

**KANNUR UNIVERSITY**

**(Abstract)**

M.Sc Botany Course- Scheme & Syllabus- Revised and Implemented-With effect from 2010 admission-Orders Issued.

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**ACADEMIC BRANCH**

U.O.No.Acad/C2/8962/2008

Dated, K.U.Campus.P.O,31-05-2010.

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- Read: 1. U.O.No.Acad/C2/3180/2001 dated 09-06-2004.  
2. Minutes of the meetings of the Board of Studies in Botany (PG) held on 26-09-2008 & 18-03-2010.  
3. Minutes of the meeting of the Faculty of Science held on 19-06-2009.  
4. Item No.I B(iii) of the minutes of the ninth meeting of the Academic Council held on 16-02-2010.  
5. Letter dated nil, from the Chairman, BOS in Botany (PG).

**ORDER**

1. As per the paper read first above the Scheme and Syllabus of M.Sc Botany Course were implemented in this University with effect from 2004 admission.
2. As per the paper read second above, the Board of Studies in Botany (PG) recommended to revise the Scheme & Syllabus of M.Sc Botany Course with effect from 2010 admission.
3. As per the paper read third above, the Faculty of Science held on 19-06-2009, approved the recommendation of the Board of Studies in Botany (PG) on the revision of the Scheme & Syllabus of M.Sc Botany Course, for the approval of the Academic Council.
4. As per the paper read fourth above, the Academic Council of the University resolved to approve the above recommendation of the Board of Studies as approved by the Faculty of Science.
5. As per the paper read fifth above, the Chairman, Board of Studies in Botany (PG), forwarded the revised Scheme & Syllabus of M.Sc Botany Course under Semester Pattern for implementation with effect from 2010 admission onwards.
6. The Vice Chancellor, after considering the whole matter in detail has accorded sanction *to implement the revised Scheme & Syllabus of M.Sc Botany Course, as approved by the Academic Council, with effect from 2010 admission.*
7. The regulations for Post graduate Programme in Semester Pattern in affiliated Colleges (2001 admission) is applicable to this Course also.
8. The U.O read above, stands modified to this extent.
9. Orders are issued accordingly.
10. The Revised Scheme & Syllabus of M.Sc Botany Course effective from 2010 admission is appended.

Sd/-  
REGISTRAR

To  
The Principals of Colleges offering M.Sc Botany Course.

Copy to:

- 1.The Examination Branch (through PA to CE).
- 2.The Chairman, BOS in Botany(PG).
- 3.PS to VC/PA to PVC/PA to Registrar.
- 4.DR/AR-I (Academic)
- 5.The Computer Programmer (to publish in the Website)
- 6.SF/DF/FC.

Forwarded/By Order

SECTION OFFICER



# **KANNUR UNIVERSITY**

*SCHEME & SYLLABUS*

*FOR*

*POST GRADUATE COURSE*

*IN*

# **B O T A N Y**

*Effective from 2010 Admission*

**SCHEME OF EXAMINATION AND MARK DISTRIBUTION (2010 ADMISSION)**

<b>Semester</b>	<b>Paper Code</b>	<b>Title of Paper</b>	<b>CA</b>	<b>ESA</b>	<b>Total</b>
<b>I</b>	B I	Phycology, Lichenology and Bryology	20	70	90
	B II	General Microbiology, Mycology and Plant pathology	20	70	90
	B III	Plant Ecology, Conservation Biology, Phytogeography and Forest Botany	20	70	90
	<b>Total for Semester I</b>			<b>60</b>	<b>210</b>
<b>II</b>	B IV	Pteridology and Gymnosperms	20	70	90
	B V	Angiosperm Anatomy, Microtechnique and Evolution	20	70	90
	B VI	Cytology, Genetics and Molecular Biology	20	70	90
	<b>Total for Semester II</b>			<b>60</b>	<b>210</b>
Practical Paper-I Practical Paper-II Record and tour report Slides (10slides)		Subject of Semester-I	10	55	65
		Subject of Semester-II	10	55	65
					25
					5
<b>Total for Semesters I &amp; II</b>					<b>700</b>
<b>III</b>	B VII	Plant tissue culture, Biotechnology, Bioinformatics and Biometrics	20	80	100
	B VIII	Angiosperm Taxonomy and Morphology	20	80	100
	B IX	Angiosperm Embryology, Palynology & Plant breeding	20	80	100
<b>Total for Semester III</b>			<b>60</b>	<b>240</b>	<b>300</b>
<b>IV</b>	B X	Plant Physiology, Biochemistry and Biophysics	20	80	100
	B XI	Elective –Special Paper	20	80	100
Practical Paper-III-Subject of Papers VII, VIII, IX Practical Paper IV-Subject of Paper IX & Elective Paper. Record & Tour Report Herbarium Project Viva (based on Project and entire Course)			20 40	80 80	100 120 25 10 25 20
<b>Total for Semesters III &amp; IV</b>			<b>160</b>	<b>640</b>	<b>800</b>
<b>Grand total for Semesters I,II,III,IV</b>			<b>1500</b>		

**COURSE STRUCTURE**  
(Effective from 2010 admissions)

Semester	Paper Code	Title of the Paper	Hours / Semester	Hours/ Week	
				L	P
<b>I</b>	I	Phycology, Lichenology and Bryology	125	5	3.5
	II	General Microbiology, Mycology and Plant pathology	125	5	3.5
	III	Plant Ecology, Conservation Biology, Phytogeography and Forest Botany	125	5	3
	<b>Total for Semester I</b>			<b>375</b>	<b>15</b>
<b>II</b>	IV	Pteridology and Gymnosperms	125	5	3.5
	V	Angiosperm Anatomy Microtechnique and Evolution	125	5	3.5
	VI	Cytology, Genetics and Molecular Biology	125	5	3
	<b>Total for Semester II</b>			<b>375</b>	<b>15</b>
<b>III</b>	VII	Plant tissue culture, Biotechnology, Bioinformatics and Biometrics	125	5	3.5
	VIII	Angiosperm Taxonomy and Morphology	125	5	3.5
	IX	Angiosperm Embryology, Palynology and Plant breeding	125	5	3
	<b>Total for Semester III</b>			<b>375</b>	<b>15</b>
<b>IV</b>	X	Plant Physiology, Biochemistry and Biophysics	125	5	3.5
	XI	Elective –Special Paper	250	10	6.5
<b>Total For Semester IV</b>			<b>375</b>	<b>15</b>	<b>10</b>

## Elective Special Papers

- 1) Biotechnology
- 2) Ethnobotany
- 3) Angiosperm Taxonomy and Floristics
- 4) Seed Technology
- 5) Plantation Crops
- 6) Genetics and Crop Improvement
- 7) Mycology
- 8) Physiology of Growth
- 9) Seed Pathology
- 10) Environmental Biology
- 11) Plant Biochemistry and Enzymology

The special paper comprises detailed studies of a subject. A Department can select one of the above subjects as Special Paper. There shall be provision for change of subject of Special Paper if necessary in the subsequent years.

### Mark Distribution I & II Semester

#### Theory

Subjects	Marks	Total
i. Paper –B I-Phycology, Lichenology and Bryology	40+ 4 + 26	70
ii. Paper –B II- General Microbiology, Mycology and Plant pathology	26+ 26+ 18	70
iii. Paper –B III-Plant Ecology, Conservation Biology, Phytogeography and Forest Botany	45+15+5+5	70
iv. Paper –B IV-Pteridology and Gymnosperms	40+30	70
v. Paper–B V-Angiosperm Anatomy, Microtechnique and Evolution	40+25+5	70
vi. Paper–B VI-Cytology, Genetics and Molecular Biology	30+25+15	70

#### (Duration of Exam--3hours)

Theory	70x6=420
Practical	55x2=110
<b>Internal assessment</b>	
Semester I Theory	60
Semester II Theory	60
Practicals I&II	20
Practical Record and tour report	25
Slides (10)	5
<b>Total</b>	<b>700</b>

### Mark Distribution III & IV Semester

Theory			
Subjects		Marks	Total
vii	Paper –B VII- Plant tissue culture, Biotechnology, Bioinformatics and Biometrics	40+10+ 5+ 25	80
viii	Paper –B VIII-Angiosperm Taxonomy and Morphology	60+ 20	80
ix	Paper –B IX-Angiosperm Embryology, Palynology and Plant breeding	45+15+ 20	80
x.	Paper –B X Plant Physiology, Biochemistry and Biophysics	35+ 25+ 20	80
xi.	Paper –B XI –Elective		80
	Theory	80x5 = 400	
	Practical	80x2 =160	
<b>Internal assessment</b>			
Semester III	Theory 20x3	60	
Semester IV	Theory 20x2	40	
	Practical of Semester III	20	
	Practicals of Semester IV	40	
	Practical Record and tour report	25	
	Herbarium (30 nos)	10	
	Project	25	
	Viva-voce	20	
	<b>Total</b>	<b>800</b>	

#### **Study tour and submissions**

Students should undergo field study in each year not less than 7 days under the supervision of teachers and should submit reports during practical examination.

There shall be two practical examinations at the end of semester II &IV. Viva-voce will be at the end of semester IV.(Based on entire course & Project )

Students should submit not less than 10 neatly prepared permanent slides of different categories (free hand sections, microtome sections and whole mounts) prepared by them at the time of practical examination after semester II.

Internal assessment for practicals should include submission of materials in the first and second semester.

Students should prepare and submit certified records of practical works done during the course at the time of practical examinations

Students should submit at least 30 herbaria of Angiosperm specimens of different families, during the practical examination at the end of semester IV.

Duration of examinations-Theory: 3hours.Practicals: 4hours

### Dissertation /Project work

Each student should submit a Project work from any area of Botany, which may be laboratory based, field based or both. This should be submitted at the time of practical examination and should include

Introduction

Objectives of the study

Materials and methods

Results and discussions

Summary and conclusions

References

### SCHEDULE OF WORK LOAD

Semester	Paper code	Subject	Theory Hours/week	Practical Hours/week
I	B I	Phycology	2½	2
		Lichenology	½	½
		Bryology	2	1
	B II	General Microbiology	2½	1
		Mycology	2	1
		Plant pathology	1	1
	B III	Plant Ecology	2	3
Conservation Biology		2		
Phytogeography and Forest Botany		1		
II	B IV	Pteridology	3	2
		Gymnosperms	2½	1
	B V	Angiosperm Anatomy	2½	2
		Microtechnique	2½	1
		Evolution	½	
	B VI	Cytology	2	1
Genetics		2	1	
Molecular Biology		1	1	
III	B VII	Plant tissue Culture, Biotechnology	2½	2
		Bioinformatics	½	1
		Biometrics	2 ½	
	B VIII	Angiosperm Taxonomy	4½	2
		Morphology	1	1
	B IX	Angiosperm Embryology	3	1
Palynology		1	1	
Plant breeding		1	1	
IV	B X	Plant Physiology	3	1
		Biochemistry	2	1
		Biophysics	1	1
	B XI	Elective, Project	10	6

## Paper -B I- Phycology, Lichenology and Bryology

(8 ½ Hrs / week)

### PHYCOLOGY

#### Theory : -

1. Introduction: Thallus organization, Reproduction-vegetative, asexual and sexual life cycles.
2. Ultra structure of cell, flagella, chloroplast, pyrenoids and eye spot in major groups of Algae.
3. Recent criteria of classification of Algae-Fritsch, G.M. Smith.
4. Outline of principles and modern trends in the Algal systematics of Classification. Evolution and Phylogeny of different groups of Algae - Endosymbiotic theory of chloroplast evolution and algal origin.
5. General account of Structure, reproduction, lifecycle, relationships and evolutionary trends in the following groups with special reference to the types mentioned under each group.

#### a) Cyanophyceae.

- *Gloeocapsa*
- *Microcystis*
- *Oscillatoria*
- *Lyngbya*
- *Spirulina*
- *Anabaena*
- *Rivularia*
- *Gleotrichia*

#### b) Chlorophyceae.

- *Chlamydomonas*
- *Volvox*
- *Chlorella*
- *Hydrodictyon*
- *Enteromorpha*
- *Ulva*
- *Cladophora*
- *Pithophora*
- *Chaetophora*
- *Fritschiella*
- *Draparnaldiopsis*
- *Cosmarium*
- *Caulerpa*
- *Acetabularia*
- *Halemeda*
- *Chara*
- *Nitella*

#### c) Xanthophyceae

- *Botrydium*
- *Vaucheria*

- d) Bacillariophyceae
  - *Navicula*
  - *Pinnularia*
- e) Dinophyceae
  - *Peridinium*
- f) Cryptophyceae
  - *Cryptomonas*
- g) Phaeophyceae
  - *Ectocarpus*
  - *Doctyota*
  - *Padina*
  - *Turbinaria*
  - *Sargassum*
- h) Rhodophyceae
  - *Batrachospermum*
  - *Gracillaria*
  - *Gelidium*
  - *Polysiphonia*

6) Economic importance of Algae-Algal biofertilizers, algae as food, feed and used in industries.

7) Algal blooms and their special importance in global climatic change.

8) Coastal algae of Kerala.

**Practicals:**

1. Study and make micro preparations of vegetative structure of the types mentioned in the syllabus.
2. Identify the algal specimens up to generic level and make labeled sketches of the specimens observed.
3. Culture of some important algae.
4. Students are expected to prepare an algal herbarium (minimum 15 specimens)

**References:**

1. Chapman.V.J. - *Sea weeds and their uses*- Methuen & Co, London
2. Fogg, G.E; Stewart, W.D.P.Fay, and Walsby A.E.-*The Blue green Algae*-Academic press.
3. Fritsch.F.E.1945 - *The structure and reproduction of Algae* Vol. I and II.
4. Harold C Bold & Michael J.Winne - *Introduction to the Algae*-Prentice Hall of India.
5. Kashyap, A.K andKumar H.D. – *Recent Advances in Phycology*-Rastogy & Company.
6. Robert Edward Lee - *Phycology*
7. Round F.E; –1965. - *The Biology of Algae*
8. Smith G.M - *Cryptogamic Botany* Vol.I
9. Smith G.M. – *The fresh water Algae of United States*.
10. Van der Hoek, C, Mann, D.G.Johns, H.M -*Algae-An Introduction to Phycology*
11. Journals- *Journal of Indian Botanical Society*, *Proceedings of Indian Academy of Sciences*.

## LICHENOLOGY

### Theory:

1. General account of structure and life cycle of Lichens-broad outline classification.
2. Structure, reproduction and lifecycle of the following types: a) *Parmelia*; b) *Usnea*
3. Ecological role and economic importance of lichens.

### Practical:

1. Collect and identify the lichen specimens and make labeled sketches of specimens.
2. Study the external and internal structures of the types mentioned.

### References:

- 1) *Lichens of India*- Ajay Singh 1961.
- 2) *Lichens* – Misra and R.P. Aparayal-1978.

## BRYOLOGY

### Theory:

1. General characters and classification –Rothmaler and Proskauer.
2. Origin, Evolution and alternation of generation in Bryophytes.
3. General account of morphology, anatomy, life history and phylogeny of the following groups with special reference to the types mentioned under each group.
  - a) Sphaerocarpaceae
    - *Sphaerocarpos*
  - b) Marchantiales
    - *Marchantia*
    - *Lunularia*
    - *Targionia*,
    - *Cyathodium*
  - c) Jungermanniales
    - *Riccardia*
    - *Porella*
  - d) Anthocerotales
    - *Anthoceros*
    - *Notothylas*
  - e) Sphagnales
    - *Sphagnum*
  - f) Andreales
    - *Andreaea*

g) Funariales

- *Funaria*

h) Polytrichales

- *Polytrichum*

4. Morphological variations in gametophytes and their affinities.
5. General account on fossil Bryophytes.
6. Bryophytes as bioindicator of water and air pollution.
7. Economic importance of Bryophytes.
8. Contributions of Indian Bryologists.

**Practicals:**

1. Study of Bryophytes in their natural habitats.
2. Morphological and structural study of representative member of the groups mentioned in the syllabus using cleared whole mount preparations, dissections and sections.

**References:**

1. Campbell, H.D. - *The Evolution of land plants (Embryophyta)*
2. Chopra, R.N. & Kumra, P.K - *Biology of Bryophytes*-Wiley Eastern Ltd.
3. Smith, G.M - *Cryptogamic Botany Vol II* Mc Graw Hill Book Company
4. Parihar, N.S. - *An introduction to Embryophyta*- Vol. Bryophyta
5. Waston, E.V; -*The structure and life of Bryophytes*, Hutchinson University Library, London



## **Paper – B II General Microbiology, Mycology, and Plant pathology**

(8 ½ Hrs/week)

### **General Microbiology**

1. Bacterial classification: Morphological classification, Classification based on staining reaction, Serological method of classification, and Bergy's Manual of Systematic Bacteriology.
2. Structure and Chemistry of cell wall, cell membrane, Capsule, Slime layer, Flagella, Pili, Bacterial genome, Classes of plasmids, Episome.
3. Nutrition of Bacteria, Nutritional groups among bacteria, aerobic and anaerobic organisms.
4. Bacterial growth: Growth curve of Bacterial population, Continuous culture of microbes, Synchronous culture.
5. Bacteriological media-types of media, uses of different media.
6. Pure culture and cultural characteristics.
7. Microbial growth control-Different methods of sterilization-heat, pasteurisation, radiation, Filter-Chemical growth control-disinfectants and antiseptics, antibiotics, Resistance to antibiotics.
8. Microbial genetics: Bacterial recombination-Transformation, Transduction, Conjugation
9. Mollicutes and Actinomycetes-General account and economic importance
10. Virus: General study of the structure and chemistry of virus, structure of TMV and bacteriophage.  
Replication of plant viruses with reference to TMV, Nomenclature and classification of plant viruses, Interferon, virion, viriod, and prion.
11. Soil microbiology-Disposal of sewage and industrial effluents, plant microbe interaction, Crown gall due to Agrobacterium, Symbiosis between Rhizobium and legume plant. Rhizosphere microflora. Microbes in decomposition and recycling process.
12. Food microbiology-Food spoilage and preservation methods, Microbiology of fermented food, diary products- idli and butter. Food borne pathogens and food poisoning, pathogenic bacteria.
13. Industrial microbiology-Production of alcohol, vinegar, antibiotics, vitamins, vaccines, insulin, production of organic acid, lactic acid and citric acid. Fermentation processes. General design and application of bioreactors/ biofermenters.

### **Practicals:**

1. Test for the presence of coliform bacteria in contaminated water.
2. Isolation of micro organisms from soil by dilution method.
3. Isolation of pure bacterial culture by streak plate method.
4. Demonstration of Bacterial motility by hanging drop method.
5. Measurement of cell number in culture using Haemocytometer.
6. Isolation of Rhizobium from root nodule of legume.
7. Bacterial staining-Simple staining, differential staining, staining of capsule and spores.
8. Measurement of growth of bacteria by turbidity method-growth curve.

## References:

1. Dubey, R.C., and Maheswary, D.K. 2000 - *A Text Book of Microbiology*. S.Chand & Co.Ltd. New Delhi.
2. Kumar, H.D., and Swati Kumar, 1999 – *Modern concepts of Microbiology*. Vikas Publishing House Pvt. Ltd. New Delhi.
3. Mathew, R.E.F. (1981) - *Plant Virology*. Academic Press.
4. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. 1993. *Microbiology - Concepts and Applications*. McGraw Hill, Inc. New York.
5. Stainer, R.Y. et al. 1990 - *The Microbial World*. Prentice Hall.

## Mycology

1. Characteristics of Fungi, General characters, fungi-cell wall-hyphal tip growth - organelles, reproduction and spores, sexual incompatibility (heterothallism)
2. Fungal Systematics- Traditional and modern systems of fungal classification, characters used in fungal classification - phylogeny of fungi-Systems as proposed by Ainsworth, Alexopoulos Fungal dictionary (1983).
3. Fungi as symbionts: Lichens, mycorrhizae, endophytes
4. Ecology and distribution of fungi
  - 1) Aquatic fungi - Fresh water and Marine fungi.
  - 2) Terrestrial fungi.
  - 3) Phyllosphere fungi.
  - 4) Rhizosphere fungi.Role of fungi in degradation of plant and animal materials.
5. Economic importance of fungi, deteriorating activity of fungi - deterioration of textiles, paper, plastics, food, pesticides and other waste materials.

Fungi and human health: Fungi as allergens, fungal toxins and mycotoxins.

Fungi used in medicine, Industrial mycology-production of alcohol, enzymes, organic acids, proteins, and food processing. Fungi in biological control of plant pathogens, insects, and nematodes.
6. Biology, general characters and classification of following phyla with emphasis on structure and life cycle of genera mentioned against each.
  - Chytridiomycota - Synchytrium.
  - Zygomycota - Mucor, Rhizopus, Pilobolus, Syncephalastrum.
  - Ascomycota - Xylaria, Claviceps, Chaetomium, Erysiphe, Peziza.
  - Basidiomycota - Ustilago, Ganoderma, Polyporus Auricularia, Geaster, Cyathus, Lycoperdon.
  - Oomycota - Saprolegnia, Albugo, Phytophthora.
  - Myxomycota - Stemonites.
  - Deuteromycotina - Aspergillus, Cercospora, Collectotrichum, Alternaria, and Curvularia.

## Practicals

Study of the morphological features and reproductive structures of genera, mentioned under item 6.

## References:

1. Ainsworth.G.C, *Fungi-an advanced treaties*, Academic press.
2. Alexopoulos C.J, 1996. - *Introductory mycology*, Edward Arnold.
3. Burnet J.H.1976. - *Fundamentals of mycology*. Edward.Arnold Publishers.
4. Deacon J.W.1886. - *Introduction to modern mycology*, Blackwell.
5. Mehrotra R.S. and Arieja K.R. 1990. - *An introduction to mycology*, New age international publishers.
6. Moore-Lendeker 1996. - *Fundamentals of the fungi*. Prtentice Hall.
7. Subrahmaniam C.V. 1983. - *Hyphomycetes-Taxonomy and biology*. Academic press.
8. Webster J. 1980. - *Introduction to fungi*-Cambridge University Press.
9. Gunasekaran P. 1995. *Laboratory manual in Microbiology*, New age International pvt. Ltd

## Plant Pathology

1. Causal agents of plant diseases-fungi, bacteria, viruses, mycoplasmas, nematodes, phanerogams, Abiotic agents - nutrient and mineral deficiencies, atmospheric pollutants ozone, SO<sub>2</sub>, latrogenic diseases.
3. Symptoms of plant diseases, etiology, disease diagnostic criteria used under different etiological agencies.
4. The infection processes-mechanical and physiological enzymatic and toxic effects in pathogenesis, host metabolic changes, and growth alternations.
5. Defence systems of the host, chemically induced defence, mono and polygenic resistance, new technologies in crop improvement.
6. Plant quarantine - national and international agencies.
7. Biocontrol of plant diseases ;chemical agents, systemic chemicals, environmental problems, toxic residues in food and feed.
10. Etiology and control of the following diseases:Coffee rust, blast of paddy, red rot of sugarcane, Root rot and brown rot of forest trees, Tikka disease of ground nut, Rust of wheat, Powdery mildew of Rubber.

## Practicals:

1. Detailed lab study of diseases mentioned above.
2. Isolation of pure culture of any one pathogen.
3. Lab evaluation of fungicidal efficiency using any standard fungicide and an appropriate plant pathogen.

## References:

1. *Plant pathology*, Harsfall, and Diamond (VI Volumes) Academic press.
2. *Plant pathology*, R.S. Mehrotra, Tata Mcgraw Hill.
3. *Physiological plant pathology*, Black wett, London.
4. Rangaswamy, *Diseases of crop plants in India*.Prentice Hall, New Delhi
5. *Plant pathology*, Agrios G.N, academic press,
6. *Pathology*-Singh.



# **Paper –B III Plant Ecology, Conservation Biology, Phytogeography and Forest Botany**

(8 Hours/week)

## **Plant Ecology**

### **Theory**

1. Introduction to Ecology: Ecology Vs Environmental Science; Concept of environment.
2. Habitat Ecology: Terrestrial (Biomes), Fresh water (Limnology), wet land, marine habitats- salient features; major vegetational and soil types of the world.
3. Community Ecology: mechanism of ecological succession; changes in ecosystem properties during succession; characters of pioneer and climax species; stress ecology and adaptations.
4. Ecosystem stability: concepts (resistance and resilience); ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems; ecology of plant invasion; ecosystem restoration.
5. Ecological management: concept; sustainable development; sustainability indicators.
6. Global biogeochemical cycles of C, N, P and S, mineral cycles (pathways, process, budgets) in terrestrial and aquatic ecosystem.
7. Productivity and energy flow: concepts, limits and process of primary production, methods of productivity measurements; global trends in primary productivity, energy dynamics (trophic organization, energy flow pathways, ecological efficiencies).
8. Population Ecology: population characteristics-density, frequency, dominance, IVI, alpha, beta and gamma diversity, natality, mortality, distribution, biotic potential, population growth, environmental resistance, aggregation and dispersal, carrying capacity, ecotone and edge effect.
9. Environmental Pollution: types, (soil, air, water, thermal, noise), quality parameters, effect on plants, control with emphasis on biological methods; solid waste management- concept of waste, significance of recycling, reuse and recovery.
10. Cumulative effect on global environment- global warming, acid rain, ozone depletion, El Nino, and La-Nina effects.
11. Brief account of the following: afforestation, social forestry, environmental impact assessment (EIA), international biological programme (IBP), man and biosphere programme (MAB), IUCN, UNCED (earth summit), wild life preservation act (1972), Indian forest (conservation) act (1980), Biodiversity act (2002), United Nation's Environment Programme (UNEP), remote sensing.

### **Conservation Biology:**

Problems of conservation- causes of extinction; red list categories; hot spots, key stone species, flag ship species; umbrella species; strategies of conservation; insitu and exsitu conservation – gene bank, cryopreservation, protected areas, wild life sanctuaries, national parks and bioreserves; role of Botanic

Gardens in conservation.

## Practical

1. Determination of the minimum size of the quadrat suitable for an area using 'species area curve' method.
2. Determination of Importance Value Index (IVI) of the plant species in the community by quadrat method.
3. Visit to a meteorological station, National Park, wild life sanctuary, sewage treatment unit and major construction site.
4. Estimation of dissolved oxygen content in the water sample by Winkler's method.

## References:

1. Abbasi, S.A. 1998. - *Environmental pollution and its control*. Cogent International, Pondicherry.
2. Abbasi, S.A. & Ramasami, E.V. 1999. - *Biotechnological methods of pollution control*. Universities press (India) Ltd., Hyderabad.
3. Abbasi, S.A. & Ramasami, E.V. 2001. - *Municipal solid waste management with earthworm*. Discovery publishing house, New Delhi.
4. Ambasht, R.S., 1988. - *A Text Book of Plant Ecology*. Students Friends Co., Varanasi.
5. Ambasht, R.S. 1990. - *Environment and pollution*. Students Friends Co., Varanasi.
6. Brady, N.C. 1990. - *The natural properties of soils*. Prentice-Hall of India pvt. Ltd. New Delhi.
7. Clarke, G.L. 1954. - *Elements of Ecology*. John Wiley Publ. New Delhi.
8. Dash, M.C. 1993. - *Fundamentals of Ecology*. Tata McGraw Hill Publ. Co. Ltd., New Delhi.
9. Freeman, B. (ed.), 1995. - *Environmental Ecology- The ecological effects of pollution, disturbance, and other stresses*. Academic press.
10. Glasson, J., Therivel, R. & Chadwick, A. 1995. - *Introduction to environment impact assessment*. UCL Press Ltd., London.
11. Heywood, V.H. & Wyse Jackson, R.S. (eds.), 1991. - *Tropical Botanical Gardens- their role in conservation and development*. Academic Press, San Diego.
12. Hill, M.K. 1997. - *Understanding environmental pollution*. Cambridge Uni. Press.
13. Janwar, M.L. & Chauhan, T.S. 1998. - *Remote sensing and Photogrammetry*. Vigyan prakasan, Jodhpur.
14. Jha, V.C. (ed.) 2000. - *Geomorphology and remote sensing*. ACB Publ. Calcutta.
15. Kormondy, E.J., 1996. - *Concepts of Ecology*. Prentice Hall Biological Science Press.
16. Kumar, H.D. 1977. - *Modern concept of Ecology*. Vikas Publ. New Delhi.
17. Lucas, G. & Synge, H. 1986. - *IUCN Plant Red Data Book*.
18. Michael, P. 1990. - *Ecological methods for field and laboratory investigations*. Tata McGraw Hill, New Delhi.
19. Misra, R. 1968. - *Ecology Work Book*. Oxford & IBH, New Delhi.
20. Moldan, B & Billharz, S. 1997. - *Sustainable indicators*. John Wiley Sons, New York.
21. Mukherjee, B. 1996. - *Environmental biology*. Tata McGraw Hill Publ., New Delhi.
22. Muralikrishna, I.B. 1992. - *Remote sensing: Applications and geographical information systems*. Tata McGraw hill Publ., New Delhi.

23. Nayar, M.P. 1996. - *Hot spots of endemic plants of India, Nepal, and Bhutan*. TBGRI, Trivandrum.
24. Nayar, M.P. & Sastry, A.R.K. 1987, 1989, 1990. - *Red Data Book of Indian Plants* (3 vols.).
25. Odum, E.P. 1971. - *Fundamentals of Ecology*. W.B. Saunders, Philadelphia.
26. Pickering, K.T. and Owen, L.A. 1997. - *An introduction to global environment issues* (2<sup>nd</sup> ed.), Butterworths, London.
27. Rajasekhara, C.V. 1994. - *Critical issues in environmental management*. Discovery Publ. House, New Delhi.
28. Ryding, S.O. 1994. - *Environment management handbook*. Lewis Publ. Ltd., New Delhi.
29. Smith, R. - *Ecology, and field Biology*. Harper Collins, New York.
30. Tchobanoglous, G., Theisen, H. & Vigil, S.A. 1993. - *Integrated solid waste management; engineering principles and management issues*. McGraw Hill International Edition.
31. Treshow, M., 1985. - *Air pollution and plant life*. Wiley Interscience.
32. Walter, K.S. & Gillett, H.J. 1998. - *IUCN Red List of threatened plants*. The World Conservation Union, Cambridge.

## Phytogeography

### Theory

1. Definition and objectives of phytogeography.
2. Patterns of plant distribution: Continuous distribution – circum polar, circum boreal, circum austral, pan tropical. Discontinuous distribution-theory of land bridges, theory of continental drift, theory of polar oscillations, theory of glaciation.  
Different cases of discent distribution (vicarism, migration, extinction)
3. Centers of origin and diversity of plants: methods of dispersal, migration, and isolation.
4. Endemic distribution (neoendemic, paleoendemic) age and area hypothesis.

### Practicals:

Students should be able to identify various floristic regions of world and India in maps.

### References:

1. Bharucha, F.R. - *A textbook of plant geography*. Oxford Uni. Press.
2. Cain, S.A. 1944. - *Foundation of Plant Geography*. Harper, New York.
3. Furley, P.A. et al. 1983.-*Geography of the Biosphere: an introduction to the nature, distribution, and evolution of the world's life zones*. Butterworths, London.
4. Good, R. 1974. - *The geography of flowering plants*. Longman's Publ.
5. Walter 1987. - *Vegetation of the earth*. Springer Verlag, New York.

## Forest Botany

### Theory

1. Definitions of forests and an introduction on various types of forests in world and in India.
2. Forest products: major and minor forest products with special reference to Kerala.

3. Influence of forests on environment.
4. Forest based industries with special reference to Kerala.

**Practicals:**

Students should be well versed in the major and minor forest products of Kerala and their uses.

**References:**

1. Agarwal, A.P. 1988. - *Forests in India*. Oxford & IBH.
2. Gregory, G.R. 1971. - *Forest products, production, trade and consumption, quantity and value of raw materials, requirements*. Ford foundation, New Delhi.
3. Puri, G.S. - *Indian Forest Ecology*. Vol. II & I. Oxford & IBH.
4. Champion, G.H. & Seth, S.K. 1968. - *A revised survey of the forest of India*. Manager of Publ. New Delhi.



## Paper – B IV- Pteridology and Gymnosperms

(8 ½ Hrs/week)

### Pteridology

1. General characters and life history of Pteridophytes: apogamy, apospory, and parthenogenesis.
2. Origin and evolution of Pteridophytes; general classification; recent trends (Molecular phylogenetics)
3. Importance of Histology in relation to ecology of Pteridophytes. Stelar evolution in Pteridophytes. Vessels in Pteridophytes.
4. Development and evolution of sorus and sporangium in Pteridophytes.
5. Spore: morphology, germination, and pattern of gametophyte development in Pteridophytes.
6. Habitat diversity of Pteridophytes (with special reference to Kerala flora): Halophytes, hydrophytes, epiphytes, lithophytes, rheophytes, xerophytes, saprophytes, mesophytes and sciophytes.
7. Conservation of Pteridophytes: Rare, endangered, and endemic Pteridophytes with special reference to South India. Methods- *In situ* and *ex situ* conservation.
8. Applied Pteridology-Horticultural importance, Biofertilizer production(*Azolla*). Pteridophytes as weeds-aquatic weeds (*Salvinia*), Terrestrial weeds (*Pteridium*),-weed problems,its control and management, biological control. Medicinal and edible Pteridophytes. Pteridophytes as ecological indicators.
9. Contribution by Indian Pteridologists.
10. General morphological and anatomical features of the following orders:
  - a. **Psilopsida**: Rhyniales, Psilophytales and Psilotales
  - b. **Lycopsidea**: Lycopodiales, Selaginellales, Isoetales and Lepidodendrales
  - c. **Sphenopsida**: Calamitales, Equisetales and Sphenophyllales
  - d. **Filicopsida**: Primofilicales, Ophioglossales, Marattiales, Osmundales, Schizaeales, Cyatheaales, Gleicheniales, Marsileales and Salviniiales

### Practicals:

1. Study of vegetative and reproductive features of the following (Morphology and anatomy)  
*Ophioglossum, Angiopteris, Osmunda, Lygodium, Ceratopteris, Pteris, Trichomanes, Asplenium, Blechnum, Gleichenia, Pyrrosia, Salvinia & Azolla.*
2. Study of the following fossils:  
*Lepidodendron, Calamites, Sphenophyllum and Botryopteris*
3. *In vitro* culture of fern gametophytes (any three) in Knop's agar medium.
4. Study of the Pteridophytes in their natural habitats (students should submit field study report and 10 herbarium sheets of local Pteridophytes with notes on their habitat. (**Avoid rare, endangered and endemic Pteridophytes**).

## References

- 1) Andrews, H.N. 1961. *Studies in Paleobotany*, Wiley, New York.
- 2) Bierhorst, D.W. 1971. *Morphology of Vascular Plants*, Macmillan, USA
- 3) Bower, F.O. 1923-28. *The Ferns Vol.III* Today and Tomorrows Book Publ., New Delhi.
- 4) Dyer, A.F. (Ed.) 1979. *The Experimental Biology of Ferns*. Academic Press, London
- 5) Gupta, K.A. 1962. *Marsilea*, CSIR Monograph, New Delhi.
- 6) Hameed, C.A, Rajesh, K.P. and Madhusoodanan, P.V. 2003. *Filmy Ferns of South India* Penta Books, Calicut.
- 7) Hasebe, *et al.* 1995. *Fern Phylogeny based on rbcL, Nucleotide Sequences*. American Fern Journal 85(4): 134-181.
- 8) Kramer, K. U. and P. S. Green (eds.). 1990. *Pteridophytes and Gymnosperms*. In: K.Kubitzki (ed.). *The Families and Genera of Vascular Plants*.Vol. 1. Springer-Verlag, Berlin.
- 9) Kumar, M., Ramesh, M. and Sequiera, S. 2003. *Medicinal Pteridophytes of Kerala, South India*. Indian Fern Journal, 20(1-2): 1-28.
- 10) Kurup, V.V.G.K., Azeez, K. and Madhusoodanan, P.V. 2008. *Primitive ferns of India*, Rainbow publishers, Kalliassery.
- 11) Lumpkin, T.A. and Plucknett, D.L. 1980. *Azolla: Botany Physiology and use as a green manure*, Economic Botany Vol. 34.
- 12) Manhart, J.R. 1995. *Chloroplast 16S rDNA Sequences and Phylogenetic relationships of Fern Allies and Ferns*. American Fern Journal. 85: 182-192.
- 13) Nampy, S. and Madhusoodanan, P.V. 1998. *Fern Flora of South India-Taxonomic Revision of Polypodioid Ferns*. Daya Publishing House, New Delhi.
- 14) Nayar, B.K. 1950. *Medicinal Ferns of India*. Bulletin of National Botanic Garden, Lucknow, No. 29, 1-36.
- 15) Pryer, K.M., H. Schneider, A.R. Smith, R. Cranfill, P.G. Wolf, J.S. Hunt and S.D. Siper. 2001. *Horsetails and ferns are a monophyletic group and the closest living relatives to seed plants*. Nature 409: 618-621
- 16) Pryer, K.M., *et al.* 1995. *Phylogenetic relationship of extant Ferns based on evidence from morphology and rbcL sequences*. American Fern Journal 85: 205-282.
- 17) Rashid, A. 1976. *An Introduction to Pteridophyta*, Vikas Publ. Co. New Delhi.
- 18) Raubeson, L.A. and Stein, D.B. 1995. *Insight into Fern Evolution from Mapping chloroplast Genomes*. American Fern Journal 85: 193-204.
- 19) Remesh, M., Kumar, M. and K.S. Manilal. 2003. *Medicinal Pteridophytes in Rheede's Hortus Malabaricus*. Indian Fern Journal 20(1-2): 51-59.
- 20) Singh, H.B. 1999. *Potential Medicinal Pteridophytes of India and their chemical constituents*. Journal of Economic and Taxonomic Botany 23: 63-78.
- 21) Sporne, K.R. 1976. *The Morphology of Pteridophytes*, Hutchinson Book Co. London.
- 22) Surenge, K.R. 1966. *Indian Fossil Pteridophytes*, CSIR Monograph, New Delhi.

## Gymnosperms

1. General characters, classification and Evolution of Gymnosperms.
2. Distribution of gymnosperms in the past and present; in India and Kerala.
3. Geological Time Table, fossilization, types of fossils, methods of fossil study.
4. Economic Importance of Gymnosperms.
5. General characters, distribution. General account including morphology, anatomy phylogeny and interrelationship of the following orders mentioned below (with special emphasis on the genera specified).
  - a. Pteridospermales (Lygenopteris, Heterangium, Medullosa, Trigonocarpus)
  - b. Glossopteridales (Glossopteris)
  - c. Caytoniales (Caytonia)
  - d. Cycadeoidales (Cycadeoidea)
  - e. Pentoxylales (Pentoxylon)
  - f. Cycadales (Zamia)
  - g. Ginkgoales (Ginkgo)
  - h. Coniferales (Cedrus, Cryptomeria, Cupressus, Araucaria, Agathis, Podocarpus)
  - i. Taxales (Taxus)
  - j. Ephedrales (Ephedra)
  - k. Welwitschiales (Welwitschia)
  - l. Gnetales (*Gnetum*)
6. Contribution by Indian botanists to Indian Gymnosperm studies.

## Practicals

1. Identification of fossil specimens: *Heterangium*, *Medullosa*, *Trigonocarpus*, *Glossopteris*, *Williamsonia*, *Pentoxylon* and *Cordaites*.
2. Study of morphological and anatomical features of vegetative and reproductive structures of: *Zamia*, *Ginkgo*, *Cedrus*, *Cryptomeria*, *Cupressus*, *Araucaria*, *Agathis*, *Podocarpus*, *Ephedra* and *Gnetum*.

## References

- 1) Andrews Jr., H.N. 1961. *Studies in Paleobotany*. John Wiley, New York.
- 2) Arnold, C.A. 1947. *An introduction to Paleobotany*, New York Mc Graw Hill.
- 3) Chamberlin, C.J. 1935. *Gymnosperms-Structure and Evolution*, Chicago University of Chicago Press.
- 4) Delevoryas 1962. *Morphology and Evolution of fossil plants*. New York, Hold Rinchart & Winston
- 5) Delevoryas 1968. *Some aspects of Cycadenid Evolution*. Journal of Linnaean Soc. (Bot.) 61: 137-116.
- 6) Foster, A.S. and K.M. Gifford. 1974. *Comparative morphology of Vascular plants*, San. Fransisco: Frceman.

- 7) Kramer, K. U. and P. S. Green (eds.). 1990. *Pteridophytes and Gymnosperms*. In: K.Kubitzki (ed.). *The Families and Genera of Vascular Plants*. Vol. 1. Springer-Verlag, Berlin.
- 8) Mehra,P.N.1988 *Indian Conifers:Gnetophytes and phylogeny of Gymnosperms*.Pramodh P.Kapur,Rajbandhu Ind.Complex,New Delhi.
- 9) Pant, D.D. 1975. *The Classification of Gymnospermous Plants*-Paleobotany 6:65-70.
- 10) Ramanujan, C.G.K. 1976. *Indian Gymnosperms in time and space*, New Delhi: Today & Tommorrow's Printers and publishers.
- 11) Sharma.B.D.1994.*Gymnosperms: Morphology,Systematics ,Reproductive Biology*  
In:Jori,B.M.(ed.),*Botany in India:History and Progress*.Vol.2.Oxford & IBH,New Delhi.pp 1-23.
- 12) Sporne, K.R. 1974. *The Morphology of Gymnosperms*. 2<sup>nd</sup> Ed. London: Hutchinson University Library.
- 13) Singh.H.1978,*Embryology of Gymnosperms*.Geb Borntrager,Berlin.
- 14) Stewart.W.N.1981.*The Progymnospermopsida:The construction of a concept*,Can.J.
- 15) Stewart.W.N.1983.*Paleobotany and the evolution of Plants*.Cambridge University Press.



# Paper B V Angiosperm Anatomy, Microtechnique and Evolution

(8 ½ Hrs/week)

## Angiosperm Anatomy

### 1. Cell wall and its development

Chemistry of cell wall constituents. Cellulose, polysaccharides, proteins, water, chemical organisation of primary wall. Cytokinesis and growth-plasmodesmata. Secondary wall-chemical constituents-Lignin, Cutin, Suberin, Callose. Organisation of wall, Eg. Cotton wall fibre.

### 2. The Plant Body:

a) Stem apex concept, theories of Buvat, Popham and Chan, Cytohistological Zonation, Anneau Initial and meristeme deattente.

Vegetative shoot apical meristem-General features and activity, phylogenetic and ontogenetic development. Arrangement of tissues, vascular tissues, axial and radial system, sympodium, open and closed. Node- Nodal patterns, Unilacunar, trilacunar, trilacunar with split lateral and multilacunar. Phylogenetic considerations. Leaf trace and branch trace-origin, departure, effect on stele and pith, secondary growth.

b) Root: Concepts: Apical meristem, Theories, Korper-kappe theory, Promeristem, Quiescent centre.

Velamen roots, origin of lateral roots, pneumatophores. Root-shoot interface (transition region)-*Linum*, *Daucus carota*, *Medicago sativa*, *Triticum*

c) Leaf: Concept, Phyllotaxy, General structure of foliage leaves

Structure of modified leaves-Kranz anatomy, zeromorphic foliage leaves, submerged foliage leaves, cataphylls. Hysophylls of primordial origin. Plastochrone index.

### 3. Cambium:

Development of Cambium in root and stem. Cell type in vascular cambium.

Infected vascular cambia, polarity of cambium, seasonal activity in cambium, cambium in wound healing and grafting. Inter conversion of fusiform initials and ray initials.

Vascular cambium and periderm formation in monocot wound periderm. Factors affecting formation and activity of phellogen. Abnormal cambium.

### Anomalous Secondary Growth:

Concepts-Modification of the common type of vascular cambium-Unique activity of the vascular cambium

Discontinuous, unidirectional and bidirectional activity of cambium.

Anomalous Secondary growth in storage roots-Beet root, sweet potato. Anomalous Secondary growth in roots.

### 4. Development and differentiation:

The structure of specialized cells. Vascular system Sieve element differentiation, Cytoplasmic changes, P-Protein in sieve element wall, sieve plate, and mechanism of movement of solutes. Control of phloem differentiation. Phylogenetic development. Xylem-tracheary element differentiation, secondary wall thickening-cytoplasmic changes, and autolysis.

## **Control of differentiation, genetical aspects**

Induction of secondary xylem structure in relation to function in water conduction. Phylogenetic development.

## **5.Wood Anatomy:**

Basic structure of wood-Sap wood, Heart wood, compression wood, tension wood, Tree exudates and extracellular materials, Resin, Gum, Kino, Latex, manna / Amber, Balsam and their uses.

Dendrochronology. Taxonomic value of wood.

## **6.Plant Surfaces:**

Concept ; Epidermis: Type of epidermal cells-Ordinary epidermal cell. Stomatal complex-ontogeny, distribution, classification function-phylogenetic development. Trichomes-Different types, classification, ontogeny distribution-function. Unusual epidermal cells, silica cells, cork cells, Bulliform cells, and cystoliths. Ultra structure of cuticle, sporopollenin. Plant surface as source of materials. Secretion of metals, wax, resin, Terpenes, Oils. Fibres from plant trichomes, commercial use of barks. Plant surface and origin of petroleum. Taxonomic value of epidermis.

## **7.Secretary cells and Tissue:**

Concepts, nature, Mechanism, and purpose of secretion. Secretion by single internal cells: -Stinging hairs, nectary. Secretion by internal complexes of cells: -Hydathodes, articulated laticifers, Latex ducts, Secretion by external complexes: - Extra floral nectaries, salt glands, digestive glands.

## **8.Fruit Anatomy:**

Concepts:Anatomy of different type of fruit walls

## **9.Seed Anatomy:**

Concepts:Anatomy of seed coat. Endosperm anatomy and drought resistance from anatomical part of view.

## **10.Seedling Anatomy:**

Concepts, Anatomy of the cotyledon, hypocotyle, seedling root, mesocotyle differentiation, Genetic control, Polarity control of cell differentiation.

## **11.Anatomy- its relation to ecology:**

### **Practicals**

1. Anomalous secondary growth, root and stem of *Aristolochia*, *Strychnos*, *Thumbergia* *Leptadenia*, *Nyctanthus*, members of Amarathaceae, Menispermaceae, Nyctaginaceae
2. Nodal Anatomy-Different types
3. Stomatal type, stomatal index
4. Seedling anatomy-root stem transition

### **Reference Books**

1. Arthur J.Eames (1961). *Morphology of the Angiosperms* - Tata McGraw Hill
2. Fahn.A. - *Plant Anatomy*- Pergamon Press 3<sup>rd</sup> edin 1974.

3. Katherine Esau. (1960). *Plant Anatomy*- Wiley Eastern, 1953,1974.
4. Katherine Esau. - *Anatomy of seed plants*- Wiley Eastern.
5. Elizabeth G.Cutter *Plant Anatomy*, Part I and Part II- Edward Argold 1979.
6. Arthur J.Eames, and Laurence Mc Daniels. *An introduction to Plant Anatomy*- Tata MacGraw Hill 1953.
7. James D Mauseth. *Plant Anatomy*-, D Benjamin/Cummings Puling 1988
9. Juniper, B.E. & Jefree *Plant surfaces*. Oxford IBH 1982.
10. John E.Dale .*The Growth of leaves*. Oxford IBH 1982.
- 11 .*The Physical Biology of Plant cell walls*- Prestion Chapman and Hall 1974.
12. Hans Slereder. (1908). *Systematic Anatomy of Dicotyledons*-.Ajay Book services.
13. David N.Sen.*Structure, Functio, and Ecology of Stomata*-. Bishen Singh Mahendra Pal Singh

### **Micro technique**

1. Introduction
2. Tools in Microtechnique – Instruments and Apparatus used – Principles involved
  - a) Microscopes: Compound Microscope – parts and uses – Types of eye pieces and objectives – Resolving power – Binocular and stereo type -Phase contrast microscopy - –Electron microscopes - General account
  - b) Micrometry
  - c) Camera Lucida
  - d) Microtomes – Rotary and sledge
  - e) Photomicrography – Brief account
3. Killing and Fixing plant tissues
  - a) Reagents in Killing and Fixing – Formalin, Ethyl alcohol, Chromic acid, Acetic acid.
  - b) Common chemical fixatives, their composition, preparation and specific uses: FAA – Rawlin’s formula, Carnoy’s fluid, Chromo acetic acid formalin mixtures – Navaschin’s formula, Crafi; Potassium chromate mixture – Zircle-Elriki formula.- Fixatives for different plant materials –Techniques of fixing.
  - c) Dehydration: Reagents – Ethyl alcohol, Acetone, Glycerine, TBA, Dioxan
  - d) Clearing: Reagents used – Xylene, Chloroform, Clove oil
4. Staining:
  - a) Principle and purpose
  - b) Stains – Classification
  - c) Preparation of stains – Basic: Safranin, Crystal violet, Basic Fuchsin Cotton blue; Acidic: Fast green, Toludine blue, Light green, Orange G, Erythrosin, Eosin; Natural – Haematoxylin, Carmine, Orcein
  - d) Vital staining
  - e) Technique of staining – Methods of double staining – Triple staining.
5. Preparation of whole mounts, maceration and smears:
  - a) Glycerin – Xylene method
  - b) TBA method
  - c) Maceration fluid – Preparation of maceration slides of plant tissues

6. Methods of double staining free hand sections using the following combination
  - a) Safranin – Fast green
7. Methods of embedding plant materials in Paraffin wax.
8. Technique of sectioning materials embedded in Paraffin wax. Microtoming – Adhesives – Mounting.
9. Method of staining Paraffin sections
10. Technique of mounting, clearing, labelling, and storing permanent preparations.
11. Histochemistry: Staining for Protein, Carbohydrate, Lipids and Nucleic acids
12. DNA and Protein Staining (Ethidium bromide, fluorescent stains, silver staining)

### **Practicals:**

1. Measurements of Algal filaments, Spores, Pollen grains etc. by using Micrometer
2. Camera Lucida drawing of stele, Algal filaments, Anatomy of different organs etc.
3. Preparation of Paraffin blocks serial sections preparing permanent slides.
4. Preparation of double stained permanent slides of free hand sections.
5. Preparation of whole mounts, smears, maceration.
6. Histochemical staining using Bromophenol blue or PAS.
7. Students are expected to submit ten permanent slides of maceration, smears, whole mount and free hands sections, and serial sections.

### **References**

1. Johansen, D A. (1940). *Plant Microtechnique*
2. Peter Gray (1958). *Hand Book of Basic Microtechnique*- Mc Graw Hill
3. Krishnamurthy, K.V. 1998. *Methods in Plant Histochemistry*.

### **Evolution:**

1. Principles of Evolution
2. Molecular theory of evolution.
3. Mechanism of evolution.
4. Role of polyploidy in evolution.
5. Cataclysmic evolution.
6. Origin and evolution of species

### **References**

1. Savage.J.M 1969, *Evolution* –Oxford
2. Stebbins, G.L. *Variation and evolution in plants*
3. Wooley, P. -*Molecular theory of Evolution*.



## Paper- B VI Cytology, Genetics and Molecular Biology

(8 ½ Hrs / week)

### Cytology

- 1) The nucleus-The interphase nucleus, Structure and organization of chromatin, Chromosomes and packaging of DNA, molecular organization of centromere and telomere, Euchromatin and Heterochromatin, satellite DNA, repetitive DNA, nucleolus – Structure, Organization and significance.
- 2) Structure and function of ribosomes-Role in protein synthesis, protein sorting, targeting of proteins to organelles.
- 3) Mitochondrial and chloroplastic genetic organization.
- 4) Karyotype and evolution, Idiogram.
- 5) The cytoskeleton-organisation and role of microtubules and microfilaments, Cell cycle-mitosis and meiosis, synaptonemal complex, apoptosis, control mechanism. Role of cyclins and cyclin dependent kinases, retinoblastoma and E2F proteins , cytokinesis and cell plate formation. Mechanism of programmed cell death.
- 6) Chromosome banding - Types and significance.
- 7) Special chromosomes-polytene chromosome –Significance. Unineme theory and C-value paradox. Supernumerary chromosomes-B chromosome and significance, Endo mitosis and somatic reduction.
- 8) Cytogenetics - Structural and numerical alterations in chromosomes.
  - a) Nature, consequence and evolutionary significance of altered chromosomal structure - Deficiencies, duplications, inversions, translocations, structural heterozygosity and maintenance of heterozygosity in nature, Renner complexes, Isochromosomes, Pseudoisochromosomes, ring chromosome.
  - b) Sources, consequences and evolutionary significance of altered chromosome number- Euploidy and Anueploidy. Symbols and terminology.
  - c) Human cytogenetics-Normal karyotype and affected karyotype.
- 9) Cell interactions- communication, recognition, adhesion, and application.
- 10) Cellular differentiation and specialization- general characters of cellular differentiation, molecular mechanisms of cellular differentiation. Intrinsic and extrinsic interactions.
- 11) Cancer and aging
  - a) Cancer- carcinogenic agents, phenotype of the transformed cell, oncogenic viruses, genetic basis of cancer.
  - b) Aging- cellular aging and basis of cellular aging, extra cellular aging.
- 12) Dosage compensation and sex determination.

### Practicals

- 1) Study of Mitotic stages in root tip cells of Allium/ Chlorophytum-Study of Mitotic index.
- 2) Pretreatment of root tips with colchicines and staining of chromosomes with acetocarmine/ acetoorcein and preparation of Idiograms.
- 3) Study of endosperm mitosis in coconut endosperm.

- 4) Study of meiotic stages in *Chlorophytum* or *Datura*.
- 5) Study of meiotic behaviour in translocation heterozygotes (eg. *Rheo*)
- 6) Induction of polyploidy using colchicines.
- 7) Study of polytene chromosomes in Dipteran larvae.

## References:

- 1) Adolph. K.W (Ed). *Chromosomes and Chromatin*. Boca Raton FL: CRC Press. 1988.
- 2) Alberts, A; Johnson .A; Lewis J; Raff M; Roberts K and Walter, P.*Molecular Biology of the cell*. 4<sup>th</sup> Edn. Garland Science Taylor and Francis group. New York. 2002.
- 3) Bishop, J.M -*Molecular themes in Oncogenesis*. Cell 64, 235, 1991.
- 4) Buriham.G.R.*Discussion in Cytogenetics* (1962) Burgers Publishing Co.
- 5) Gesteland, R .F; Cech T.R, Atkins J .F (Eds). *The R N A world*. 2<sup>nd</sup>Edr. Cold Spring Harbour. New York. 1999.
- 6) Hartwell, L; Hood .L; Goldberg et al. *Genetics from Genes to Genomes*. Boston. Mc Graw Hill.200.
- 7) Hankalo, B, and Elgin.S.C.R. *Functional Organization of the Cell Nucleus*.San Diegi.Academic Press-1992.
- 8) Karp, G. *Cell Biology*.Mc Graw Hill.New York.1979.
- 9) Kleinsmith, L.J.& Kish.V.M. *Principles of Cell Biology*. Harper and Rao Publishers.New Delhi, 1988.
- 10) Lodish, H; Berk, A Zipursty, S.L.*et al. Molecular Cell Biology*, 4<sup>th</sup>Ed.W.H.Freeman.NewYork.2000.
- 11) De Robertis, E.D.P. &De Robertis, E.M.F.*Cell &Molecular Biology* 8<sup>th</sup>Edn. Lea & Febiger. Philadelphia1987.
- 12) De Robertis, E.D.P., F.A.Saez, and E.M.F.De Robertis, Jr (1975)-*Cell Biology*, Saunders.Philadelphia.
- 13) Gupta.P.K (1995)-*Cytogenetics*, Rastogi & Co.
- 14) Sadava.D.E, *Cell Biology-Organelle structure and function*. Jones and Bartlett. Publishers, Boston.1993
- 15) Swanson, C.P. (1957) *Cytology and Cytogenetics*; Prentice-Hall.Nae Jersey.
- 16) Swanson, C.P. (1971) *The Cell*; Prentice-Hall.Naw Delhi.
- 17) Stebbins, G.L. (1971) *Chromosomal Evolution in Higher Plants*. Edward Arnold, London.
- 18) Darlington (1965) -*Cytology*. Churchill, London.

## Genetics

1. Introduction.
2. Linkage and gene mapping. Three point test cross analysis, centromere mapping. Linkage mapping in humans pedigree analysis.
3. Fine structure of gene. Ultrastructure of DNA, Alternative forms of DNA, Repetitive DNA Satellites, minisatellites and microsatellites, Coding and noncoding sequences. Eukaryotic genome organization.
4. Replication of DNA-Experimental evidence, Enzymology of replication, Mechanism of replication in prokaryotes and Eukaryotes.
5. Gene expression one gene-one enzyme concept, one gene one polypeptide concept, concept of co linearity,

genetic code, properties of the Genetic Code, deciphering of the code.

6. Protein synthesis transcriptional, post transcriptional processing RNA processing capping, Polyadenylation, splicing, introns and exons- structure of mRNA translation, Antisense RNA technology.
7. Regulation of gene expression-The operon concept. Attenuation and antitermination, Gene regulation in eukaryotes, Methylation, heterochromatisation, Transposition, enhancers, and silencers.
8. Mutation: Molecular basis of Spontaneous and induced, mutations and their role in evolution. Physical and chemical mutagens. Environmental mutagenesis and toxicity testing. Site-directed mutagenesis. DNA damage and repair mechanisms. Inherited human diseases and defects in repair.
9. Population genetics: Gene frequencies and genotypic frequencies, Systems of mating, Hardy Weinberg principle. Factors affecting equilibrium: Selection, mutation, migration, and genetic drift.
10. Applied genetics: Genetics of blood group and RH factor, Euthenics Euphenics and Eugenics-Genetic enquiry and human welfare.

### **Practicals:**

Work out problems from linkage, tetrad analysis, quantitative traits, population genetics, and mutation.

### **References:**

- 1) Brown.T.A. –*Genetics, A Molecular Approach*.
- 2) Bevan M.W.Harrison B.D. and Leaver.C.J.*The production and uses of Genetically Transformed Plants* (1994)
- 3) Chopra V.L.*Genetics: New frontiers*. Vol 1-4(1984) Oxford IBH
- 4) Cocking E.C.*Uptake of foreign Genetic Material by Plant Protoplasts International Review of cytology*, 48:323-341(1977)
- 5) Daniel.L.Hartt and Elizabeth.W.Jones–*Genetics-Principles and Analysis*
- 6) David Freifelder: *Molecular Biology* (1987) Narosa Publishing House.
- 7) David Freifelder: *L Microbial Genetics* (1997) Narosa Publishing House.
- 8) Desmond S.T. *An introduction to Genetic engineering* Cambridge.
- 9) Gardner E.J.Simmons M.J. and Snustad D.P.*Principles of genetics* John Wiley
- 10) Gupta P.K.and Bahl.J.R. (Eds.) : *Genetics and crop improvement* (1986) CBS Publishers and Distributors.
- 11) Gunther S.Stent and Richard Calendar: *Molecular Genetics* (1986) CBS Publishers and distributors.
- 12) Hackett.Fuch Messing: *An introduction to Recombination, basic experiment in Gene Manipulation* (1988) The Benjamin-Cummings Publishing Company.Inc.
- 13) Harold, More Wintraub.*Antisense RNA and DNA* Scientific American Jan 1990.
- 14) HawkinsJ.S. *Gene Structure and expression* (1996) Cambridge University Press.
- 15) Jha P.K. and S.Nair: *Man made organisms in the environment Science Reporters* Apr. 1988.
- 16) Lynn.Burnet: *Exercises in applied genetics*-Cambridge Uty.Press.
- 17) Lalgi Singh: *DNA Profiling and its application*. Current science Vol 60, May 1991

- 18) Murphy, T.M. and Thempson V.F. *Molecular Plant Development* (1988) Prentice Hall
- 19) Old, R.W. and S.B. Primrose, *Principles of Gene Manipulation* (1998) 5<sup>th</sup> Edn. *An introduction to Engineering*. Oxford.
- 20) Richard, R. Sinder- *DNA Structure and Function*.
- 21) Sinnot, E.W., Dunn, L.C. and Dobzhansky, T. (1958).- *Principles Of Genetics*.
- 22) Strickberger, M.W. (1977); *Genetics*
- 23) Watson, J.D. (1975)- *Molecular Biology of the Gene*, Benjamin, New York
- 24) Watson, J.D- *A Passion For DNA*
- 25) Stent, G.S. and Richard Calender- *Molecular Genetics*.
- 26) Waever, R.F. and P.W. Hedrick. - *Genetics*.
- 27) William, S. Klug and Michael, R. Cuning- *Concepts of Genetics*.

### **Molecular Biology**

- 1) Structure and evolution of Genetic material. Recombination. Double helical form of DNA and RNA, Alternate forms of DNA- B, C, & Z DNA, supercoiling of DNA and enzymes involved in replication.
- 2) DNA repair enzymes, polymerase, nucleases, photolyase, Mismatch connection, recombination repair, and error prone repair.
- 3) Regulation of gene function and gene expression in Bacteriophages and Eukaryotes.
- 4) Molecular cloning / gene cloning, genomic library.
- 5) Gene transfer techniques – Physical and Biological -Direct gene transfer and indirect gene transfer through vectors like Ti-plasmids of *Agrobacterium*.
- 6) Principles and methods of Genetic engineering and gene targeting in crop plants and microorganism.
- 7) Brief account of human genome project.
- 8) Mobile Genetic elements: Transposable elements in bacteria. Is elements Tn elements, Copia and P elements in maize, Retrotransposons. Molecular characteristics and significance in development and evolution.
- 9) Molecular analysis of Gene products, Southern, Northern and Western blots South Western and North Western blots. PCR, restriction maps, & RFLP. Chromosome walking and jumping, Physical maps and clone banks, Nucleotide sequencing. DNA finger printing and DNA hybridization. Cancer genomics and SNPs.

### **Practicals:**

Extraction and Isolation of Plasmids, DNA using any suitable method.

### **References:**

1. Horsa P.B. (1974) *In Mechanism of Recombination* (R.F. Grelled) pp.337-383. Plenum Press, New York, London.
2. Smith, H & D. Grierson (1982) Edn. *The Molecular Biology of Plant Development*. Black wall, Oxford.
3. Holiander A & J. Setilona (1983) (eds.) *Genetic Engineering Principles & Methods* Vol IV Plenum Press.

4. Vasil.I.K.Scoweroft. W.R. and Frey K.J. (1982) *Plant Improvement and Somatic cell Genetics*
5. Old.R.W. and S.B. Primrose, *Principles of Gene Manipulation* (1998) 5<sup>th</sup> Edn. *An introduction to Engineering.*
6. Ratheesh S.V.L. Chopra & S.Ramachandran (1987) *Biotechnology in Agriculture*, Oxford, IBH Publ  
New Delhi
7. Watson, J.D. (1975)-*Molecular Biology of the Gene*, Benjamin, New York
8. Watson J.D. (1976) *Molecular Biology of the gene*.3<sup>rd</sup> ed.W.A.P Jamin. Inc. Meulo Park California.



## Paper- B VII Plant Tissue Culture, Biotechnology, Bioinformatics and Biometry

(8½ hours/week)

### Plant Tissue Culture, Biotechnology

1. Introduction, Definition, Totipotency, Laboratory organization etc.
2. Callus Culture-explant, medium, Callus initiation, internal structure of callus -hard, Friable, meristemoid, non- meristemoid, chlorophyllous, non-chlorophyllous; Somaclonal variation.
3. Differentiation-Dedifferentiation, Redifferentiation, Organogenesis, factors effecting organogenesis, direct and indirect organogenesis; micropropagation-stages, mass propagation, vitrification, habituation/canalization, disease indexing and eradication, advantages / disadvantages. In vitro conservation, slow growth, recovery, genetic stability, cryopreservation, DNA bank, & Gene bank.
4. Somatic embryogenesis, direct and indirect, maturation of somatic embryos, problems / advantages. Synthetic seed technology, advantages.
5. Cell suspension culture, Hairy root culture and secondary metabolite production, biotransformation, elicitors.
6. Organ culture-Shoot tip / meristem culture, ovary, ovule, flower bud, endosperm and embryo.
7. In vitro production of haploids-Anther and pollen culture and its Significance.
8. In vitro fertilization and its significance
9. Protoplast isolation, different methods, culture, hybridization, selection, cybrids, genetic consequences, gene transfer.
10. Recombinant DNA-Technology –Vectors and enzymes- rec. DNA cloning strategies –c DNA library, genomic library, selection, screening, and expression of cloned genes, genetic engineering in plants, electroporation, biolistics, liposome mediated delivery, Biological delivery. Transgenic plants,herbicide and insect resistance. Vaccines,antisense RNA technology, transgene inactivation.
11. Applications of Biotechnology.
12. **Bioinformatics**Introduction to data structures, data base concepts, application of database in biology, sequence databases. Sequence comparisons, structural database, proteomics (elementary) and genomics (elementary).Major Bioinformatics resourss-NCBI,EBI,Ex DASL.
- 13.**Biometry** Statistical methods-Numerical distribution and their graphical representation. Sampling-theory and methods. Measures of central tendency-mean, median, mode;ogive, skewness, kurtosis Measures of dispersion-range quartile deviation, mean deviation, variance and standard deviation. Frequency distribution-normal, binomial, and Poisson distribution. Test of significance and Chi Square and factorial. Design of experiments-randomized blocks, Latin square, and factorial. Analysis of variance. Theories of probabilities, correlation, and regression.

### Practicals:

#### Tissue culture & Biotechnology

1. Sterilization of glassware, media, and explant.

- 2.Preparation of media and Stock solution
- 3.Initiation and maintenance of callus
- 4.Induction of single shoot / multiple shoot from axillary bud/shoot tip
- 5.In-vitro fertilization.
- 6.Somatic embryogenesis and production of artificial seeds.

### **Biometrics**

Solve and work out problems in biometry ie: to find mean.mode, median, standard deviation, coefficient of variation, chi-square, t-test, ANOVA.

### **References:**

#### **Tissue culture & Biotechnology**

1. Bhojwani.S.S. and Razdan,M.A.-*Plant tissue culture*.
2. Gamborg, O.L. and Philips, G.C.1998- *Plant cell, tissue and organ Culture*, Narosa Publishing House, New Delhi.
3. Razdan-*An introduction to plant tissue culture*. Oxford & IBH publishing Co. New Delhi.
4. Purohit S.S 1997- *Laboratory Manual of Plant Biotechnology*.
5. Kalyan Kumar De-*An introduction to plant tissue culture*-New Central Book Agency
6. Narayanaswamy.S, -*Plant cell, tissue and organ culture*
7. Bajaj, Y.P.S. and Rienert J, 1997- *Applied and fundamental aspects of Plant Cell and Tissue Culture*.

### **References:**

#### **Bioinformatics**

1. *Introduction to Bioinformatics* – Atwood, T.K. & Parry-Smith, D.j.Peartson Education Ltd.
2. *Bioinformatics- Sequence and Genome Analysis* – Mount, D.W., Cold Spring Harbor Laboratory Press, New York.
3. *Bioinformatics* – 2<sup>nd</sup> edition, Baxevanis, A.D, & Quелlette, B, F.F., John Wiley & Sons Inc.
4. *Evolutionary Computations in Bioinformatics* – Fogel, G.B. & Corne, D.W., Morgan Kaufman Publishers.
5. *Computerised Data Acquisition and Analysis for the Life Sciences*, Young, SS., Cambridge University Press.

### **Biometrics:**

- 1) Khan and Khan, 1994.*Biostatistics*.Vikas Publishing House.Pvt.Ltd.New Delhi.
- 2) Panse and Sukhatme, 1992.*Statistical methods for Agricultural workers*. ICAR, New Delhi.
- 3) Steel and Torrie, 1986.*Principles and procedures of Statistics with special reference to Biological Sciences*.



## Paper- B VIII Angiosperm Taxonomy and Morphology

(8½ hours/week)

### Angiosperm Taxonomy

1. Scope and importance of Taxonomy.
2. A critical study of the current ideas of the origin of Angiosperms with special reference to their ancestral stock and time and place of origin. The concept of primitive Angiosperm.
3. General survey of the history of classifications-Artificial, natural, and Phylogenic systems. Comparative study of the systems of classifications proposed by - Linnaeus, Bentham & Hooker, Engler & Prantl, Bessey, and Takhtajan.
4. Taxonomic structure- Taxonomic hierarchy-major and minor categories used in Taxonomy. Concept of species, and infraspecific categories. Expression of relationship: Monophyletic, Polyphyletic. Homology, analogy / Parallelism, Divergence, Cladistics, Cladogram, Adansonian principles.
5. Methods of plant exploration and identification-field data-Herbarium methods-construction of keys(intended and bracketed) –their utilization. Revisionary studies and Monographs.
6. Plant nomenclature-History of nomenclature-Detailed study of salient features and major provisions of the International Code of Botanical Nomenclature. Effective and valid publication,ranks of Taxa,-rule of priority and its limitations- typification, author citations, rejection, Choice and retention of names-names of hybrids.
7. Herbaria and Botanic gardens-their importance in taxonomic research. Major herbaria and Botanic gardens in the world and in India.
8. Sources of taxonomic evidences-Anatomy, Palynology, Morphology, Ecology, and Embryology.
9. Modern trends in Taxonomy-Cytotaxonomy, Chemotaxonomy, Biosystematics and Numerical taxonomy.
10. Study of the following families in detail with special reference to their economic aspects.
  - 1) Ranunculaceae 2) Magnoliaceae 3) Menispermaceae 4) Cruciferae (Brassicaceae)
  - 5) Polygalaceae 6) Caryophyllaceae 7) Portulacaceae 8) Guttiferae (Clusiaceae)
  - 9) Sterculiaceae 10) Geraniaceae (with subfamilies) 11) Sapindaceae 12) Rosaceae
  - 13) Rhizophoraceae 14) Melastomaceae 15) Passifloraceae 16) Aizoaceae
  - 17) Asclepiadaceae 18) Gentianaceae 19) Boraginaceae 20) Scrophulariaceae
  - 21) Pedaliaeae 22) Lauraceae 23) Loranthaceae 24) Casuarinaceae
  - 25)Scitaminae 26)Amaryllidaceae 27)Commelinaceae 28)Aroideae 29)Cyperaceae
11. Search engines-Arboreta and Botanical gardens-biologists-botanical museums-Herbaria-Natural History-Botanical societies-International Botanical organizations-checklist-floras and taxonomic database-conservation of threatened plants.

### Practicals

1. During the course of these study students shall get familiar with local flora, construction of keys, use of floras in the identification up to species.

2. Study of the diagnostic features of the families (Plants not included in the Flora of Gamble are not expected to be given for practical examination)
3. The students are supposed to study at least 2 members of each family in the laboratory, make suitable sketches describe them in technical terms and identify them constructing appropriate keys up to species.
4. Each student shall undertake a field study for at least seven days under the guidance and supervision of a teacher at a place ecologically different from the locality of the respective college and submit a field study report certified by the teacher concerned. The report should be a concise ecological flora of the area studied. Each student shall submit a minimum of 30 herbarium specimens of different categories along with the field book for the practical examination.

### References:

1. Davis, P.H. & V.H. Heywood, 1963-*Principles of Angiosperm Taxonomy*
2. Heywood, V.H. (Ed.) 1963 *Modern methods in Plant Taxonomy*.
3. Stace, C., 1985 -*Plant Taxonomy and Biosystematics*, London.
4. Heywood, D.H. Moore (Eds.) 1984. *Current concepts in Plant Taxonomy*.
5. Stebbins, G.L. 1974. *Flowering Plants, Evolution above species level*.
6. Mayr, E. 1976-*Evolution and diversity of life*.
7. Sivarajan, V.V. 1991. *Introduction to Principles of Plant Taxonomy*.
8. Stuessy, T.F. 1990. *Plant Taxonomy*.
9. Naik, V.N. 1984 *Taxonomy of Angiosperms*.
10. Hooker, J.D. *The flora of British India* Vol I-VII
11. Gamble, J.S. *Flora of the Presidency of Madras*. Vol I-III
12. Geffrey, C. 1968. *An Introduction to Plant Taxonomy*.
13. *International Code of Botanical Nomenclature* (latest)
14. Henry, A.N. and Chandrabose, M. 1980. *An aid to the International Code Of Botanical Nomenclature*.

## MORPHOLOGY

### Theory

1. General concepts of morphology, origin and evolution of flower, co evolution of flowers vis-à-vis pollinators.
2. Stamens: Origin and evolution in structure and morphology; nectarines and nectar.
3. Evolution of carpels; different types of carpels, concepts of foliar origin of carpels-Types of ovary-evolution of placentation types.
4. Role of floral anatomy in interpreting the origin and evolution of flower and floral parts.

### Practical

1. Preparation of cleared whole mounts of floral parts to show vasculature.
2. With the help of dissection and hand sections examine:
  - a) Different types of ovaries
  - b) Different types of placentation

c). Vasculature of androecium and gynoecium in special types of flowers.

## References

1. Earnes.J. -*Morphology of Angiosperms*. Mc Graw Hills N.Y
2. Barnard C. -*The Interpretations of Angiosperms Flower* Aus.J.Sci 24:6664-72(1961)
3. Manilal K.S. *Vascularisation of Corolla of Compositae*. Jour. Indian Bot.Soc.59.189-196 (1971)
5. Melville-*New Theory of Angiosperm Flower*-Nature 188: -18(1960)
6. Puri.V. -*Inferior ovary*- *Phytomorphology* 2:122(1952)
7. Spome.K.R.*The Morphology of the Angiosperms*. Hutchinson Uni.Press London (1974)



# Paper- B IX Angiosperm embryology, Palynology and Plant Breeding

(8 hours/week)

## Angiosperm embryology

1. Introduction to angiosperm embryology - Unique features of plant development, differences between animal and plant development.
2. Seed germination and seedling growth - Metabolism of nucleic acids, proteins and mobilization of food reserves, hormonal control of seedling growth.
3. Reproduction - Vegetative options and sexual reproduction, flower development, genetics of floral organ differentiation.
4. Male gametophyte - Structure of anthers, microsporogenesis, structure and functions of wall layers, role of tapetum, pollen development, male sterility, sperm dimorphism and hybrid seed production, pollen germination, pollen tube growth and guidance, pollen storage, pollen allergy, pollen embryos.
5. Female gametophyte - Ovule development, megasporogenesis, megaspore triad, diad and embryosac, different types, ultra structure of components, synergid, antipodals, haustoria, nutrition of the embryosacs.
6. Pollination-Fertilization - Artificial pollination, floral characteristics, pollination mechanism and vectors Structure of the pistil, ultra structural heterochemical details of style and stigma, significance of pollen pistil interaction, role of pollen wall proteins and stigma proteins, intraovarian and invitro pollinations, role of synergids, filiform apparatus, double fertilization, post fertilization, metabolic and structural changes, invitro fertilization.
7. Seed development and fruit growth - Endosperm development during early maturation and dessication stages embryogenesis, ultra structure, physiology, and cytology of endosperm, storage proteins of endosperm and embryo ruminant endosperm.
8. Embryo -Classification, dicot and monocot embryo development, structure, and function of suspensor.
9. Polyembryony - Clasification, practical value, Apomixis, general account embryo culture
10. Parthenocarpy-seedless fruits, Dynamics of fruit growth, biochemistry and molecular biology of fruit maturation.

### Practicals

1. Study of anther development of *Datura / Crinum* etc.
2. Preparation of dessected microspore, meiosis in microspore mother cells.
3. Study of the receptivity of stigma and in situ germination of pollen.
4. Dissection of embryos at various stages of growth.

### References: -

1. Boniman, F. 1978. *Ovule initiation, ovule development, and seed chat structure in angiosperms*, Today and tomorrow publication, New Delhi.
2. Bhojwani S.S. and Bhatnagar S.P 2000. *The Embryology of Angiosperms*. Vikas publishing House. New Delhi.
3. Davis, C.L. 1965. *Systematic embryology of Angiosperms*. JohWilley, New Delhi.

4. James, A.J.1960.*Morphology of angiosperms*. McGraw Hills New York
5. Maheswari .1950. *An introduction to the embryology of Angiosperm*. McGraw Hill Back C.O.Inc.New York.

## **PALYNOLOGY**

- 1.Historical outline of Palynology-contributions of Erdtman and P.K.K.Nair
- 2.Development and evolution of pollen type - ultrastructure and development of pollen walls-application of pollen morphology.
- 3.Aeropalynology-methods of aero spore survey and analysis.
- 4.Pollen analysis of honey - nutritive value of honey.
- 5.Recent advance in palynological studies-palynology in relation to taxonomy.

### **Practicals:**

- 1.Study of pollen types using acetolysis.
- 2.Collection and identification of local pollen.
- 3.Pollen germination study in different media (Brew baker's, sucrose, tap water) Growth increment.
- 4.Analysis of honey for microscopic examination of pollen.
- 5.Calculation of percentage of viable pollen by using TZ test.

### **References:**

- 1) Erdtman, G. 1969.*Hand book of palynology*. Hafuer publication Co.New York .
- 2) Erdtman, G. *Pollen morphology and taxonomy*.
- 3) P.K.K.Nair .1970, *Pollen morphology of angiosperms*, Scholar publi. London&Vikas Publi.Delhi.  
Weedhow, R.D. *Pollen grains*.
- 4) Fagera, K.and Ivensen, J. *Text book of pollen analysis*.

## **PLANT BREEDING**

### **Theory: -**

- 1.Introduction.
- 2.Plant Introduction-History, type principles, procedure Plant Introduction agencies in India, acclimatization, Germ plasm collection, types of germ plasm collection, Preservation and utilization.
- 3.Breeding for pest resistance, disease resistance, and stress resistance, genetics of resistance.
- 4.Plant breeding institutes in India and their major achievements.
- 5.Production of improved seed, seed certification, variety release procedure, conservation of traditional seeds, farmers movements.  
Terminator seed technology, genetically engineered crops and future of Indian agriculture.
- 6.Genetic resources, conservation, and utilization in crop improvement, centres of origin and diversity, gene bank,rural gene banks, International network of gene banks IBPGR.
7. Social and economic aspects of agriculture in Kerala.
8. Patenting lag forms- Patent laws, farmers rights and plant breeders rights.

9. Production of improved seed-seed certification-variety release procedure.
10. Conservation of traditional seeds.
11. Terminator seed technology, genetically engineered crops and the future of Indian Agriculture.

### **Practicals**

1. Practice of the vegetative propagation methods: -
  - 1) Budding-T, 2) Patch, and Ring budding 3) Layering-air and trench 4) Grafting Approach, whip.
2. Practice of hybridization techniques in self and cross-pollinated plants- (Rice, Cashew, Pulses, Solanum, Capsicum)

### **References**

1. Allard, R.W.-*Principles of Plant Breeding* (1999) John Wiley&Sons.
2. Chaudhari, H.K.-*Elementary Principles of Plant Breeding* Oxford IBH.
3. Chaudhari, R. -*Introduction to Plant Breeding* Oxford.
4. Chopra. -*Approaches for incorporating Draught and Salinity Resistance in crop plants*. Salish Book Enterprise, Agra.
5. Darbeswhar Roy, 2000.*Plant Breeding*. Narosa Publishing House, New Delhi.
6. Elliot, F.C.-*Plant breeding and cytogenetics*-1958. McGraw Hill.
7. Hays, H.K, F.R.Immer and, D.C.Smith. - *Methods of Plant Breeding* 1956 McGraw Hill.
8. Hawkes J.C.- *Crop Genetic Resources.Field collection manual* (1980) IBPGR pub.
9. Kenneth J.Frey.*Plant Breeding II*-Sathish Book Enterprises.
10. Maliwal-*Salt tolerance of crops and plant metabolism in saline substrate: An annotated Bibliography* Springe-Verlag.
11. Nover, L. - *Heat Shock and their stress Response systems of plans* 1989 Springer Verlag.
12. Palt, J. - *Advisory work in crop pest and Disease management* –International Book Distributers, Dehra Dun.
13. *Proceedings of the seminar on crop breeding in Kerala Part I* Dept. of Botany, University of Kerala.



# Paper- B X Plant Physiology- Biochemistry & Biophysics

(8½ hours/week)

## Plant Physiology

1. Water relations in plants: Physico - chemical properties of water, water potential, chemical potential, methods to determine water potential, the role of water potential in agricultural productivity – Gibb’s free energy concept, Types of soil water, mechanism of water uptake via apoplastic, symplastic and transmembrane pathways, aquaporins and their ultra structure, water movement through xylem, mechanism and theories of transport. Cavitation and embolism. Physiology of stomatal transpiration.
2. Mineral nutrition: Nutrient elements, classification and their role types of fertilizers supplementing essential elements, EDTA, calmodulin, nutrient medium, heavy metal toxicity, methods of plant culture, ion transport across the membranes, diffusion and facilitated diffusion, membrane channels, ultra structure of K<sup>+</sup> channel, active transport, symport and antiport.
3. Assimilation of mineral nutrients, nitrogen and biogeocycle, nitrate assimilation, reduction, biological nitrogen fixation. Symbiosis; dinitrogenase activity, leghaemoglobin, assimilation of ammonia: pathways and enzymes - GS, GOGAT and GDH. Transport of amides and ureids. Sulphur assimilation, biogeocycle, reduction of sulphate. Phosphorus assimilation, biogeocycle.
4. Photosynthesis: Ultra structure of chloroplast, photoreceptors and their role in energy trapping, energy transformation, electron transfer system in chloroplast membranes. ATP synthesis in chloroplast. Photosynthetic carbon reduction (PCR) cycle, Carbondioxide cycle (Photorespiratory cycle), C4 and CAM metabolism. Photosynthetic efficiencies of C3, C4 and CAM plants, distribution of photoassimilates, sink-source relationship-phloem loading and unloading, Concepts of osmotically generated pressure flow.
5. Respiration: Glycolytic reactions, entry of pyruvate into mitochondria and Krebs cycle, electron transport system and ATP, unique electron transport enzymes of plant mitochondria. Alternate electron pathways in plants and their significance-“external NAD(P) H dehydrogenase-Cyanide insensitive cytochrome C oxidase. Respiration in the germinating seeds.
6. Growth, differentiation and development. Growth analysis, correlative development, shoot:root ratio. Plant Growth Regulators: auxins-biosynthesis, transport, physiological roles, role in signal transduction pathways. Gibberellins-biosynthesis, physiological roles, signal transduction amylase synthesis in germinating seeds. Cytokinins-biosynthesis, biological roles, morphogenesis in tissue culture, mode of action. Ethylene biosynthesis, physiological role, commercial uses. Abscissic acid-biosynthesis, physiological role in seed dormancy and senescence.
7. Physiology of flowering, phytochromes-photochemical and biochemical properties. Cryptochromes and biological clock, photoperiodism and thermoperiodism.
8. Physiology of fruit development, ripening (softening and enzymes involved in biochemical changes) and senescence.
9. Physiological and biochemical changes during seed germination – conditions of germination, food sources and reserves mobilization during germination. Classification of seed and seed dormancy, and the methods to break

dormancy.

10. Stress physiology- stress concepts, types of stresses: water stress, salt stress, chilling stress and heat stress.

Plant responses to stress, heat shock proteins, stress resistance, physiological adaptations to stress, stress resistant genes, transgenic plants and stress tolerance.

### **Practicals**

1. Determination of moisture content of different plant tissues using oven.
2. Determination of stomatal frequency of the leaves of three different species of plants.
3. Determination of root-shoot ratio of five species.
4. Determination of osmotic potential by plasmolytic methods.
5. Separation of plant pigments by paper chromatography/thin layer chromatography.
6. Quantitative estimation of chlorophyll content using spectrophotometry.
7. A comparative study on the growth pattern in the drought stressed and the irrigated seedlings of a few economically important crops.
8. Determination of the germination percentage of a few economically important crops.
9. Viability test of seeds by excised embryo methods.

### **References**

1. Beck, C.B. 2005 *An Introduction to plant Structure and Development*. Cambridge University Press.
2. Bewley, J.D and Beck E. 1994. *Seeds: Physiology of Development and Germination*. 2<sup>nd</sup> Edn. Plenum Publishing Corporation.
3. Bidwell, R.G.S. 1979 *Plant Physiology*. McMillan. New York.
4. Buchanan, B.B. Gruissem, W. and Jones. R.L. 2000. *Biochemistry and Molecular Biology of Plants*. American Society of Plant Biologists.
5. Devlin, R.M. and Witham, F.H. 1986. *Plant Physiology* 4<sup>th</sup> Edition. CBS Publishers & Distributors, New Delhi.
6. Hopkins, W.G. 2004, *Introduction to Plant Physiology*, John Wiley & Sons, Inc.
7. Krap, G. 1996. *Cell and Molecular Biology-Concepts and Experiments*. John Wiley & Sons, Inc.
8. Mayer and Poljakoff-Mayber. 1989. *The Germination of Seeds*. 14<sup>th</sup> Edition. Pergamon Press.
9. Noggle, G.R and Fritz, G.J 1992 *Introduction to Plant Physiology*.
10. Pandey and Sinha. 1981. *Plant Physiology*, Vikas Publishing House.
11. Salisbury, F.M. and Ross, C.W 1992 *Plant Physiology* 4<sup>th</sup> Edition. Wordsworth Publishing Corporation.
12. Taiz, L and Zeiger. E. 2002 *Plant Physiology* –The Benjamin Cummings Publishing Corporation Inc..
13. Willkins, M.B. 1984. *Advances in Plant Physiology*, Longman Scientific and Technical.

### **BIOCHEMISTRY**

- 1) pH and buffers-properties of buffers, Derivation of Henderson-Hasselbach equation. Buffers in living system, common buffers.
- 2) Carbohydrates: Occurrence, Classification, chemistry of -Monosaccharides (Ribose, Ribulose, Glucose, Fructose), Oligosaccharides (Maltose, lactose, sucrose, raffinose, stachyose and verbascose) and

Polysaccharides (starch, cellulose, hemicellulose, pectin). Structure and function of major homo- and heteropolysaccharides. Metabolism of carbohydrates – Glycolysis TCA cycle and terminal oxidation, gluconeogenesis, glyoxylate pathway, Pentose Phosphate pathway. Role of NDP sugars in biosynthesis of carbohydrates. Sugar derivatives-amino sugars, deoxy sugar phosphates, glycosides, Peptidoglycans.

- 3) Amino acids and Proteins– Structure, properties and classification of amino acids. Amino acid metabolism, non-oxidative deamination. Biosynthesis and breakdown of amino acids. Proteins: Classification of proteins, Biological functions, Conformation of proteins (primary, secondary, tertiary and quaternary). Ramachandran plot, Lectins (Glycoproteins) and their importance.
- 4) Lipids: Classification of lipids, brief account on compound and derived lipids with examples. Fatty acids- Saturated and unsaturated fatty acids – triglycerides – Metabolism- Fatty acid biosynthesis,  $\alpha$  and  $\beta$  oxidation of fatty acids.
- 5) Nucleic acids- Nucleotides: Composition and properties. Structural polymorphism of DNA, RNA and three dimensional structure of tRNA.
- 6) Enzymes – structure, function and classification of enzymes, co-enzymes, regulation of enzyme activity. Enzyme Kinetics – Michaelis Menton equation – derivation. Enzymes assay – Enzyme regulation, Allosteric enzymes, isozymes, ribozyme and coenzymes.
- 7) Vitamins- classification, function and source of vitamins. Role of vitamins as co – enzymes.
- 8) Immunochemistry- Antigens, antibodies, Structure and functions of different types of immunoglobulins. Primary and secondary immune response. Humoral and cell mediated immunity. MHC, Mechanism of immune response, Genetic control of immune response and applications of immunological techniques. ELISA, RIA, Hybridoma, and monoclonal antibodies.

## Practicals

1. Preparation of buffers and measurement of pH using pH meter.
2. Preparation of Standard graphs of BSA and glucose.
3. Extraction and estimation of starch from plant tissue by a suitable method.
4. Estimation of protein by Lowrey *et al.*, method/Biuret method.
5. Estimation of amylase/invertase/protease/polyphenol oxidase activity in plant tissue by suitable method.
6. Human blood typing.
7. Immunodiffusion.

## References

1. Berg, J.M., Tymoczko, J.L. & Stryer, L. 2006. Biochemistry 6<sup>th</sup> Edn. W.H. Freeman & Co.
2. Conn, E.E. and Stumpf, P.K. 1999. Biochemistry. John Wiley and Sons, New Delhi.
3. Delves, P., Martin, S., Burton, D & Roitt, I. 2008. Roitt's essentials of Immunology 11<sup>th</sup> edition., Blackwell publishing.
4. Goodwin, Y.W. and Mercer, E.I., 2003 Introduction to Plant Biochemistry 2<sup>nd</sup> Edn., CBS Publishers and Distributors.
5. Jain, J.I., Sanjay, J. & Nithin, J.S. 2006 Fundamentals of Biochemistry 6<sup>th</sup> Edn. S.Chand & Co. Ltd. New Delhi.

6. Kindt, T.J., Goldsby, R.A & Osborne, B.A 2008 Kuby Immunology 6<sup>th</sup> Edn. W.H. Freeman & Co.
7. Nelson, D.L. & Cox, M.M. 2008. Lehninger Principles of Biochemistry 4<sup>th</sup> Edn W.H. Freeman & Co.
8. Pandey, A., Webb, C., Soccol, C & Larneche, C. 2007. Enzyme Technology, Springer.
9. Upadhyay, A., Upadhyay, K & Nath, N. 2008 Biophysical Chemistry-Principles and Techniques. Himalaya Publishing House.
10. Voet, D.J & Voet, J.J 2005, Biochemistry 5<sup>th</sup> Edn. John Wiley & Sons.
11. Wilson, K & Walker, J. 2008. Principles and Techniques of Biochemistry and Molecular Biology. 6<sup>th</sup> Edn. Cambridge University Press.

## **BIOPHYSICS**

1. Principles and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy. Photometry, colorimetry and spectrophotometry, their application.
2. Principles and application of gel – filtration, ion exchange and affinity chromatography. Paper chromatography, thin layer and gas chromatography. H PLC; Electrophoresis –PAGE, Agarose gel electrophoresis and electrofocussing. Ultra centrifugation - principles and types.
3. Principles of biophysical methods used for analysis of biopolymer structure X-ray diffraction, fluorescence, UV ORD / CD, visible NMR, and ESR spectroscopy. Atomic absorption and plasma emission spectroscopy.
4. Radioactive isotopes. Autoradiography, liquid scintillation spectrometry, Cerenkov radiation.
5. Cryobiology – freeze drying (Lyophilization) its applications in biology.

### **Practicals**

1. Paper and thin layer chromatography –separation of amino acid mixtures and Chlorophyll.
2. Separation of pigments by column chromatography.
3. Absorption spectra of chlorophylls and carotenoids; estimation of chlorophyll a and b in leaves.
4. Estimation of lipids by gravimetric method.
5. Electrophoretic separation of proteins.

### **Practicals**

1. Daniel, M. 1989. Basic Biophysics for Biologists. Agro-Botanica Publishers and Distributors.
2. Glaser, R. 2001. Biophysics 5<sup>th</sup> Edn. Springer.
3. Upadhyay, A., Upadhyay, K. & Nath, N. 2008 Biophysical Chemistry-Principles and Techniques. Himalaya Publishing House.



## Elective Special Paper- B XI (1) – Biotechnology

(16½ hours/week)

1. Research methodology.
2. Introduction, History, major achievements, Biotechnology in India
3. Food Biotechnology-single cell protein / Mycoprotein: -Microbial collection, Culture and uses, algal biomass collection, Culture, harvesting (*Chlorella*, *Spirulina*) Mycoprotein - yeast. Mushroom cultivation and nutritional value.
4. Recombinant DNA-Technology, enzymes, Vectors for gene cloning- pBR 322, pUC, phage DNA, cosmids, plasmids, transposons, rec. DNA cloning strategies- cDNA library, genomic library, selection, screening and expression of cloned genes, genetic engineering in plants-Gene transfer methods -Physical delivery methods- microinjection, macroinjection, electroporation, biolistics, liposome mediated delivery. Biological- Agrobacterium mediated-Structure of Ti plasmid, Ri plasmid, Binary vectors, Cointegrate vectors.
5. Transgenesis-Transgenic plants, Objectives and achievements, Herbicide resistance, insect resistance, Virus resistant etc. antisense RNA technology, gene silencing.
6. Restriction mapping of DNA fragments and map construction.
7. c DNA synthesis and cloning- mRNA enrichment, reverse transcription, DNA primers, linkers, adapters and their chemical synthesis, cloning interacting genes, two and three hybrid systems, cloning differentially expressed genes, nucleic acid micro arrays.
8. Study of gene regulation-DNA transfection, Northern blot, Primer extension, S1 mapping, and reporter assays.
9. Expression strategies for heterologous genes. Vector engineering, codon optimization, host engineering. *In vitro* transcription and translation, expression in bacteria, expression in yeast, expression in insect and insect cells, expression in mammalian cell, expression in plants.
10. Purification and refolding, characterization of recombinant proteins, stabilization of proteins.
11. DNA sequencing-different methods fluorescent detection. PCR and applications. Site directed mutagenesis.
12. Immunotechnology-Hybridoma technology and the production of monoclonal antibodies antibody engineering, alternative methods and uses.
13. Intellectual property rights-objectives, patenting, biotechnological investigation, and patenting laws-legal protection for plants and higher organisms.
14. Biosafety-Objectives-recombinant DNA safety-Biosafety practices and aspects of transgenic plants, Terminator gene-Precautions.
15. Phage display, T- DNA and transposon tagging- role of gene tagging in gene analysis, identification and isolation of genes through T DNA or transposon. Biosensors, Biochip.

### Practical:

1. Preparation and sterilization of media.
2. Selection, Isolation, Surface sterilization, and inoculation of various explants for culture.
3. Callus and cell suspension culture of carrot / Tobacco / Datura.

- 4.Measurement of growth of cells in suspension and callus by fresh weight / dry weight, packed cell volume and cell counting.
- 5.Induction of multiple shoots using auxillary/apical meristems.
- 6.Organo genesis from callus.
- 7.Mushroom culture.
- 8.DNA&Protein separation, PCR.
- 9.Genomic DNA isolation.

### **References:**

1. Berger, S.L. and A.R. Kimmel. *Methods in Enzymology* Vol.152, *Guide to Molecular Cloning Techniques*, Academic Press, Inc. San Diego, 1998
2. Davies, J.A. and W.S. Reznikoff, *Milestones in Biotechnology. Classic papers on Genetic Engineering* Butterworth-Heinemann, Boston, 1992
3. Glover, D.M. and Hames, B.D. *DNA Cloning: a Practical Approach*, IRL Press, Oxford, 1995
4. Goeddel, D.V *Methods in Enzymology* Vol.185, *Gene Expression Technology* Academic Press, Inc., San Diego, 1990.
5. Glick and Pasternak, *Molecular Biotechnology*.
6. Kaufman, P.B. Wu, W. D.Kim and L.J: Cseke, *Molecular and Cellular Methods in Biology and Medicine*, CRC Press, Florida, 1995.
7. Kingsman, S.M.and A.J. Kingsman, *Genetic Engineering: An Introduction to gene analysis and exploitation in eukaryotes* Blackwell Scientific Publications ,Oxford ,1998.
8. Mickloss, D.A.and G.A.Freyer, *DNA Science: A First Course in Recombinant Technology* Cold Spring Harbor Laboratory Press, New York, 1990
9. Primrose, S.B. *Molecular Biotechnology* (2<sup>nd</sup> Edn.), Blackwell Scientific Publishers, Oxford, 1994
10. Sambrook, J Fritsch, E.F. and Maniatis, T. *Molecular Cloning: a Laboratory Manual*, Cold Spring Harbor Laboratory Press, New York, 2000
11. Walker, M.R and R.Rapley, *Route Maps in Gene Technology* Blackwell Science Ltd., Oxford, 1997.



## Elective Special Paper B XI (2) – Ethnobotany

(16½ hours/week)

### Theory:

- 1) Research methodology.
- 2) Ethnobotany- Introduction, definition, history, scope and categories of ethnobotany, significance-direct relationship of plants with ethnic groups-significance of native languages and dialects in the study of ethnobotany-Importance of morphological characters and physical properties in the ethnobotanical studies for Phytotaxonomy-Brown's give life forms.
- 3) Linkage of ethnobotany with other sciences and disciplines - Archaeology, Anthropology, History, Politics, Palaeobotany and Agriculture.
- 4) Linkage of ethnobotany with food and nutrition, medicine, sociology and culture, region and social customs.
- 5) Ethnic agricultural practices-shifting cultivation, cultivation of slopes, seed preservation, and control measures for the protection of seeds-various traditional practices of rice cultivation followed by ethnic groups and medicinal uses of rice.
- 6) Mythology and conservation of Ecosystems in India - Ethnobotany and conservation of plants with special reference to India. The role of ethnobotany in relation to minor forest products, wild medicinal plants and plant products required in religions, rituals and ceremonies.
- 7) Sacred groves—Various names attributed to sacred crops in native languages - socio-religious belief- sacred crops and their role in the preservation of gene pool –Important plant ecosystems preserved in Kerala by religious believes. Eg.Poomkavanam (Sabarimala)
- 8) Umbrella stones-Historical background –location of umbrella stones in Kerala- ethnobotanical interest of umbrella stones-Tribal superstitions connected with mushrooms-Mushroom as food and poison.

### Practicals

1. Visit to 3 sacred- groves nearby and study the area covered and the type of plants
2. Visit to umbrella stones of central Kerala.
3. Submit the detailed report of 1& 2 to illustrate the ethnobotanical interests of sacred groves and umbrella stones.
4. Study of any tribal society of Kerala- the historical, cultural, and social aspect of the tribe with special reference to hut and implements. Tribal design of huts, implements unique to certain tribes. Identification of tribes from their huts and implements. Special plants connected with tribes.
5. Collection of some important medicinal plants on folklore information and preparation of herbarium (minimum 10 species)
6. Ethnobotanical field work in the locality. Identification and study of 15 plants of ethnobotanical interest. Submit the herbarium.

### References:

- 1) Jain.S. K.(ed)1981.*Glimpses of Indian ethnobotany*.Oxford IBH

- 2) Jain. S.K.(ed) 1989.*Methods of approaches in ethnobotany*, Society of ethnobotanists-Lucknow.
- 3) Jain S K. -*Dictionary of Indian folk medicine and ethnobotany* Deep Pub.
- 4) Jain S.K. *Manuel of ethnobotany*-Scientific pub-Jodhpur
- 5) Sivarajan. V., Indira.Balachandran. -*Ayurvedic medicines and their plant sources*.
- 6) Warriar-*Medicinal plants of India*, Modern Book CentreTVM.
- 7) Jain.S.K.*Contribution to Indian Ethnobotany*.Periodical experts Book agency.
- 8) Krishna Iyer, 1987.*The travancore cases, and tribes*-Govt. PressTVM.
- 9) Manilal.K.S.1979.*Relationship of Hortus Malabaricus with Kerala and Malayalam*.
- 10) Manilal.K.S. *Linkage of Ethnobotany with other Sciences and disciplines*.
- 11) Dey.A.C. 1998. *Indian Medicinal plants and Ayurvedic preparations*. Bishen Singh Mahendrapal Singh, Dehra Dun.



## Elective Special Paper- B XI (3) -Angiosperm Taxonomy and Floristics

(16½ hours/week)

### Theory

- 1) Research methodology
- 2) A critical study of pre Darwinian theories of Angiosperm classification. -Essentialism Nominalism, Empiricism.
- 3) Modern trends in Taxonomy-Cytotaxonomy, Chemotaxonomy, Biosystematics, and Numerical taxonomy.
- 4) Concept of Characters.Character variation-Their taxonomic implications, reproductive isolation, isolation mechanism and speciation.
- 5) Concept of species, Genus Family, and intraspecific categories.
- 6) A critical comparative account of the basic principles of evolutionary systematics and phylogenetic systematics.
- 7) International code of Botanical Nomenclature.Detailed study of rules and applications.
- 8) Taxonomic literature-Floras, revisions and Monograph.
- 9) A review of the accomplishments, Limitations, and future of plant taxonomic research.

### Practical:

1. Exercises on the analytical preparation of a minimum 25 local plants using taxonomic terminology.
2. Exercises on preparation of diagnostic and analytical keys
3. Exercises on solving nomenclatural problems

### References:

1. Davis.P.H. AndHeywood.V.H, 1963-Principles of Angiosperm taxonomy.
2. Heywood.V.H. (Ed) 1968-Modern methods in Plant Taxonomy
3. Steet H.S. (Ed) 1974-Essays in Plant Taxonomy.
4. Heywood.V.H. &D.M.Moore(ed) 1984 Current Concepts in Plant Taxonomy.
5. Stebbins.G.H.1974-Flowering Plants.Evolution above species level.
6. Mayr.E1976-Evolution and Diversity of life.



## Elective Paper- B XI (4) - Seed Technology

(16½ hours/week)

1. Research methodology.
2. Introduction-History of seed technology and Seed testing, their development in India and importance to agriculture.
3. Seed testing procedures: Objectives ISTA Rules-Prescriptions and recommendations. Sampling type of samples. Storage seed purity. Physical purity and analysis. Genetic purity and determination. Seed moisture content and effects. Methods to determine moisture contents. Seed germination –Viability and germination tests. Seedling evaluation. Seed and seedling vigour.
4. Morphology and anatomy of seed. Exomorphic characters. Gross internal morphology, Development and structure of seed coat in main group of angiosperms. Classification of seed on seed coat character, Identification, and structure of seed of important field crops and their seeds.
5. Seed production: Principles, Seed production in self pollinated, cross pollinated and vegetatively propagated crops, hybrid seed production, maintenance of inbred lines and breeders seeds, germplasm banks, life span of varieties and factors responsible for their deterioration Harvesting, separation, cleaning and upgrading of seeds including the equipment used.
6. Seed storage: Principles and methods of storage, types of storage structures. Seed factors affecting storage life, effects of storage environment on seed longevity Seed deterioration in storage and its control.
7. Physiology and biochemistry of seed germination. Seed maturation. Food reserves, inhibition mobilization of food reserves, germination, and growth. Factors affecting germination.
8. Seed dormancy and longevity: Dormancy significance, types, and control of dormancy and release of dormancy. Longevity-life span of seed, factors affecting longevity, biochemical, and cytological effects of longevity.
  - i) Reserve mobilization-mobilization of carbohydrates, Proteins, fats, Phytins
9. Seed certification: Definitions, development of seed certification.concept, minimum seed certification standards- general and specific crop standard-field inspection ISTA certificates.
10. The Seed Act of India (1996) and seed rules (1968) with amendments, limitations of the Act.
11. National seeds programme, National seed corporation Seed industries in India, Agencies responsible for achieving reliance in production and supply of quality.

### Practical

1. Preparation of working sample using mechanical seed divider.
2. Determination of physical purity of seed samples of five field crops.
3. Composition of pure crop seed of a sample.
4. Moisture content of seed using oven and any other method.

5. Determination of viability of seed through germination, biochemical, and excised embryo methods.
6. Percent germination of crop seeds using laboratory methods.
7. Top of paper (ii) between paper (iii) Roll towel method and (iv) pot method
8. Evaluation of seedlings in the above germination tests.
9. Determination of hard and fresh ungerminated seeds in a suitable seed sample.
10. Determination of dormancy and methods to overcome the same.
11. Exo and endomorphic features of seeds of representative crops and their weeds
12. Identification of common seeds using seed photographs, seed manuals, seed atlas
13. Detection of microflora of stored seed samples by SBT /PDA method.
14. Symptoms, Loss in seed viability and seed vigour in stored seed sample.
15. Detection of aflatoxin contamination in stored seed sample by UV, Fluorescent light.
16. Determination of aflatoxin contents in affected seed lots by thin layer chromatography
17. Comparison seed leakages from normal and infected seed loss.
18. Visits to different seed production field. Seed testing station, seed industries, seed storage, NSC, SSC,
19. Quarantine centers.
20. Demonstration of ISTA phytosanitary certificates.
21. Qualitative and quantitative determination of chemical constituents of seed.
22. Determination of enzymatic activity during germination.
23. Seed adulterants, identification of adulterant, effect of adulterants of food value.

## References

1. Barton -Seed preservation and longevity 1961
2. Bewley. J.D. and Black.M.Physiolgy and Biochemistry of seeds in relation to germination Vol I&II, 1983
3. Bewley. J.D. and Black.M-Seeds Physiology and germination1985 Plenum press Newyork.
4. Bouman.F-Development of ovule and seed coat structure in Angiosperms.Today and tomorrow,Delhi, 1978.
5. Fenner.M-Seed Ecology-1985.Chapman and Hill
6. Mayer.K.M. And Poljakoff-Germination of Seeds.(1989)
7. Roberts. (Ed)-Viability of Seeds.1972.Caman and Hall, London.



## Elective Special Paper- B XI (5) -Plantation Crops

(16½ hours/week)

### Theory

1. Importance of the plantation crops in the economy of Kerala State.
2. Diagnostic features of the crop plants like Areca nut, Cashew, Cocoa, coconut, coffee, Pepper, Rubber, Tea and other major spice crops
3. Origin, Distribution, climatic and soil requirements of the above crops
4. Different varieties of the crops: Selection, propagation and nursery technique
5. Crop improvement programmes: Breeding and Biotechnology
6. Agronomic practices such as: Planting techniques: Maintenance of plantations; manuring and other operations.
7. Harvest index and post harvest technologies of the crop.
8. Pest and disease management
9. Importance of Research and Developmental programmes and marketing

### Suggested practicals

1. Collection and identification of crop plant specimens.
2. Laboratory investigations of the vegetative and floral morphology of the crop plants.
3. Fruit and seed morphology and germination studies.
4. Special techniques on propagations like budding, grafting and layering.
5. Identifications of common pests and disease of the crop plants.

### References

1. Menon, K.P.V.& K.M.Pandal 1969. *The coconut plant, monograph*. Indian Central Committee
2. I.C.A.R.1969-*Hand book of Agriculture*, Now Delhi
3. Poulouse T.T. 1972-*Areca nut and spices-A growers Hand Book*
4. P.K.Narayanan (1976.ed)-*Rubber and its cultivation*. Rubber Board
5. Thampan P. 198- *Handbook of coconut plant* Oxford & IBH New Delhi
6. Srivastava. H.C.B. Sastry and K.K.C.Menon1986-*Plantation crops Vol-1*, Oxford&IBH New Delhi.



## **Elective Special Paper- B XI (6) - Genetics and Crop Improvement**

(16½ hours/week)

### **Theory**

1. Crop Genetics – a general account of origin, genetic variability, floral biology, breeding programmes, agronomic practices and major breeding achievements in the case of the major cereals, millets, plantation crops, cotton, sugarcane and spices.
2. Genetic resources: Conservation and utilization in crop improvement centres of origin and diversity. Gene banks – rural gene banks international network of Gene banks- IBPGR, Role of Domestication, and plant introduction and acclimatization improvement.
3. Selection as a method of crop improvement -principles and practices, Selection of segregating populations.
4. Hybridization-Systems of inbreeding and sterility. Back crossing theory and practice. Inbreeding - inbreeding depression heterosis -Production of hybrid seed.
5. Applications of euploidy in crop improvement-significance of haploids and polyploids
6. Clones and clonal propagation-clonal selection-somatic variation-somatic hybridization. Applications of tissue culture in crop improvement –micro propagation and in vitro exchange of germplasm.
7. Mutations in crop improvement -achievements and future.
8. Breeding for pest resistance, disease, resistance and stress resistance Genetics of resistance (disease, pest and stress resistance)
9. Nitrogen fixation: Genetics of Nitrogen fixation, Usable fertilizers in crop improvement
10. Genetics of photosynthesis.
11. Applications of recombinant DNA Technology in crop improvement transgenic plant production.
12. Genetics of seed storage proteins.
13. Plant Breeding Institute in India and their major achievements.
14. Social and economic aspects of agriculture in Kerala
15. Patenting life forms-Patent laws, farmers rights and plant breeders rights
16. Production of improved seed-seed certification-variety release procedure
17. Conservation of traditional seeds- farmers movements NGOs-alternate logical agriculture, Biotech agriculture - intensive agriculture sustainable agriculture.
18. Terminator seed technology, genetically engineered crops, and the future of Indian Agriculture.

### **Practicals**

1. Morphological and cytological identification of polyploid variation
2. Study of the cytology of invitro callus
3. Identification of major pests and disease of crop plants

4. Study of chemical composition and use of pesticides weedicides. Fungicides and other plant protection chemicals.
5. Visit to the major plant breeding stations of South India and submission of a certified report / training in a plant breeding Institute for 5 days and submission of the certified report signed by the supervising scientist of the Institute.
6. Study of major diseases of crop plant by field identification as submission of specimens related to pathology, crop improvement

**References:**

1. Allard R.W. 1960 *Principles of plant breeding*. John Wilson and sons
2. Bajaj VPS 1990. *Haploids in crop improvement*.
3. Chopra V.L 1989. *Plant Breeding: Theory and Practice* Oxford IBH
4. Chopra V.L and Nasim 1993. *Generic Engineering and Biotechnology: Concepts and application* Oxford I BH
5. Frankel O.H. and E. Bannet. 1970. *Genetic resources in plants* Blackwell
6. ICAR 1989. *Forty Years of Agricultural research and education in India*
7. Kush GS 1976 *Cytogenetics of Aneuploids*, Academic Press.
8. Mather K.Anos Jinks J.L 1982 *Biometrical genetics*, Chapman and Hall
9. Poelman. J.M 1987 *Breeding Field Crops XVI* Pub. Co
10. Swaminathan M.S, Gupta P.K. and Sinha.U 1983 *Cytogenetics of crop plants*. Macmillan India.
11. Vavilov N.I 1951. *The Origin, variation, immunity, and breeding of cultivated plants*. The Ronald Press Co. New York
12. Singh, P. 1996 *Essentials of plant breeding*, Kalyani publishers
13. Sharma JR 1994 *Principles and practices of plant breeding* Tata MC Graw Hill, New Delhi.



## Elective Special Paper – B XI (7) –Mycology

(16½ hours/week)

### Theory

1. Research methodology.
2. Principles of fungal taxonomy: Nomenclature of Fungi, Taxonomic criteria, Nomenclature of pleomorphic fungi and Concepts of Anamorph, Teleomorph and Holomorphs, Traditional and modern systems of classification, phylogeny of fungi.
3. Phyla of Fungi: Detailed study of the biology, characteristics and classification of Myxomycota, Mastigomycota, Plamodiophoromycota, Oomycota, Hyphochytridiomycota, Labyrinthmycota, Chytridiomycota, Zygomycota, Ascomycota, Basidiomycota.
4. Asexual fungi (Deuteromycetes) -General characters, Habitat and Importance of Asexual Fungi-Somatic structures, structures associated with asexual reproduction, conidia and conidial ontogeny, other asexual propagules, Teleomorph-Anamorph connections, Nomenclature and classification.
5. Fungal metabolism: Carbohydrate and Energy Metabolism, Nitrogen metabolism, Lipid Metabolism, Secondary Metabolism
6. Growth: Mechanics of growth in fungi, growth of yeasts, growth of mycelial fungi, culturing of Fungi, measurements and kinetics of growth, nutrient acquisition, Nutritional requirements.
7. Sporulation: Hormonal control, General principles of environmental control, Nutrition physical factors, Molecular and Biochemical changes accompanying sporulation, reproduction in the natural habitats.
8. Spores: Passive mechanisms of spore release, active mechanisms of spore dispersal, spore dormancy, spore germination.
9. Fungi as saprotrophs - Decomposition, saprotrophs in terrestrial habitats, microbial interactions in terrestrial habitats, role of fungi in degradation of pesticides and hydrocarbons, food spoilage by fungi.
10. Fungi in pathological relations of agricultural importance, viruses affecting fungi, fungi as parasites, mucoparasites, fungi as parasites of plants, fungi as parasites and predators of nematodes, fungi as parasites of arthropods, biological control utilizing fungi.
11. Fungi of veterinary and medical interest: fungi as pathogens, fungi as allergens, fungal toxins, and mycotoxism.
12. Fungi as mutualistic symbionts: Lichens, Mycorrhizae, Endophytes, Fungi as insect symbionts, and anaerobic chytrids in herbivores.
13. Fungi and Human affairs: industrial Mycology, fungi, and food processing, Fungi collected or cultured as food. Fungi and biotransformation of useful metabolites.

### Practicals: I

Collection and study of micro-and macro fungi (representing all major groups of fungi) commonly available in nearby areas. Students shall prepare a record compiling illustrations and descriptions of at least 50 different fungal genera studies by them.

## References

1. Ainsworth, G.C. et.al (eds.) 1965. *The Fungi-an advanced treatise*. Vols. 1-4 Academic Press.
2. Alexopoulos, 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 the fungi* 4<sup>th</sup> Edition Prentice Hall
6. Webster. 1980. *Introduction to fungi*, Cambridge University press.



## Elective Special Paper- BXI (8) - Physiology Of Growth

(16½ hours/week)

### Theory

1. Research methodology.
2. The phenomenon of growth at cellular and sub cellular levels, cell wall growth, formation of organelles, etc.
3. Metabolism and growth in relation to minerals, carbohydrates, fats, protein, enzymes, nucleic acids, and nucleo proteins.
4. Vegetative growth (Meristems, Primary growth, enlargement, elongation and differentiation) Physiological aspects, of cell growth and differentiation.
5. Factors effecting vegetative growth such as climatic factors, water relations and internal factors.
6. Reproductive growth (initiation of flowers, development of floral parts, sex differentiating, pollen germination, initiation of embryo and endosperm development, seed and fruit development.
7. Factors affecting reproductive growth (Photoperiodism, vernalization, water and metabolities)
8. Study of plant hormones and growth substances (Hormone concept, classification, role, mechanism, of auxin action, synthesis, structure mode of action and the application in agriculture).
9. Study of normal and abnormal growth, wound reaction to chemical and pathogenic injuries including the formation of galls and callus and tumor growth. Study of tissue culture as a tool for the study of growth.
10. Study of growth co-relation and periodicity (co-relation between reproductive and vegetative development, shoot-root ratio, apical dominance cambial activity, co-relation between leaves and buds, daily and seasonal periodism.
11. Growth indices and the different methods employed to study the various phases of growth and development.
12. Physiology of seed/grain development-growth patterns-sigmoid and double sigmoid growth curves-phases of growth-role of pericarps, hull and seed coats in seed / grain development. Biosynthesis of proteins, carbohydrates, lipids RNA and DNA during seed grain development.
13. Physiology of seed germination Primary early biochemical events of germination. Appearance andI role of proteases and, lyases and Lipases in hydrolysing stored food materials in storage organs, Mobilization of hydrolysed products to the growing embryonic axis / seedling.

### Practicals

1. Suitable experiments to demonstrate the theory portions as given above are recommended for e.g. few experiments as given below may be conducted.
2. Experiments to determine the requirement of mineral substances.
3. Study the volume and dry weight change of different seeds during germination.
4. Measure the growth of plants periodically and find out the RGR, NAR, and LWR etc.

5. Measurement of stomatal index during the different phases of growth rate.
6. Measurement of pollen germination and its growth .
7. Study of the factors required for seed germination.
8. Study of seed initiation involving plant growth regulators.
9. Qualitative / quantitative determination of the effect of GA on seed germination.

### References

1. Bernier, G. 1970 - Cellular and molecular aspects of floral induction (Long man Ltd.)
2. Malik C.P and Srivastava. A.K.1980- Text Book of Plant Physiology( Kalyani Publication, New Delhi).
3. Evans, L.T. 1963- Experimental control of plant Growth (Acad. Press).
4. Philips, I.D.J. 1971.-Introduction to the Biochemistry and Physiology of growth hormones (Mc Graw Hill Book C U.S.A) 6.
5. Wareing, P.E. and Philips I.D.J. 1981. - The Control of growth and differentiation in Plants, Pergamon Press.
6. Halevy.A.J. (Ed.) 1985 CRC- Handbook of flowering Vlo. 1-6CRC Press, Florida.
7. Vince-Prue.D-1974-Photoperiodism in Plant ( Mc G Raw Hill, New York).
8. Davis, P.J. (Ed.) 1988-Plant Hormones and their role in plant growth and reproduction (Kluwar, Dordrecht.)



## Elective Special Paper- B XI (9) - Seed Pathology

(16½ hours/week)

### Theory

1. Research methodology.
2. History of seed Pathology, its importance in modern agriculture, losses caused by seed -borne diseases.
3. Seed health testing: Kind of seed-borne inoculums, principles, and methods of seed health testing for fungi, bacteria, viruses, and nematodes.
4. Seed-borne fungi, bacteria, viruses, nematodes, and their diseases. *Alternaria*, *Dechslera*, *Curvularia*, *Collectotricum*, *Cladosporium*, *Fusarium*, *Asperigillus*, *Penicillium*, *Phoma*, *Diplodia*, *Rhizopus*, *Stemphyllium*, *Cercospora*, *Pyricularia*, *Trichocomiella*, *Asoenyta*, *Ustilago*, *Uromyces*, *Tolyposporium*, *Tilletia*, *Neovossia*, *Claviceps*, *Sclerospora*, *Rhizoctonia*, *Urocystis*, and important diseases caused by them in important field crops with special reference to the state in India. Anthracnose, Powdery mildew, Erwinia, and the diseases. Barley stripe mosaic virus, bean mosaic virus, cowpea mosaic virus, and yellow dwarf virus. *Anguina tritici*-ear cockle diseases of wheat.
5. Seed infection and establishment: Environments of developing seed, avenues of infection, factors affecting infection and its establishment, location of infection in seed, morphology and anatomy of seed in relation to invasion and location of pathogens.
6. Seed transmission of diseases: Types modes of establishment i.e. Disease cycles with examples factors effecting establishment and course of disease from seed to plant.
7. Seed-borne inoculums and disease development: Inoculum density, its assessment in relation to plant infection, epiphytotic due to seed-borne inoculum; disease forecast based on seed infection tolerance limits.
8. Control of seed- borne diseases: Principles of controls, type of treatment (Physical, chemical biological) Mechanism with reference to important seed- borne pathogens.
9. Storage fungi- Mode of seed deterioration types of mycotoxins, detection and effects of animal and human health.
10. Quarantine for seed: History and importance, principles of quarantine regulations, quarantine regulations and their application, implications of permissible tolerances; phytosanitary certificates; plant quarantine in India. International and national cooperation in seed pathology: International organizations, national Organizations and corporation.

### Practicals:

1. Dry seed samples for determining percentages of normal looking symptomatic seeds and modified seeds like galls, sclerotia and other fungal fruiting bodies.

2. Seed washing test to determine seed-borne inoculums and to calculate the spore load using haemocytometer.
3. Viability of seed-borne propagules of fungi by TTC and germination methods.
4. Seed-borne mycoflora by standard blotter method of representative crops of different groups.
5. Effect of chlorine pretreatment of seed-borne mycoflora in standard blotter method
6. Seed-borne mycoflora using potato dextrose agar plate method in representative in crops of different groups.
7. Seed-borne mycoflora using 2,4-D blotter deep freeze method.
8. Component plating of infected seeds using standard blotter/potato dextrose agar -method.
9. Location of pathogen in infected seeds by clearing and whole mount preparation of seed parts.
10. Location of infection in seed through hand section / prepared microtome slides in endospermic and non-endospermic seeds.
11. Seed transmission by seedling symptom test using (a) cleared whole mount preparation.
12. Infection pathway of pathogen in infected seedling by cleared whole mount preparation.
13. Bacterial symptoms in seed of local crops.
14. Bacterial symptoms cost during germination on seed and seedling.
15. Isolation and culture of seed-borne bacteria use of stemming techniques to study the morphology.
16. Symptoms caused by viruses on seedling and adult plant.
17. Symptoms caused by nematode(s) on plant and seed using specimens and permanent preparation.
18. Common methods of control: Physical (Heat treatment): Chemical common chemicals demonstration, preparation of solution, mixtures. Slurry etc. for seed treatment: platted seeds. Equipment used for treatment.
19. Study of specimens of common seed-borne diseases; seed mycoflora-herbarium and permanent slides of fungi and bacteria.

### **Reference**

1. Christensen.C.M. & 1969 -Grain storage The role of fungi in quality lose
2. Kaufmann H.HUniv. of Minnesota Press Minneapolis 1959 -Deterioration if stored train by fungi boy Rev. 23: 108-124
3. Neergaard, Paul .1977. -Seed pathology Vols. 11, MacMillan PressLtd, Madras & I.
4. Salunkhe D.K. Adsele.R.N. &1987& Padule.D.N- Aflatoxins in Foods and Feeds.



## Elective Special Paper B XI (10)- Environmental Biology

(16½ hours/week)

1. Research methodology.
2. Scope, Historical perspective - Interdisciplinary approach. Habitat Ecology- Detailed study on the four major types of habitats in the biosphere, fresh water, marine, estuarine and terrestrial.
3. Planktonology - Phyto and Zooplanktons rmeasurement - relationship -Ecological significance.
4. Population Ecology - Basic concepts - population characteristics, population dynamics, regulation of population - Growth curves -population structure - population theories.
5. Human activities and environment - potential hazards of carelessness in developmental activities – Bhopal tragedy and Chernobyl accident. Effects of all air pollutants and chemical toxicants on biological systems –on plants and on animals. Some concepts in water pollution -BOD, Eutrophication, self-purification of natural waters, bioaccumulation, biological magnification.
6. Land degradation - Causes of land degradation - Natural and human activities. Effects of land degradation. Remedial measures.
7. Concept of waste management – Waste minimization, Recycling of industrial wastes, Treatment of hazardous wastes, Effects of improper waste disposal.
8. Environmental Biotechnology - Bioremediation - need and scope. Applications - Removal of toxic chemicals from industrial wastewater. Biological gas treatment systems (biofilters, biofilms, bioscrubbers). Japanese global applications of bioremediation technology- Replacement of petrochemicals, Reversal of global warming, Biodegradable plastics, Reversal of desert formation. Microbial conversion of CO<sub>2</sub> to alcohol. Phytoremediation (brief account).
9. Prospects of remote sensing in environmental studies.
10. Environmental issues of Kerala. Industrialization.

### Practicals

1. To find out primary production in the given water sample by using light and dark bottles.
2. Estimation of phosphate and nitrite in the water samples.
3. Estimation of hardness, and salinity in the water samples.
4. Quantification of the planktons, present in the given two water samples.
5. Analysis of major elements (Na, K., Ca and Fe) of water samples.
6. Analysis of chlorophyll pigments in water.
7. Elemental analysis (Na, K, Ca, Mg and Fe) of plant samples.
8. Study of morphological, anatomical, ecological, cytological, or elemental analysis of a few plant samples of different habitats (not less than five) plants and any two parameters from an environmentally

significant area.

9. Visit to any environmental hot spot area and submit a report.

## References

1. Aaradhana P.S. (ed.) 1998, *Environmental Management*. Rajat Publications Delhi.
2. Ambasth, R.S and Ambasth, N.K. 1996. *A Textbook of Plant Ecology*. Students Friends and Co, Varanasi.
3. Burdon J.J. 1987, *Diseases and Plant Populations in Biology*. Edward Arnold.
5. Crawford R.M.M (ed) 1986. *Plant life in aquatic and amphibian habitats*, Black Well Sci.
6. De Kok, L.J. and Stulen, I. (Eds). 1998. *Responses of Plant Metabolism to air pollution and Global change*. Backhuys Publishers, Leiden.
7. Grace, J. et al., 1981. *Plants and their atmospheric environment*. Black Well Sci.
8. Jeffrey D.W. 1987. *Soil Plant Relationship- an ecological approach*. Croom Helm.
9. Jones H.G. 1983. *Plants and microclimate: a quantitative approach to environmental Plant Physiology*.
10. Kershaw K.A and Looney J.H.H. 1985. *Quantitative and dynamic Plant Ecology*. Cambridge University Press.
11. Mohan, I. 1989. *Environmental Pollution and Management*. Ashish Publishing House, New, Delhi.
12. Nag P. and Kudrat, M. 1998. *Digital remote sensing*. Concept Publishing Co. New Delhi.
13. Naskar, K. and Mandal, R. 1999. *Ecology and Biodiversity of Indian mangroves*. Daya Publishing House, Delhi .
14. Odum E.P. 1971. *Fundamentals of Ecology*, W.B. Saunders and Co.
15. Park, C. 1997. *The Environment. Principles and Applications*. Routledge London and New York.
16. Reeve R.N., 1994. *Environmental Analysis*. John Wiley and Sons, New York.



## **Elective Special Paper B XI (11) - Plant Biochemistry and Enzymology**

(16½ hours/week)

### **Plant Biochemistry**

1. Research methodology-Metabolic pool of the cell, Structure, metabolism and functions of primary metabolites - carbohydrates, lipids, proteins and nucleic acids.
2. Primary metabolic pathways and their interrelationships.
3. Primary metabolic conjugates, structure and function - glycolipids, glycoproteins, metalloproteins.- Cytochromes, leghaemoglobin, nucleoproteins, - RNPs and DNPs. Protein DNA interactions, Hormone DNA interactions.
4. Secondary metabolites, relevance, major secondary metabolites. (Alkaloids, Phenolics, Terpenoids, Cyanogenic compounds etc.) biosynthetic pathways of secondary metabolites and their interrelationships, regulation of secondary metabolism.
5. Enzyme engineering for increased secondary- metabolite production.
6. Links between primary and secondary metabolic pathways.

### **Enzymology**

1. Plant enzymes - metabolic role of major classes. O, T, H, L, 1, L (Oxidoreductases, Transferases, Hydrolyases, Lyases, isomerases, Ligases) and membrane bound enzymes.
2. Sub cellular localization of enzymes by LM and TEM. Histochemistry of enzyme reaction.
3. Enzyme purification procedures (a general design), Dialysis - Desalting methods, isolation and assay of plant enzymes and factors affecting activity.
4. Relationship between initial velocity and substrate concentration, Michaelis - Menten equation, and its significance. Lineweaver plots. Enzyme inhibition, competitive, non -competitive, Allosteric, irreversible, enzyme activation, Zymogen. Allosteric enzymes, metabolic regulation, sigmoid, kinetic, steady state metabolic pathways by control of enzymatic activity.
5. Native PAGE in Enzyme localization, principle and methodology, Zymogram.
6. Isoelectric focusing (IEF)
7. Immobilization of enzymes, enzyme engineering - Techniques and applications.
8. Biotechnological application of enzymes.

### **Practicals**

1. Isolation, partial purification, and estimation of specific activity of plant enzyme - Poly phenol oxidase, malate dehydrogenase,
2. Isoenzyme analysis, and preparation of Zymogram.

3. Separation of enzyme proteins by Native PAGE.

### References

1. Adams R.L.P, Knowler J.T, Leader D.P. 1986. The Biochemistry of the nucleic acids, 10<sup>th</sup>ed. Chapman and Hall.
2. Burdan R.H, Knippenberg, P. H. (editors). 1989. Techniques in Biochemistry and Molecular Biology, 2<sup>nd</sup> ed, Elsevier.
3. Fersht. A: 1985. Enzyme structure and mechanism, 2<sup>nd</sup> ed. Freeman.
4. Gennis, R.B .1989. Biomembranes: Molecular structure and function. Springer-Verlag.
5. Gurr, M.I, Harwood, J.L: 1991. Lipid Biochemistry: An Introduction 4<sup>th</sup> ed. Chapman and Hall.
6. Vance D.E., Vance J.E (editors) 1991. Biochemistry of lipids, lipo proteins, and membranes. Elsevier.



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