red list Categories, Red Data Books, Threatened plants and animals of India and Kerala-case histories. In situ-ex situ conservation, protected area

concepts, wildlife sanctuaries, national parks and biosphere reserves. Afforestation – social forestry, agroforestry, environmental impact assessment, participatory management. Wildlife preservation Act (1972), Indian Forest Act (1980), Biodiversity Act, Intellectual Property Rights (IPR) and patenting.

#### Practicals

1. Evaluation of biotic and abiotic components of any two important ecosystems.
2. Evolution of food chain in the ecosystems mentioned in I.
3. CoxDetermination of the importance value Index (IVI) of plant species in the community by quadrats, line and belt transect methods.
4. Comparative study of polluted and non-polluted aquatic ecosystems.
5. Visit to a meteorological station, Wildlife Sanctuary, National Park, sewage treatment unit and major construction areas.

#### References

1. Agarwall, U.P., 1988. Forests in India.
2. Clarks, G.L. 1954. Elements of Ecology.
3. Cox. G.W. 1969. Readings in Conservation Ecology.
4. Dasman, R.F. 1968. Environmental conservation.
5. Lucas, G. & Synge, H., 1986. IUCN Plant Red Data book.
6. Misra, R., 1968. Ecology Workbook.
7. Nayar, M.P. & Sastry, A.R.K. 1987, 1989, 1990, Red Data Book of Indian Plants. 3 Vols.
8. Odum, E.P., 1976. Fundamentals of Ecology.
9. Odum, P. 1978. Basic Principles of Ecology.
10. Puri, G. Indian Forest Ecology.

#### T.P. 2.3 CELL BIOLOGY, BIOPHYSICS, IMMUNOTECHNIQUE CELL BIOLOGY

1. The structure and organization of prokaryotic and eukaryotic cells. Cell concept and cell cycle regulation.
2. Detailed study of ultra structure and function and organization of cell, cell membrane and cell organelles. Theories of origin of cell organelles.

3. Special types of Chromosomes: Polytene chromosomes and lamp brush chromosomes; structure and significance of giant chromosomes in plants, B-chromosomes, minute and mega chromosomes.
4. Chromosomes mechanism and events in mitosis and meiosis. Comparison and their significance, Ultrastructure of spindle apparatus and synaptonemal complex.
5. Karyotype and Karyomorphometry, Karyotype analysis, Role in evolution. Chromosome banding and various banding techniques – G, C, T,N, R, Pr, Q and Flurochrome banding.
6. Numerical and structural variations of chromosomes and their consequences, Breakage – Fusion – Bridge; Mobile genetic elements; Translocation heterozygotes; Renner complex. Induction of polyploidy by colchicines.
7. Nucleic acid biosynthesis and different pathways involved in it. Structure and composition of DNA and RNA. Forms of DNA (A,B,C,D,E,H,Z,R,L) and RNA – different types. Evidence of DNA as genetic material, satellite DNA and selfish DNA. Different modes of replication of DNA. Chromosomal proteins and their molecular interactions. Chondromes and plastomes.
8. Gene action: one gene one enzyme hypothesis, one cistron one polypeptide hypothesis. Genetic code – features, protein synthesis and its regulations. Transpositions in bacteria and eukaryotes. Operon concept – genetic regulation in prokaryotes – lac operon, trp operon. Gene expression in eukaryotes.
9. Radiation cytology, Isotopes and their applications. Biological, Physiological and chromosomal effects of radiations. Radiation hazards.
10. On cogenes. Cytology of cancer, chromosome rearrangement and cancer, radiation and DNA repair in carcinogenesis and future prospects, Cancer gene therapy.
11. Modern techniques in cytogenetic characterization : in situ hybridization technique – DIRVISH. FISH; Electrophoretic karyotyping, spectral karyotyping, chromosome painting;

PCR techniques- RFLP, RAPD; chromosome uptake, chromosome engineering and cell fusion.+

#### Practicals

1. Study of mitotic index of the specimen supplied.
2. Camera Lucida drawings of Karyotype from a permanent slide.
3. Study of meiosis in *Datura/Rhoeo/Chlorophytum* by smear preparation of PMCs.
4. Study of giant chromosomes in *Drosophila*.

#### Reference

1. Sharma, A. (1990). *The Chromosomes*, Oxford & IBH. Delhi.
2. Celis, E.J. (1994) *Cell Biology – A Laboratory Hand Book*. Vol. I & III, Academic Press.
3. Darnell, J., Lodish, H. and Baltimore, D. (1991) *Molecular Cell Biology*, Scientific American Books.
4. De Robertis E.D.P. and Robertis E.M.F. (1991) *Cell and Molecular Biology*, Washington; Lea & Febiger.
5. Gunning, B.E.S. and Steer, M.W. (1996). *Plant Cell Biology- Structure and function*. Jones and Bartlett Publishers, Sudbury, Massachusetts.
6. Hall, J.L., Flowers, T.J. and Roberts, R.M. (1981). *Plant cell structure and Metabolism*, Longman, London and New York.
7. Lewin, B. (1997) *Gene VI*, London :Oxford University Press.
8. Sharma, A.K. and Sharma, A. (1980) *Chromosome Techniques : Theory and practice*, Aditya Books; New Delhi: Butterworths. London.
9. Sharma; A. (1986) *Chromosomes*, Oxford and IBH. New Delhi.
10. Roy, Satyesh Chandra and Kalyan Kumar De (1997) *Cell Biology*, New Central Books Agency (P) Ltd. Calcutta.

### BIOPHYSICS

#### Theory

1. Buffers : Derivation of Henderson Hasselbatch equation of the buffers. Function of buffers in biological system; uses in biological research.

2. Photometry : Colorimetry and spectrophotometry; their applications in biological/ biochemical studies.
3. Principles and application of chromatography.
4. principles and application of electrophoresis.
5. A brief account of centrifugation as a separation technique.
6. Bioenergetics : Free energy and entropy. Standard free energy change in equilibrium reaction. High energy phosphorylated compounds; Energy hydrolysis of ATP.

#### Practicals

1. Preparation of buffers and measurement of pH using pH meter.
2. Determination of isoelectric pH of casein.
3. Paper chromatographic separation of sugars.
4. Thin layer of Chromatography of amino acids
5. Separation of subcellular particles by sucrose density gradient centrifugation.

#### References

1. *Physical Biochemistry. Application to biochemistry and molecular biology*. By David Freifelder.
2. *Biophysics* by D.C.S. White.
3. *Biophysics : Concepts and Mechanics : by E.J. Casey*. Pub. Van Nostrand Rein.
4. *Biophysics : Ed. Walter Hoppe (ed.)*. Pub. Springer Verlag. (1983).
5. *Optical methods in biology : by E.M. Slayeter*. Pub. Wiley Interscience.

### IMMUNOTECHNIQUES

#### Theory

1. General account on lymphocytes, types of immunity, concept of antigen and antibody, cellular and humoral immunity, theories involved in antibody formation, immunoglobulins, complements dependent immunity, antigen presentation, MHC and gene shuffling and antibody polymorphism HLA, hypersensitivity, opsonisation, monoclonal and polyclonal antibodies, immunological memory,

precipitation, reaction, immunodiffusion, immuno-electrophoresis, electro-immunodiffusion, radio-immunoassay, Immunofluorescence, immunoblotting, enzyme-linked immunosorbent assay.

#### Practicals

1. Blood group testing, for the determination of ABO antigens in man.
2. Immunodiffusion studies on agar gel.

#### Reference

1. Stryer. (1995). Biochemistry : Toppas Company Ltd., Japan.
2. J. Darnell, H. Lodish, D. Baltimore (1994) Molecular Cell Biology : Scientific American Books Inc, USA.
3. J.D. Watson, H. Hopkins, J.W. Roberts, J.A. Steitz, A.M. Weiner (1996). Molecular Biology of Genes. The Benjamin Cummings Pub. Co. USA.
4. K.M. Prescott, J.P. Harley, D.A. Klein (1996) Microbiology : Wm. C. Brown Publishers, USA.
5. R. Ananthanarayan, C.K. Jayaram Panicker (1992) Test Book of Microbiology : Orient Longman Ltd. Madras.
6. C.B. Powar, H.F. Danganwala (1997) General Microbiology (Vol. II) : Himalaya Publishing House, Bombay.

### T.P. 3.1 ANGIOSPERM MORPHOLOGY AND SYSTEMATICS, ETHANOBOTANY ANGIOSPERM MORPHOLOGY

#### Theory

1. General concepts of morphology, origin and evolution of flower, co-evolution of flowers vis-a- vis pollinators.
2. Origin and evolution of monocot and dicot flowers.
3. Evolution of carpels: Different types of carpels, concepts of foliar origin of carpels – alternative concepts and approaches.
4. Specialized carpels – poly and syncarpy – superior, semi-inferior and inferior ovary- appendicular and receptacular concepts – evolution of placentation types.
5. Role of floral anatomy in interpreting the origin and evolution of flower and floral parts.

#### Practicals

1. Preparation of cleared whole mounts of floral parts to show vasculature.
2. With the help of dissections and hand sections, examine
  - a) Transmitting tissue/canals in style and stigma.
  - b) Different types of ovaries.
  - c) Different types of placentation.
  - d) Vasculature of androecium and gynoecium in special types of flowers.

#### References

1. Eames A.J. Morphology of Angiosperms.
2. Barnard C. The interpretation of Angiosperm flower. Aust. J. Sci. 24; 64-72 (1901)
3. Manilal K.S. Vascularisation of corolla of Compositae. J. Ind. Bot. Soc. 50: 189-196. (1981).
4. Meeuse A.D.J. Some fundamental principles of interpreting floral morphology. Intl. Biosci. Publ., Hissar (1974).
5. Melville R.A. New theory of angiosperm flower, Nature : 188 (14418) (1960).
6. Puri V. Inferior Ovary. Phytomorphology, 2:122 (1952).
7. Sporne K.R. The morphology of the Angiosperms. Hutchinson Univ. Press. London (1974).

### ANGIOSPERM TAXONOMY

#### Theory

1. Taxonomy – Its objectives, scope and importance.
2. Historical development of theories and concepts of biological classification and classificatory systems – with special emphasis on the conceptual basis of the classification of the following : Bentham & Hooker, Engler & Prantl, Hutchinson, Cronquist and Takhtajan.
3. Taxonomic structure. Taxonomic hierarchy and concepts of Taxonomic categories, species, genus, family and infraspecific categories.
4. Concept of character, character variations and their taxonomic implementations. Sources of taxonomic characters – morphology, anatomy, embryology, palynology, cytology, and phytochemistry

5. Modern trends in Taxonomy Conceptual and methodological problems; Bisystematics, Numerical Taxonomy, Cladistics, Chemotaxonomy.
6. Practical identification of plants; Different types of keys; construction of dichotomous keys; various kinds of taxonomic literature.
7. Plant nomenclature – A detailed study of the major provisions of the International Code of Botanical Nomenclature – Effective and valid publication, rank of taxa, rule of priority and its limitations, typification, author citation, rejection and retention of names of hybrids.
8. Methods of plant exploration, collection and herbarium preparation, importance of Herbaria, Botanical Gardens.

#### Practicals

1. During the course of this study, the students shall get familiarity with the local flora.
2. The students should get familiar with the method of dissecting and studying plants in the laboratory, describing them in technical terms, preparing scientific illustrations, constructing artificial keys and identifying them based on Bentham and Hooker's system of classification. For this purpose, each student shall work out at least 3 members of each the following families of Angiosperms available in the area.  
**Families** : Menispermaceae, Polygalaceae, Caryophyllaceae, Tiliaceae, Rhizophoraceae, Melastomataceae, Passifloraceae, Aizoaceae, Rubiaceae, Oleaceae, Asclepiadaceae, Gentianaceae, Boraginaceae, Lentibulariaceae, Pedaliaceae, Acanthaceae, Lauraceae, Loranthaceae, Euphorbiaceae, Utricaceae, Orchidaceae, Commelinaceae, Zingiberaceae, Araceae, Cyperaceae and Poaceae.
3. During the course of this study, each student shall undertake a field study tour for at least ten days, under the guidance and supervision of a teacher, at a place ecologically and floristically different of their place of regular study. Each one shall also collect plant specimens for herbarium preparation

and shall submit at least one hundred, well prepared, correctly identification during the course of their practical examination.

#### References

1. Davis, P.H. & V.H. Heywood. 1963. Principles of Angiosperm Taxonomy, New York.
2. Burkill I.H. 1865. Chapters in the history of botany in India. Delhi.
3. Heywood V.H. (Edn) 1968. Modern methods in Plant Taxonomy, London.
4. Street. H.S. (Ed.). 1978. Essays in Plant Taxonomy. Leiden.
5. Heywood, V.H. & D.M. Moore (Edn). 1984. Current concepts in Plant Taxonomy, London.
6. Vogel E.F. (Ed.) 1987. Manual of Herbarium Taxonomy. Leiden.
7. Styles B.T. (Ed.) 1986. Intraspecific classification of wild and cultivated plants. Oxford.
8. Stebbins, G.L. 1974. Flowering plants, Evolution above the species level. Cambridge, Mass.
9. Mayr. E. 1976. Evolution and diversity of life, Cambridge.
10. Jeffrey. C. 1968. An introduction to principles of Plant Taxonomy, London.
11. Sivarajan V.V. 1991. Introduction to Principles of plant Taxonomy, Delhi.
12. Stuessy. T.F. 1990. Plant Taxonomy, Columbia.
13. Naik. V.V. 1984. Taxonomy of Angiosperms, New Delhi.
14. International Code of Botanical Nomenclature (latest).

#### ETHNOBOTANY

1. Ethnobotany – relevance in modern medicine.
2. Ethnic societies of Kerala and their traditional herbs.
3. Ethnobotanical documentation.
4. Medicines derived from herbal drugs.

### T.P. 3.2 GENETICS, PLANT BREEDING AND HORTICULTURE GENETICS

#### Theory

1. Evolution of genetics and modern advances : Mendelism: Recent concepts on rediscovery of Mendelism; Modified Mendelian ratios: Genetic interaction: Multiple alleles; Statistical applications in genetics.
2. Linkage – crossing over and gene mapping : Classical experiments of Bateson and Punnett, Morgan, Bridges, two point and three point crosses, models of crossing over, Trisomics and translocation in Linkage analysis, Linkage and recombination in Neurospora, Bacteria and Bacteriophages; sex-linked, sex-influenced and sex – limited inheritance. Extra chromosomal inheritance.
3. Mutation : Spontaneous and induced mutations; physical and chemical mutagens, sex – linked mutation, the mutator gene and paramutation, reverse mutation, detection of mutation, mutation rate, molecular basis of mutation, site directed mutagenesis, DNA repair, mutation and evolution, significance of mutagenesis, vitality mutation.
4. Population genetics : Basic concepts, genetic equilibrium, genetic polymorphism, genecology, gene flow and gene migration. Eugenics Euphenics and Euthenics.
5. Quantitative genetics : polygenes, Multiple gene concept, transgenic variation.
6. Organic evolution: Populational and molecular mechanisms. Origin of species.

#### Practicals

1. Problems related to the theory parts have to be worked out.
2. Recombination analysis and gene mapping in Neurospora/Sordaria.

#### References

1. Sinnert, Dunn and Dobshansky. Principle of Genetics, McGraw Hill.
2. Narin P. (1990). Statistical Genetics, New Delhi, Wiley Easter Ltd.

3. Singer, M. and Berg. P. (1991). Genes and Genomes, Black Well Scientific Publications.
4. Watson, J.S. (1990). Molecular Biology of the Gene. Benjamin Sydney.
5. Potry KUS, I and Spangenberg, G. 1995. Gene transfer to plants. Springer Verlag, Berlin.
6. Mahiga, P.' Klessing, D.F. Casmore, A.R. Grinssen, W. and Varner, J.E. 1995. Methods in plant molecular biology – A laboratory course – manual CSHL Press, New York.
7. Dodds, J.H. 1985. Plant genetic Engineering, Panima Education Book Agency.
8. Weaver, R.E. and Hedrick, P.W. 1985. Basic genetics W.M.C. Brown Publishers.
9. Hartl. Daniel, L. and Andrew, G. Clark, Principles of population genetics, II editions Sunderland, M.A: Sinaver, 1989.
10. Maurten, J. Chrispeels and David, E.Sadava. 1994. Plant, genes and Agriculture, Jones and Bartlett Publishers International, London.

#### PLANT BREEDING

#### Theory

1. Introduction, History of Plant Breeding and Breeding systems in Plants.
2. Floral biology and its significance in hybridization.
3. Plant introduction, Genetic resources conservation and utilization in plant breeding – National and International germplasm centers – types of germplasm collections.
4. Selection technique – Principles and application of selection, genetic basis of selection, pure line selection, disruptive selection, recurrent selection; selection of segregation populations, clonal selection.
5. Hybridization – Genetic and breeding consequence of hybridization and consequent selection. Systems of incompatibility and hybrid sterility and methods of overcoming. Methods of handling segregating population for superior strain selection – Bulk method and pedigree method. Inter specific and intergeneric hybridization in crop

improvement. Back crossing – Theory and practice; inbreeding depression, Heterosis and heterobeltiosis; methods of exploitation of heterosis or hybrid vigor; use of male steriles.

6. Polyploidy in plant breeding.
7. Mutation breeding – Major achievements in India and other countries in different crops
8. Breeding for pest, disease and stress resistance.
9. Recent advances in genetic manipulations of crop through in vitro induced mutation, somatic hybridization, tissue culture and transgenesis. Micropropagation – theory and practice – In vitro storage and exchange of germplasm – terminator seeds and suicidal plants.

#### Practicals

1. Study of floral biology and flower structure in crop plants (rice, cashew, pulses, solanum, capsicum).
2. Practice of hybridization techniques in self and cross pollinated crops available (same plants as above under item 1).

### HORTICULTURE

#### Theory

1. Concept and scope of horticulture.
2. Basic requirements – land, water, soil, landscape, propagules, implements and practices – types of garden plants.
3. Classification of gardens – aesthetic garden, home garden, public parks, rock garden, roof garden, bonsai – vegetable garden, kitchen garden and orchids – medicinal gardens.
4. Propagation methods of garden plants.
5. Implements, tools and machineries for gardening.
6. Disease and pest control in gardening.
7. Fertilizers – types and application.
8. Problem of garden pollution – preservation.
9. Planning and management of gardens.

#### Practicals

1. Grafting, budding, layering.

2. Determination of soil ph, estimation of dissolved oxygen, and estimation of NPK ratio.
3. Operation and use of garden implements.

### T.P. 3.3 MOLECULAR BIOLOGY, GENETIC ENGINEERING AND BIOINFORMATICS

1. Molecular biology of gene. Ultrastructure of DNA. Alternative form of DNA. Repetitive DNA.
2. Replication of DNA. Experimental evidence. Enzymology of replication. Replication in Prokaryotes and Eukaryotes. Primosomes and replisomes.
3. Genetic code, Gene expression and one gene one enzyme concept, one gene one polypeptide concepts, concept of Co-linearity. Properties of genetic code. Deciphering of the genetic code.
4. Protein synthesis action. Transcription, post transcriptional events. Introns and their significance. Translation, post transcriptional events – role of chaperons.
5. Regulation of gene expression – The operon concept. Alternation in the operon – gene regulation in Eukaryote – Enhancers and silencers.
6. Molecular analysis of gene and gene product – Southern, Northern and Western Blot – Restriction maps – RFLP and RAPD. Chromosome walking and jumping, fish, PCR and its application, DNA finger printing DNA chips.
7. DNA sequencing, enzymatic methods. Gilbert & Maxam method – Sanger's method. Messing's Shot gun method – Fluorescent detection and automation – The human genome project.
8. Recombinant DNA technology - Enzymes, Vectors, Gene-cloning strategies, construction and screening of gene and cDNA libraries. Expression of cloned genes in bacteria and mammalian cells, prospects and achievements.
9. Transgenic organisms : Gene cloning strategies in plants – vector dependent and vector independent methods. Identification and selection of transformed plants – the

reporter enzyme technology-Objectives and achievements – engineering for secondary metabolites, resistance against herbicides, insects, pathogens, stress – novel nutritional and qualitative changes in plants. Plants as bioreactors, phytopolymers, biodegradable plastics, antisense RNA technology – Transgene inactivation. Terminator and traitor technologies.

10. Cloning – Objectives. Creation of dolly. Other developments in cloning. Human cloning – Ethics of cloning.
11. Patenting of genes and GMOs. Gene piracy. Ethics and biosafety aspects, rec. DNA safety, IPR biosafety protocol.

#### Practicals

1. Problem related to the theory parts have to be worked out.
2. Extraction and isolation of nucleic acid from leaf tissue.
3. Quantitative estimation of DNA and RNA calorimetric bar spectrophotometric.

#### References

1. Sinnert, Dunn and Dobshansky, Principle of genetics, McGraw Hill.
2. Narin P. (1990). Statistical genetics, New Delhi, Wiley Easter Ltd.
3. Singer, M. and Berg. P. (1991). Genes and Genomes, Black Well Scientific Publications.
4. Watson, J.S. (1990). Molecular Biology of the Gene. Benjamin Sydney.
5. Potry KUS< I and Spangenberg, G. 1995. Gene transfer to plants. Springer Verlag, Berlin.
6. Mahiga, P., Klessing, D.F. Cashmore, A.R. Grinssen, W. and Varner, J.E. 1995. Methods in plant molecular biology – A laboratory course – manual CSHL Press, New York.
7. Dodds, J.H. 1985. Plant genetic Engineering, Panima Education Book Agency.
8. Weaver, R.E. and Hedrick, P.W. 1985. Basic genetics W.M.C. Brown Publishers.
9. Hartl. Daniel, L. and Andrew, G. Clark. Principles of population genetics, II editions Sunderland, M.A: Sinaver, 1989.

10. Maurten, J. Chrispeels and David, E. Sadava. 1994. Plant, genes and Agriculture, Jones and Bartlett Publishers International, London.
11. Molecular Biology and Biotechnology: J.M. Walker and R. Rapley. Panima Publishing Corporation.
12. Molecular Biotechnology Principles and Applications of Recombinant DNA: Bernard R. Glick and Jack J. Pasternack; ASM Press Washington.
13. Gene cloning and DNA Analysis : T.A. Brown; Blackwell Science Pub:
14. Molecular Biotechnology, S.B. Primrose; Panima Publishing Corporation.
15. Plants, Genes and Agriculture. Maarten J. Chrispeels and D.E. Sadava. Jones and Bartlett Publishers.
16. Brave New Seeds: The threat of GM crops to farmers : Robert de la Pemere and Franck Seuret: : Global Issues Series.

#### Computer application in Biology with special reference to Bioinformatics

##### General topics

1. Computer in science with special reference to biology, the scope and prospects.
2. Information super highway (Internet) the philosophy and ethics of science (with special reference to biological) resources online; www, FTPs, Gopher, list servers, new groups, online archives, data bases, the Public Library of Science (www. Publiclibraryofscience. org), Open archive Initiative (www. Openarchive. org), Biomedcentral, Pub Med Central, freedom of scientific information access, e-access debate concepts and implications, Free software Movement, Free software foundation, GNU/Linux etc.
3. Digital divide, Information poverty and information overload – the Indian scenario a general account.
4. Online publications with special reference to biology, electronic journals, books, downloading and uploading.
5. Detailed account of computer packages for Bio-statistics, Database preparation and graphic applications in biology.

6. Programming for biology.

Suggested Laboratory works:

1. Acquire basic computer operation and internet browsing skills in windows and linux platforms.
2. Acquire basic word processing/ data entry skills using popular (both commercial and open source) packages such as MS-Word, K-Word, Open Word, Pagemaker etc.
3. Acquire graphic processing skills using popular (both commercial and open source) packages such as Photoshop, CorelDraw, Chem Draw, etc.
4. Preparation of scientific presentations using packages such as MS- Powerpoint.
5. Acquire skills in use of statistical packages such as SPSS, Biostat, Origin, MS-Excel etc.
6. Acquire skills in data base packages such as MS-Access, Foxbase etc.
7. Acquire basic programming skills using C/C++, VC, VB, Pearl, etc.

**References**

Online resources freely available at internet sites such as

[www. publiclibraryofscience .org](http://www.publiclibraryofscience.org)

[www. openarchives. org](http://www.openarchives.org)

[www. pubmedcentral. gov](http://www.pubmedcentral.gov)

[www. biomedcentral. com](http://www.biomedcentral.com)

The journal Nature and its online archives ([www. nature. com/nature/debates/e-ccess/index.html](http://www.nature.com/nature/debates/e-ccess/index.html))

**BIOINFORMATICS**

1. Introduction : Importance, scope. Bioinformatics sites and centers.
2. Information networks: Internet, World Wide Web. Web browsers, HTTP, HTML and URLs. Biological networks.
3. Biological databases
  - a. Nucleic acid databases: EMBL, Genbank – stmsture of GenBank entries. Specialized genomic resources, UniGene.
  - b. Protein Sequence Databases:

- Primary sequence databases: PIR, SWISS-PROT- structure of SWISS-PROT entries. TrEMBL.
- Composite protein databases: NRDB, OWL.
- Secondary databases: PROSITE, PRINTS, BLOCKS, IDENTIFY.
- Structure classification databases. SCOP, CATH.

4. Database searching

- a. Sequence database searching. EST searches. CDNA libraries and ESTs. Different approaches to EST analysis. Merck/MAGE, Incyte, TIGR. EST analytical tools. Sequence similarity, sequence assembly and sequence clustering.
- b. Pair wise akignment technique: Comparison of sequences and sub-sequences. Identity and similarity. Substitution matrices, BLOSUM, DOTPLOT and BLAST.
- c. Multiple alignment technique: Objective, Manual, Simultaneous and Progressive methods. Databases of multiple alignments. PSI-BLAST.

5. Protein structure prediction:

- a. Secondary structure prediction. Chou-Fasman. Jpred.
- b. Tertiary structure prediction: Comparative modeling – Modeller, RasMol.

6. Software in Bioinformatics: C/C+, Biojava, Bioperi, BIOXML, BIOCOBRA, ORACLE< BIODAS, BIOML. (General account).

7. Emerging areas of Bioinformatic: DNA microarrays, functional genomics, comparative geomics, Pharmacogenomics, Chemoinformatics, Medical informatics.

**Suggested laboratory works:**

1. Acquisition of basic skills in Internet browsing.
2. Familiarization of web browsers and search engines.
3. Familiarisation of important biological and bioinformatic website e.g., Agris, Agricola, BIOSIS, CABWeb

## References

1. Introduction to Bioinformatics. T.K. Attwood and D.J. Arry-Smith. Pearson Education.
2. Introduction to Bioinformatics. S. Sundararajan and R. Balaji. Himalaya Publishing House.

## SPECIALIZATION SUBJECT - I ENVIRONMENTAL SCIENCE

### Theory

1. Introduction : What is environmental Science? Interdisciplinary nature – Ecosystem – components – population, community and biosphere – history and development – natural history to ecological models.
2. Conditions for life: **Climate**: Solar radiation – origin of earth – evolution of environment – origin of life – Gaia hypothesis – levels of organization – theory of integrative levels, continental drift – land – bridge hypothesis.
3. Physical factors: **Light**: Solar radiation – Beer's Law and attenuation of light – adaptation. **Temperature**: Plant-temperature interactions – metabolic adaptation. **Temperature**: Plant-temperature interactions-metabolic adaptations of plants-life in extremes. **Moisture** Structure of water molecule-unique properties of water – water cycle – tolerance towards floods, water scarcity, and salinity – phenology. **Nutrients** : Macro and micronutrients – geology, climate and nutrients – role of microorganisma in nutrient cycle – Leibig – Blackman theory. Biogeochemical cycles – Carbon, Nitrogen, Sulfer and Phosphorous cycles – food chain, food web and ecological pyramids. **Soil** : Soil formation – Soil horizons – Soil types – Soil organisms – Soil properties – Soil mosaics – Cat ion exchange capacity – Soil erosion.
4. Population : Unique feature – density – dispersion of individuals – demography – age structure – fertility and fecundity – natality and mortality – population growth- growth rate – limiting factors – population interaction and regulation – interspecific competition – Lotka – Volterra equation – predation, commensalisms, mutualism and parasitism – human interaction with natural population – Biological control.
5. Population genetics: Genetic variation and natural selection – source of variation – genetic consequence of different reproductive systems – cloning – patterns of genetic variation – ecotones, ecotypes, ecophenes and ecoclines.
6. Communities : History and development of community concepts – concepts and definitions – structure and function – habitat and niches – succession (ecosystem development) – causes and consequences of succession – dynamics and products of succession – gause's competitive exclusion principle – fundamental and realized niches – recent developments in community ecology- wood wide web.
7. Energetics : Energy and entropy – principles of thermodynamics – energy flow and transfer-efficiency – primary productivity in aquatic and terrestrial habitats.
8. Ecosystems: Ecosystem pattern- tundra and taiga, grass lands and savannas, shrubland and desert-temperate and tropical forests-lakes and ponds-fresh water wetlands, lakes and ponds – rivers –oceans, intertidal zones and coral reefs-estuaries, slot marshes and mangrove forests-phytogeographic zones of the world-vegetation types of India-Gadgil-Mehr-Homiji's Classification –Remote sensing, satellite imagery-Western Ghats-Himalayas.
9. Conservation: Reasons for conservation – Noah's mission-first conservationist – environmental hazards and disasters – Impact of environmental modification-deforestation, urbanization, industrialization, application of chemicals as fertilizers and pesticides – Biopesticides, Biofertilizers – applied biological control. Sustainable development – Rio Earth Summit – Silent Spring – IUCN, UNDP, Red Data Book, IBPGR, Global environmental – Facility conservation strategy – Biodiversity conservation – Endangered flora and fauna – Wild Life Sanctuaries, National Parks and

Bioreserves. Environmentalism. Project Tiger and Project Elephant patents, GATT, Biopiracy and Biosafety - EIA.

10. Pollution: Kinds of pollution: air, water, land noise thermal and radiation – CFCs and Ozone depletion. Global warming-Green House effect-Pollution abatement. Pollution special reference to Kerala (Chaliyar and Periyar), Environmental laws- NGOs and environment movement (Special reference to Kerala and India – Silent Valley, Narmada).
11. Research methodology

#### Practicals

1. Standardization of quadrat size using species- area curve method for the analysis of local vegetation.
2. Determination of frequency of 10 common species in the local grassland vegetation.
3. Determination of density of 10 dominant species in the local vegetation.
4. Determination of IVI (Importance Value Index) of 4 species of the local flora.
5. Soil analysis-physical characteristics – components – texture – humus content. Chemical characteristics – pH, salinity, chemical components.
6. Water Analysis - Technique
7. Sampling – colour and odour – Dissolved oxygen estimation – Estimation of COD (Chemical O<sub>2</sub> demand)- Total organic carbon – N<sub>2</sub> and p-Suspended particles – Bacteriological methods-Extraction of pesticides of analysis – Chromatographic analysis – spectrophotometric analysis.

#### References

1. Chapman J.L. and Reiss, M.J. 1992. Ecology – Principle and Applications Cambridge Univ. Press.
2. Park C. 1997. The Environment – Principles and Applications Rontledge – London.
3. Smil, V. 1997. Cycles of life. Civilization and Biosphere W.H. Freeman and Co. N.Y.
4. Smith, R.L. and Smith T.M. 1998. Elements of Ecology Benjamin/Cummings Publishing Co. USA.

5. (Also the references given to the Core paper Env'tl. Science page-).

### SPECIALIZATION SUBJECT – II TISSUE CULTURE AND PLANT BIOTECHNOLOGY

#### Theory

1. (A) Biotechnology : History, Definitions; Branches; Major Centers in India.
2. Medicinal and aromatic Plants: Introduction; importance of exploitation by tissue culture with special reference to India / Kerala.
3. Basic aspects of plant tissue culture; history; different media; components; growth regulators; growth retardants; undefined supplements; Explants; sterilization; inoculation; subculturing etc.
4. Different types of culture: Callus – Different types; cell culture; suspension culture-different types; culture methods of single cells; Testing of viability of cells; Application of cell and callus culture with special reference to Medicinal and Aromatic Plants in vitro Morphogenesis:
  - (a) Organogenesis – Different types; factors affecting; problems related to micropropagation of woody (Medicinal) plants.  
Different stages of Micropropagation; Rooting and Establishment. Somaclonal variation and its importance with special reference to medicinal and aromatic plants.
  - (b) Somatic embryogenesis: Different methods; Factors affecting Embryo maturation; Application. Synseeds and its significance.
5. Production of pathogen free plants: Different methods; Meristem culture and its importance in commercialization especially of Medicinal and Aromatic plants.
6. Protoplast : Isolation and culture methods; Factors affecting; Somatic hybridization : Different types; Fusion methods. Application with special reference to medicinal and aromatic plants.

7. Haploids: Different methods; Anther and Pollen culture. Advantage of pollen culture. Significance in crop improvement with special emphasize on medicinal and aromatic plants.
8. Ovary, ovule, endosperm and embryo culture; importance. Invitro fertilization (recent advances) and its significance.
9. Secondary metabolites : Different classes; methods of production – factors affecting yield. Biotransformation; Different types with example. Immobilization: Different approaches; Techniques; Advantages. Biosensors, Biochips.
10. Major centers of secondary metabolite production in India.
11. Germplasm storage: In Vitro methods; long term and short term; Cryopreservation and its significance with special reference to medicinal and aromatic plants; Major centers in India.
12. Recombinant DNA technology: Basic concepts and Strategies; DNA synthesis; Enzymes in r- DNA Synthesis Cloning vectors (Plasmids, phages cosmids, plant viruses, retroviruses, shuttle vectors, transposons Agrobacterium) Vector- Plant transformation; Direct gene transfer; Isolation of DNA fragments; Blotting, DNA sequencing, gene bank etc. Screening techniques: Polymerase Chain Reaction, Site directed mutagenesis.
13. Applications of r-DNA : Medicinal, Agricultural, industrial and Environmental. Transgenic organisms with special reference to recent developments especially in plants.

#### Practicals

1. Preparation of Stock solutions of different media: MS, BS, Whites, Nitsch. Preparation of stock solutions of Growth Regulators.
2. Preparation of solid and liquid media; suspension cultures.
3. Culture of different explants.
4. Standardization of media for callus induction, direct and indirect organogenesis and somatic embryogenesis (Medicinal Plants).
5. Standardization of media for Androgenesis, Meristem culture (shoot and root meristem).

6. Ovary, ovule and embryo culture. Demonstration of in vitro pollination.
7. Development of protocol for the multiplication of atleast one medicinal plant.

#### SPECIALIZATION SUBJECT - III BIOFERTILIZER TECHNOLOGY

##### Theory

1. Introduction- History, definition, importance of biofertilizers.
2. Integrated intensive farming – Ecological techniques, Ecofriendly Farming, Information skill, Organization and Management.
3. Chemical fertilizers – Food security, health and the environment, Nitrate pollution, nitrogen leaching.
4. Classification of beneficial microorganisms.
5. Types of biofertilizers - classification, symbiotic, nonsymbiotic and associative symbiotic organisms.
6. Importance of biofertilizers – Ecology, characteristics, mass multiplication, method of inoculation, growth / yield response of
  1. Rhizobium
  2. Azotobactor
  3. Azospirillum
  4. Mycorrhiza
  5. Bacillus megatherium
  6. Cyanobacteria
  7. Actinorrhiza
  8. VAM
7. Physiology, biochemistry, molecular biology and genetics of nitrogen fixation, nitrogen metabolism and carbon assimilation in symbiotic and asymbiotic microorganisms.
8. Molecular and ultra structural studies of the Rhizobium legume association and Azolla – Anabaena association.
9. Use of <sup>15</sup>N technique and Acetylene Reduction Assay for measuring nitrogen fixation.
10. Factors favouring the growth and multiplication of different biofertilizers.

11. Nutrient requirement of beneficial microorganisms and Azolla.
12. Germplasm conservation, preservation and utilization of biofertilizers.
13. Salinity tolerance, herbicide tolerance, pesticide tolerance and genetics of stress, herbicide, and disease resistances in biofertilizers.
14. Pests, pathogens and diseases of cyanobacteria and Azolla; and their management.
15. Soil amelioration by cyanobacteria and Azolla.
16. Mineralization : degradation and lignin decomposition of BGA and Azolla in soil.
17. Economic analysis of biofertilizers use.

#### Practicals

1. Isolation and culturing of Rhizobium from root nodules and stem nodules.
2. Biochemical tests to distinguish Rhizobium and Agrobacterium.
3. Spore collection and culturing of VAM.
4. Estimation of nitrogenase and nitrogen fixation.
5. Study of Relative Growth Rate – of Azolla and Cyanobacteria.
6. Isolation and culturing of Azospirillum, Azotobacter and Cyanobacteria.
7. Study of pests of BGA and Azolla.
8. Estimation of phosphates.
9. Pot culture experiments of paddy with Azolla and Cyanobacteria, as biofertilizers.

#### References

1. Bothe, H, D. Bruijn and W.E. Newton (eds.). 1984. Nitrogen fixation 100 years after. Bustan Fisher, Stuttgart.
2. Carr, N.G and B.A. Whitton 1973. The biology of blue green algae. University California Press, Barkdey, USA.
3. Elkan, G.H., M. Dekker. 1987. Symbiotic nitrogen fixation technology. Inc.
4. Goff. L.J. (ed.) 1982. Algal symbiots. Cambridge University Press, USA.

5. Hollaender, A (ed.) 1977. Genetic engineering of nitrogen fixation.
6. IRRI 1987. Annual report for 1986. Azolla pests. P.O. Box 933, Manila, Philippines.
7. Kannaiyan, S. 1982. Multiplication and use of Azolla Biofertilizer for rice production training. TNAU. India.
8. Ladha, J.K. and I. Watnabe 1987. Azolla utilization. Int. Rice. Res. Inst. Los Banos, Philippines.
9. Lewin, R.A. (ed.) 1976. The genetics of Blue Green Algae. Blackwell Sci. Pub. London.
10. Lodden, P.W and J.E. Burris 1985. Nitrogen fixation and carbon dioxide metabolis. Elsevier Sci. Pub. Co. Netherlands.
11. Lumpkin, T.A. and D.L. Plucknett. 1982. Azolla as a green manure.
12. Lyons, J.M., R. Valentina, D.A. Philips, D.W. Rains and R.C. Huffakar (eds). Genetic Engineering of symbiotic nitrogen fixation and conservation of fixed nitrogen, Plenum, New York, USA.
13. Newton, N.W. and O. Johnson (eds.) 1980. Nitrogen fixation. Univ. Park Press, Baltimore.
14. Raj, A.N. (ed.) 1990. Handbook of symbiotic Cyanobacteria. CRC Press Inc. Boca Raton.
15. Silver, W.S. and E.C. Shroder (eds.) 1984. Practical applications of Azolla for rice production, Martins/Nijhoff/ Dr. W. Jink Publishers. The Hague Boston and Lancaster.
16. Subba Rao, N.S. 1996. Advances in agricultural microbiology.

#### SPECIALIZATION SUBJECT - IV PRINCIPLES AND PRACTICES OF HORTICULTURE AND GARDEN MANAGEMENT

#### Theory

1. Concept and scope : Definitions of different types gardens, concept behind each, brief history, fertilization of famous gardens in the world and in India, economic – educational –

- hygienic – and aesthetic values, scope of the study and further researches on gardening.
2. Basic requirements : Land, water, soil, landscape, on – scape and off – scape, seeds and seedling materials, propagules, traditional implements and practices – factors taken care in growing nurseries and plants, ornamentals – annuals – perennials – flowering trees – climbers – bulbous plants, varietal collections, germ plasm collection and specialized collections.
  3. Classification of gardens and horticultural taxonomy : aesthetic gardens, home gardens, public parks, gardens associated with buildings, offices, schools and colleges, rock gardens, bog gardens, roof gardens, container gardens, bonsai, vegetable gardens, kitchen gardens, fruit gardens (orchards), medicinal plant gardens, forest nurseries, social forestry.
  4. Specialized features associated with gardens: Garden walks, paths, pavements, terraces, lawns, hedges, borders, arches, pergolas, fountains, benches, ponds, bridges, umbrellas, statues, dwarfing, pruning, topiary, tree surgery, avenues, green house, cold frames, hot beds, nurseries.
  5. Propagation methods related to different types of gardens: Seed propagation, seed biology, seed testing, seed storage, germination, dormancy, orthodox and recalcitrant seeds. Propagation by cutting, grafting, budding, layering, polarity in grafting, graft incompatibility, scion-stock relationships, propagation by specialized stems and roots, methods of micropropagation.
  6. Implements, tools, small-scale machineries and their uses: Ploughs, power tillers, conventional/traditional agricultural tools; specialized tools – pruning knife, budding knife, secateurs, lawn mower, sprayers, metal label, name boards.
  7. Diseases, pests, control measures.
  8. Fertilizers: manures, growth promoters, other chemical – their uses, Biofertilizers, green manure, mulching, cover crops. Insecticides, pesticides, fungicides and weedicides. Flower hormones, root hormones, ethylene.

9. Sources of pollution and prevention by suitable garden practices. Pollution, what, where and why? Pollution by pesticides, feed lots, fertilizer run-off, soil erosion, plant residues, etc.
10. Planning and management of gardens: Budget making, pricing, sales promotion and marketing, labour management, master rolls, accounting.

#### Practicals

1. Grafting: Different types of grafting.
2. Budding: Different types of budding.
3. Layering: Different types of layering.
4. Tree surgery.
5. Preparation of potting mixture, potting.
6. Imbibition rate.
7. Determination of local biomass
8. Estimation of dissolved Oxygen.
9. Alkalinity/acidity of soil
10. Estimation of NPK ratios.
11. Operation of garden.
12. Mechanisms and use of implements.

#### References

1. Hartmann H.T., Kester D.E., Davies F.T. and Geneve R.L. 1997. Propagation and practice. 6<sup>th</sup> Edn. Prentice Hall of India, Pvt. Ltd. New Delhi.
2. Lancaster P 1997, Gardening in India. Revised by Bose T.K. and Mukherjee D.
3. Laurie A and Ries V. 1956. Floriculture: fundamentals and practices Mc Graw Hill Book Co. Inc. N.Y. Trinidad, London.
4. Macmillan 1962. Tropical planting and gardening, 5<sup>th</sup> Edn. Macmillan Co. Ltd. London.
5. Northen T.H. and Northen R.T. 1956. The complete book of green house gardening. The Ronald Press Co. New York.
6. Pearce S.A. 1961. Ornamental Tree: For gardening and roadside planting, W.H & L Collingridge Ltd. London.
7. Prakash R. Choudhary D.C. and Nagi S.S. 1991. Propagation practice of important Indian trees, Intl. Book Distributors, Dehra Dun.

8. Radford A.E. 1986. Fundamentals of plant systematics. Harper & Row Publ. Inc.
9. Hay R. (Ed.) 1960. The modern garden. G. Arthur Pearson Ltd. London.
10. Shoemaker J.S. and Teskey B.J.E. 1965. Practical Horticulture. John Wiley & Sons. Inc. London.

#### SPECIALIZATION SUBJECT - V

### CONSERVATION OF MEDICINAL PLANTS, MUSEOLOGY AND HERBARIM TECHNIQUES

#### Theory

1. Global importance of medicinal plants – reasons for their conservation.
2. Medicinal Plants in India – approaches to exploitation and conservation.
3. Techniques to conserve medicinal plants – Agronomy applied to conservation – of Biotechnology in the production and conservation of the medicinal plants – role of botanic gardens in conservation.
4. Conservation of medicinal plants: The need for public awareness.
5. The development, purpose and types of herbaria.
6. Collecting – equipments used in the field – objectives – how and what to collect – recording data, pressing and drying specimens.
7. Processing of unmounted specimens, mounting and labeling – arrangements of herbarium collections.
8. Curation of succulents.
9. Incorporation of mounted specimens – stamping – numbering – filing of specimens
10. Collection and preserving specimens for the museum.
11. Collection and curation of bryophytes.
12. Collection and curation of fungi and lichens.
13. Storage of specimens – boxes – cases – storage of bulky dry materials – spirit collections.

#### Practicals

1. Collection, identifications and preservation of medicinal plants (100 nos).

2. Visit to two important medicinal plant gardens and two centers of Floristic studies and preparations of certified reports.
3. Study of medicinal plants and in the treatment of a major diseases and preparation of a report.

#### RESEARCH METHODOLOGY

#### Theory

1. Introduction – (i) Need for research (ii) Stages of research – (a) Definition of a problem (b) Execution of work (c) Interpretation of research; (iii) Methods – (a) Technical (b) Logical; (iv) Logical methods – (a) Description and classification (b) Evolutionary (c) Determination of casual function – *Inductive methods* (1) Method of difference (2) Method of concomitant variation (3) Method of residue 4) Method of agreement, *Statistical methods*, *Deductive inductive method*; (v) Relevance and assumptions
2. Review of literature – (A) Library : (i) Structure of a scientific library – journals – current and back volumes, Books – reference and issues, periodicals and other sources (ii) Catalogue – What is a catalogue and how to use it? Types of catalogues – card catalogue, holdings, computerized catalogue (iii) Classification of books Universal decimal system; (B) Journal (a) Indexing journals (b) Abstracting journals (c) Research journals (d) Reviews; (C) Other sources: (a) Reprints – Acquisition & Filing (b) CD Rom (c) Internet, world wide web (d) INSDOC Services; (D) Preparations for review: (a) Outline of review (b) Selection of key words (c) Preparation of index cards – author index & Subject index.
3. Preparation of project proposal – (a) Title and abstract (b) aim and scope, (c) Present status, (d) Location of experiments (e) Materials and methodology, (f) Date of commencement (g) Estimated date of completion, (h) Estimation cost.
4. Preparation of a dissertation : (a) Consolidation and analysis of data, photographs, illustration, tables and graphs, (b) Preparation of the outline, (c) Preparation of manuscript –

8. Radford A.E. 1986. Fundamentals of plant systematics. Harper & Row Publ. Inc.
9. Hay R. (Ed.) 1960. The modern garden. G. Arthur Pearson Ltd. London.
10. Shoemaker J.S. and Teskey B.J.E. 1965. Practical Horticulture. John Wiley & Sons. Inc. London.

#### SPECIALIZATION SUBJECT - V

### CONSERVATION OF MEDICINAL PLANTS, MUSEOLOGY AND HERBARIM TECHNIQUES

#### Theory

1. Global importance of medicinal plants – reasons for their conservation.
2. Medicinal Plants in India – approaches to exploitation and conservation.
3. Techniques to conserve medicinal plants – Agronomy applied to conservation – of Biotechnology in the production and conservation of the medicinal plants – role of botanic gardens in conservation.
4. Conservation of medicinal plants: The need for public awareness.
5. The development, purpose and types of herbaria.
6. Collecting – equipments used in the field – objectives – how and what to collect – recording data, pressing and drying specimens.
7. Processing of unmounted specimens, mounting and labeling – arrangements of herbarium collections.
8. Curation of succulents.
9. Incorporation of mounted specimens – stamping – numbering – filing of specimens
10. Collection and preserving specimens for the museum.
11. Collection and curation of bryophytes.
12. Collection and curation of fungi and lichens.
13. Storage of specimens – boxes – cases – storage of bulky dry materials – spirit collections.

#### Practicals

1. Collection, identifications and preservation of medicinal plants (100 nos).

2. Visit to two important medicinal plant gardens and two centers of Floristic studies and preparations of certified reports.
3. Study of medicinal plants and in the treatment of a major diseases and preparation of a report.

#### RESEARCH METHODOLOGY

#### Theory

1. Introduction – (i) Need for research (ii) Stages of research – (a) Definition of a problem (b) Execution of work (c) Interpretation of research; (iii) Methods – (a) Technical (b) Logical; (iv) Logical methods – (a) Description and classification (b) Evolutionary (c) Determination of casual function – *Inductive methods* (1) Method of difference (2) Method of concomitant variation (3) Method of residue 4) Method of agreement, *Statistical methods*, *Deductive inductive method*; (v) Relevance and assumptions
2. Review of literature – (A) Library : (i) Structure of a scientific library – journals – current and back volumes, Ebooks – reference and issues, periodicals and other sources (ii) Catalogue – What is a catalogue and how to use it? Types of catalogues – card catalogue, holdings, computerized catalogue (iii) Classification of books Universal decimal system; (B) Journal (a) Indexing journals (b) Abstracting journals (c) Research journals (d) Reviews; (C) Other sources: (a) Reprints – Acquisition & Filing (b) CD Rom (c) Internet, world wide web (d) INSDOC Services; (D) Preparations for review: (a) Outline of review (b) Selection of key words (c) Preparation of index cards – author index & Subject index.
3. Preparation of project proposal – (a) Title and abstract (b) aim and scope, (c) Present status, (d) Location of experiments (e) Materials and methodology, (f) Date of commencement (g) Estimated date of completion, (h) Estimation cost.
4. Preparation of a dissertation : (a) Consolidation and analysis of data, photographs, illustration, tables and graphs, (b) Preparation of the outline, (c) Preparation of manuscript –

introduction, review of literature, materials and methods, results, discussion, summary, acknowledgements, references; (d) language text – tense, capitalization, italics, punctuation, proof reading, abbreviation (e) Bibliography – methods of citing references, arrangement of references (f) Presentation – Title page, certificates, binding, (g) Presentation of research findings in seminars and workshops – OHP, Slides, Computer assisted (power point) presentation.

#### **Practicals**

1. Prepare a project proposal.
2. Prepare an outline dissertation.
3. Prepare a list of references.
4. Present a small project in the class with the help of OHP.

#### **Reference**

- Introduction and General Principles
1. Riker, A.J. & Riker R.S. (1936) Introduction to research on plant diseases, John Swift & Co, USA 177p.  
Review of Literature:
  2. Krishnakumar, K (1981) An introduction to cataloguing practice, Vikas Publ. House, New Delhi, 298p.
  3. Parashar, R.G. (1989) Index and indexing systems, Medallion Press, New Delhi, 196p  
Preparation of Research Project Proposal.
  4. Bercy, R. (1994) The research project, how to write it, Rutledge, London, 116p.

