VIMALA COLLEGE, THRISSUR

(*AUTONOMOUS*)

REVISED SYLLABUS

for

POST GRADUATE PROGRAMME

in

BOTANY

Effective from 2017 admission

BOARD OF STUDIES

Dr. Sheela George. V
Associate Professor & Head
Department of Botany
Vimala College (Autonomous)
Thrissur

Dr. Siril E. A
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Nirmala College
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Irinjalakuda

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Dr. Sheeja T Tharakan Assistant
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Dr. Manju Madhavan
Assistant Professor
Department of Botany,
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Thrissur

M.Sc Botany Programme (CSS)

Duration of the Course:

Four semesters (2 years)

Number of courses and credits required:

Ist , IInd and IIIrd semesters with four core courses (three theory and one practical), each with 4 credits (total 16 credits per semester) and IVth semester with four elective courses (two theory and two practical) each with 4 credits, one dissertation with 4 credits and one viva voce with 4 credits (total 24 credits in the semester). Total credits required for the completion of the programme is16x3 + 1x24 = 72.

Selection of subject for dissertation:

A subject is to be selected by each student for dissertation based on the facilities available and the specializations of the supervising teachers.

Evaluation:

Evaluation is to be carried out both by internal continuous evaluation and external terminal evaluation. Out of the total weightage for each course, 25% is to be given for internal continuous evaluation and 75% for external terminal evaluation.

1. Internal continuous evaluation:

Internal continuous evaluation should have five components of equal weightage as shown below. Internal evaluation will be carried out by the teacher/teachers offering the course. The marks should be displayed on the notice board of the department and the students shall be given a chance to redress grievances if any.

a. Theory courses:

Attendance	Assignments	Test paper (1)	Seminar	Test paper (2)
90%: full weightage	A: full weightage	A: full weightage	A: full weightage	A: full weightage
80%: ¾ weightage	B: ¾ weightage	B: ¾ weightage	B: ¾ weightage	B: ¾ weightage
75%: ½ weightage	C: ½ weightage	C: ½ weightage	C: ½ weightage	C: ½ weightage
Below 75%: no weightage	D: no weightage	D: no weightage	D: no weightage	D: no weightage

b. Practical courses:

Attendance	Practical skill	Test paper (1)	Drawing skill and regularity	Test paper (2)
90%: full weightage	A: full weightage	A: full weightage	A: full weightage	A: full weightage
80%: ¾ weightage	B: ¾ weightage	B: ¾ weightage	B: ¾ weightage	B: ¾ weightage
75%: ½ weightage	C: ½ weightage	C: ½ weightage	C: ½ weightage	C: ½ weightage
Below 75%: no weightage	D: no weightage	D: no weightage	D: no weightage	D: no weightage

c. Dissertation:

Regularity	Involvement/level of knowledge	Literature collection	Presentation (1)	Presentation (2) (model)
90%: full weightage	A: full weightage	A: full weightage	A: full weightage	A: full weightage
80%: ¾ weightage	B: ¾ credits	B: ¾ weightage	B: ¾ weightage	B: ¾weightage
75%: ½ weightage	C: ½ credits	C: ½ weightage	C: ½ weightage	C: ½ weightage
Below 75%: no weightage	D: no credits	D: no weightage	D: no weightage	D: no weightage

2. External terminal evaluation:

At the end of each semester, there will be external evaluation on each course. The pattern of theory question paper will be as per the general regulations of CSS. The pattern of practical question papers will be finalized by the concerned board of examiners. The answer scripts of each theory course will be valued by one member of the board of examiners constituted by the controller of examination for the purpose. There will be provision for revaluation after the declaration of results. The practical examination will be conducted by two members each of the board of examiners constituted by the university. Each dissertation will be valued by two examiners. The board of viva voce will also constitute of two examiners. One improvement chance will be given to the candidate in the case of each course. There will be no limit for supplementary chances. The candidates will have to appear for the improvement and supplementary chances along with the junior batches. Theory examinations will be of 3 hours duration and practical examination of 6 hours duration with a break in between. The practical question paper is to be set with two sections, one for the FN and the other for the AN. The

students will have to submit their tour reports and practical records on the day of the practical examination.

Pass and overall grade:

Pass and overall grade will be as per the general regulation of CSS.

Grievance redressal:

Grievance redressal should be carried out as per the general guidelines issued by the college from time to time.

Distribution of weightage of marks:

1. **Theory:**

Essay questions: 40%; Paragraph questions: 30%; Short answer questions: 30%.

2. **Practicals:**

Practical work: 75%; Practical records: 15%; Submissions and tour report: 10%.

3. **Dissertation:**

Written account: 80%; Presentation: 10%; Discussion: 10%.

4. **Viva voce:**

Viva voce at the end of the IVth semester based on the entire syllabus with 100% external evaluation.

Distribution of work based on credits:

1 credit = 1.5 hours of teaching per week.

(I Semester to III Semester: 16 credits=24 teaching hours per week. 1 hour per week for seminar; IV Semester: 16 credits for elective courses =24 teaching hours. 1 hour for CE of Dissertation.)

VIMALA COLLEGE, THRISSUR (*Autonomous*)				
M.Sc. Programme in Botany (CSS)				
Programme, structure of courses and distribution of credits				
Course	Title	Credits		
		Internal	External	Total credits
Semester I				
VPBO1C01	Phycology, Bryology, Pteridology and Gymnosperms	25%	75%	4
VPBO1C02	Mycology and Lichenology, Microbiology and Plant Pathology	25%	75%	4
VPBO1C03	Angiosperm Anatomy, Embryology, Palynology and Lab Techniques	25%	75%	4
VPBO1PL1	Practicals of Phycology, Bryology, Pteridology, Gymnosperms, Mycology and Lichenology, Microbiology, Plant Pathology, Angiosperm anatomy, Embryology, Palynology and Lab Techniques.	25%	75%	4
Semester II				
VPBO2C04	Cell Biology, Molecular Biology and Biophysics	25%	75%	4
VPBO2C05	Cytogenetics, Genetics, Biostatistics, Plant Breeding and Evolution	25%	75%	4
VPBO2C06	Plant Ecology, Conservation Biology, Phytogeography and Forest Botany	25%	75%	4
VPBO2PL2	Practicals of Cell Biology, Molecular Biology, Biophysics, Cytogenetics, Genetics, Biostatistics, Plant Breeding, Plant Ecology, Conservation Biology, Phytogeography and Forest Botany	25%	75%	4

Semester III				
VPBO3C07	Plant Physiology, Metabolism and Biochemistry	25%	75%	4
VPBO3C08	Angiosperm Morphology and Taxonomy and Plant Resources	25%	75%	4
VPBO3C09	Biotechnology and Bioinformatics	25%	75%	4
VPBO3PL3	Practicals of Plant Physiology, Metabolism, Biochemistry, Angiosperm Morphology, Taxonomy, Plant Resources, Biotechnology and Bioinformatics	25%	75%	4
Semester IV				
VPBO4E01	Elective I	25%	75%	4
VPBO4E 02	Elective II	25%	75%	4
VPBO4EPL1	Practicals of Elective I	25%	75%	4
VPBO4EPL2	Practicals of Elective II	25%	75%	4
VPBO4PR	Dissertation	25%	75%	4
VPBO4V	Viva voce	0%	100%	4
Total				72

VPBO1C01: PHYCOLOGY, BRYOLOGY, PTERIDOLOGY AND GYMNOSPERMS

(1.5+1+2+1.5=6 hours per week)

Phycology

1. Classification of algae - comparative survey of important systems - Fritsch - Smith - Round. Criteria for algal classification - Phylogenetic considerations.
2. Biological importance of planktons.
3. Algal cytology - Basic ideas of cell features - Electron microscopic studies of algal cell, cell wall, flagella, chloroplast, pyrenoid, eye-spot - their importance in classification.
4. General account of thallus structure, cell ultra-structure, reproduction, relationships and evolutionary trends in the following groups: Chlorophyta, Xanthophyta, Bacillariophyta, Phaeophyta, Rhodophyta.
5. Reproduction - Different types of life cycles in algae.
6. Economic importance of algae - role of algae in soil fertility, algae in industry - biological importance of phytoplankton and water blooms.
7. General account of energy sources and pigments in algae.
8. Brief account on the applied aspects of algae and cyanobacteria: biodiesel, hydrogen, methane and ethanol production, carbon dioxide sequestration, food supplements, pharmaceutical industries, biofertilizers, bioremediation, biodegradation, commercial cultivation of algae, mass production and field application of cyanobacteria.
9. Fossil algae and cyanobacteria.

References

1. Fritsch, F. E. 1945. The structure and Reproduction of Algae.
2. Smith, G. M. 1950. Manual of Phycology.
3. Round, F. E. 1965. The Biology of Algae.
4. Bold, H. C. and Wynne, M. J. 1978. Introduction to the Algae: structure and reproduction.

Bryology

1. General characters and systems of classifications of Bryophytes.
2. General account of the anatomy, reproduction, life history and phylogeny of Spaerocarpales, Marchantiales, Jungermanniales, Calobryales, Anthocerotales, Sphagnales, Andreales, Funariales and Polytrichales.

3. Origin and evolution of Bryophytes - gametophytic and sporophytic.
4. A general account of fossil Bryophytes and their affinities.
5. Economic importance of bryophytes
6. A brief account on applied bryology: ecological uses, house hold uses, medicinal uses (herbal medicines, transgenic products), decorative bryophytes, aquarium bryophytes, heavy metal detection and clean up, erosion control, horticultural uses (soil conditioning, air layering, pot culture, container gardens and hanging baskets), bioindicators of pollution.

References

1. Watson, E. V. 1964. The structure and life of Bryophytes. Hutchinson Univ. Press, London.
2. Cavers, F. 1910. The interrelationship of Bryophytes. New Phytologist.
3. Kashyap, S. R. 1929. The Liverworts of Western Himalaya and the Punjab Plains, Vol. I & II. Chronica Botanica.
4. Smith, G. M. 1955. Cryptogamic Botany. Mc Graw Hill Book Co., N.Y.
5. Parihar, N. S. 1961. An introduction of Embryophyta: Bryophyta. General Book House, Allahabad.
6. Verdoon, F. M. 1932. Manual of Bryology. Ashor & Co., Amsterdam.
7. Shaw, J. and Goffinet, B. 2000. Bryophyte Biology. Cambridge University Press.
8. Manju, C. N., Rajesh, K. P. and Madhusoodanan, P. V. 2005. Bryophytes of Wayanad in Western Ghats. Malabar Natural History Society, Kozhikode.

Pteridology

1. General characters and life history of Pteridophytes.
2. Cytology of Pteridophytes-Chromosome number and polyploidy.
3. Structure and evolution of stele in Pteridophytes.
4. Origin and evolution of Sporangium.
5. Heterospory and seed habit.
6. Development and evolutionary trends in the Gametophytes of Pteridophytes.
7. Apogamy, Apospory and Parthenogenesis.
8. Classification of Pteridophytes: Holttum, Pichi-Sermolli.
9. Comparative morphology, ecology and phylogeny of the following:

a. Psilopsida: Rhyniales, Psilophytales and Psilotales
b. Lycopsida:Lycopodiales and lsoetales
c. Sphenopsida: Hyeniales, Pseudobomiales, Sphenophyllales, Calamitales and Equisetales
d. Filicopsida: General account: Primofilicales, Ophioglossales, Marattiales, Osmundales, Schizaeales, Cyatheales, Gleicheniales, Marsileales and Salviniales

10. Economic importance of Pteridophytes – medicinal, horticulture, biofertilizer, weeds.
11. A brief account on applied Pteridology.
12. General account of the contribution of Indian pteridologists.

References

1. Bierhost, D. W. 1971. Morphology of Vascular Plants. Mac Miilan Co., New York.
2. Dyer, A. C. 1979. The Experimental Biology of Ferns. Academic Press, London.
3. Jermy, A. C. 1973 (Ed.): The phylogeny and Classification of Ferns.
4. Kramer, K. U. and Green, P. S. 1991.The Families and Genera of Vascular Plants. Narosa, New Delhi.
5. Nampy, S. and Madhusoodanan, P. V. 1998. Fern Flora of South India-Taxonomic Revision of Polypodioid Ferns. Daya Publishing House, New Delhi.
6. Abdul Hameed, C., Rajesh, K. P. and Madhusoodanan, P. V. 2003. Filmy Ferns of South India. Penta Book Publishers & Distributors, Calicut.
7. Azeez, K., Venugopalakrishna Kurup, V. and Madhusoodanan, P. V. 2008. Spleenworts (Aspleniaceae) of South lndia. Malabar Natural History Society, Calicut.
8. Venugopalakrishna Kurup, V., Azeez, K. and Madhusoodanan, P. V. 2008. Primitive Ferns of South India. 'V' Publishers, Kottayam.

Gymnosperms

1. Geological time scale and correlated predominant Gymnosperm flora. Classification of Gymnosperms - Chamberlain's system.
2. Geological horizons. Distribution, morphology, anatomy, reproduction and interrelationship of the following orders (Study of families and types not required)
    a. Pteridospermales; b. Glossopteridales; c. Caytoniales; d. Cycadaeoidales; e. Pentoxylales; f. Cycadales; g. Ginkgoales; h. Cordaitales; i. Coniferales; j. Taxales; k. Ephedrales; l. Welwitschiales; m. Gnetales

3. Phylogenetic relationship of Gymnosperms.
4. Economic importance of Gymnosperms.

References

1. Andrews, H. N. 1961. Studies in Paleobotany, Wiley, N. Y.
2. Banks, H. P. 1970. Evolution and plants of the past. Wadsworth.
3. Bierhost, D. W. 1971. Morphology of Vascular Plants. Macmíllan.
4. Bower, F. O. 1935. Primitive Plants. Macmillan.
5. Chamberlain, C. J. 1935. Gymnosperms-Structure and Evölution. Univ. of Chicago Press.
6. Foster, A. S. and Gifford, E. M. 1974. Comparative morphology of vascular plants. Freeman.
7. Maheshwari, P. and Vasil, V. 1960. Gnetum. CSIR, New Delhi.
8. Ramanujam, C. G. K. 1976. Indian Gymnosperms in time and space. Today & Tomorrow, Dehra Dun.
9. Sewart, W. N. 1983. Paleobotany and the Evolution of Plants. Cambridge Univ. Press.
10. Stockey, R. S. 1981. Some comments on the origin and evolution of conifers. Canadian J. Bot. 59: 75-82.
11. Taylor, T. N. 1982. Reproductive biology in early seed plants. Bioscience 32: 23-28.
12. Walton, J. 1951. An Introduction to the Study of Fossil plants.

VPBO1C02: MYCOLOGY & LICHENOLOGY, MICROBIOLOGY AND PLANT PATHOLOGY (2.5+2.5+1= 6 hours per week)

Mycology

1. General characters of Fungi: cell- ultra structure, unicellular and multicellular organization, hyphal growth, cell wall composition, nutrition (saprobic, biotrophic, symbiotic, predacious) reproduction (vegetative, asexual, sexual), heterothallism, parasexuality.
2. Classification of fungi by Ainsworth & Bisby (1983), Alexopoulos *et al*. (1996) - Phylogeny of fungi - Characters used in classification.
3. General account of Myxomycota, Mastigomycota, Zygomycota, Ascomycota, Basidiomycota and Dueteromycota. Different kinds of spores and their dispersal.
4. Fungi as saprophytes: details of the fungal decomposition of organic matter, coprophilous fungi, lignin degrading fungi, role of fungi in degradation of pesticides.
5. Fungi as symbionts: Mycorrhiza - ectotrophic, orchidaceous and Ericoid mycorrhiza, Vesicular Arbuscular Mycorrhiza - their distribution and significance. Endophytes.
6. Lichenology: General account and Systematics of lichens, thallus structure, reproductive bodies, ecological significance and economic importance of lichens.

References

1. Alexopoulos C. J., Mims, C. W. and Blackwell, M. 1996. Introductory Mycology. 4th edition. John Wiley & Sons lnc.
2. Ainsworth, G. C., Sparrow, K. F. and Susmann, A. S. (Eds.). 1973. The Fungi - An Advanced Treatise. Vol. 1 - 4. Academic Press.
3. Burnett, J. H. 1970. Fundamentals of Mycology. Edward Amolds.
4. Cariile, M. J. and Watkinson S. C. 1994. The Fungi. Academic Press.
5. Deacon, J. W. 1988. Introduction to Modem Mycology. Black well.
6. Dubey, H. C. 1990. An Introduction to Fungi. 2nd Edition. Vikas Publishers, New Delhi.
7. Hale Mason, E. 1983. The Biology of Lichens. 3rd Ed. Edward Arnold, London.
8. Jennigs, D. H. and Lysek, G. 1999. Fungal Biology. Bios Scientifìc Publishers.
9. Mehrotra, R. S. and Aneja, K. R. 1990. An Introduction to Mycology. New Age International Publishers.
10. Moore-Landecker, E. 1996. Fundamentals of Fungi. 4th Ed. Prentice Hall.

11. Nair, M. C. and Balakrishnan, S. 1986. Beneficial fungi and their utilization. Scientific Publishers, Jodhpur.
12. Nash, T. H. 1996. Lichen Biology. Cambridge University Press.
13. Webster, J. 1980. Introduction to Fungi. Cambridge University Press.

Microbiology

1. Introduction - main groups of microorganisms and their characteristics - prions, viroids, viruses, bacteria, mycoplasmas and actinomycetes.
2. Bacteria - classification based on Bergey's Manuel. Archaebacteria and Eubacteria. Morphology, ultrastructure, nutrition, genetics.
3. Plasmids and their characterization.
4. Cyanobacteria - salient features, morphology, ultrastructure, classification and economic importance.
5. Viruses - General account of plant and animal viruses, bacteriophages and their classification. Isolation, purificatíon, infection, replication and transmission of plant viruses. Detailed study of TMV and T4 Phage.
6. Microbial ecology - microbiology of rhizosphere and phylloplane. Sewage disposal, bioremediation and water purification. Detection of microbes in air and water.
7. Agricultural microbiology - management of agricultural soils, biofertilizers, biopesticides.
8. Food Microbiology - Food spoilage and preservation methods. Microbiology of fermented food - dairy products, bread and other fermented plant products. Microorganisms as source of food - single cell protein.
9. Industrial Microbiology - Production of alcohol, vinegar, antibiotics, vitamins, steroids, vaccines, organic acids, amino acids.

References

1. Adams, M. R. and Moss, M. O. 1996. Food Microbiology. New Age International Publishing Ltd., New Delhi.
2. Brock, T. D. 1996. Biology of Microorganisms. Prentice Hall.
3. Campbell, R. 1987. Microbiology. ELBS- Edward Arnold, London.
4. Carpenter, P. L. 1967. Microbiology. W.B. Sunders & Company, Philadelphia.
5. Dubey, R. C. and Maheswari, D. K. 2000. A text book of Microbiology. S. Chand.

6. Desikachary, T. V. 1959. Cyanophyta-Monograph.
7. Good fellow, M. et.al. 1993. The Biology of Actinomycetes. Academic press.
8. Kumar, H. D. and Swati Kumar. 1998. Modern Concepts of Microbiology.
9. Mathew, R. E. F. 1981. Plant Virology, Academic press.
10. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. 1986. Microbiology. Tata Mc Graw Hill.
11. Sharma, P. D. 1999. Microbiology & Plant Pathology. Rastogi Publishers, Meerut.

Plant Pathology

1. Principles of Plant Pathology - Causal agents of plant diseases - Biotic causes (fungi, bacteria, virus, mycoplasma, nematodes, angiospermic parasites. Abiotic causes (nutrient and mineral deficiencies, effect of pollution). Koch's postulates. Iatrogenic diseases. Seed pathology.
2. Details of different symptoms of plant diseases.
3. Process of infection-mechanical, physiological and enzymatic action. Penetration and entry of pathogens into host tissue.
4. Host-parasite interaction. Enzymes and toxins in pathogenesis. Defense mechanisms in plants (structural and biochemical).
5. Details of different ways of spread and transmission of plant diseases- wind and water-mediated, seed borne and vector borne.
6. Plant disease management-exclusion, eradication and protection. Different pesticides and fungicides and their application. Biocides in plant protection.
7. Study of the following diseases with reference to the symptoms, causal organisms, disease cycle and control measures:

   Bunchy top of banana, Bacterial blight of paddy, Bud rot of coconut, Mahali of Arecanut, Powdery mildew of rubber, Abnormal leaf fall of rubber, tikka disease of Groundnut, Late blight of potato, Blister blight of tea, wheat rust, coffee rust, grey leaf spot of coconut, Phytophthora foot rot of pepper, rhizome rot of ginger and turmeric, angiospermic parasites - Viscum, Dendropthoe.

References

1. Agrios, G. N. 1997. Plant pathology. 4th Ed., Academic Press.
2. Bilgrami, K. H. and Dube, H. C. 1994. A Text Book of Modern Plant Pathology. Vikas

Publishers, New Delhi.

3. Chaube, H. S. and Ramji Singh. 2001. Introductory Plant Pathology. International Book Distributing Co., Lucknow.
4. Gareth-Jones, D. 1983. Plant Pathology: Principles and Practice. Open University Press.
5. Horsfall J. G. and Cowling E. B. (Ed.). 1978. Plant Disease: An Advanced Treatise. Academic Press.
6. Lucas, J. A. l998. Plant Pathology and Plant pathogens. Blackwell.
7. Manners, J. G. 1993. Principles of Plant Pathology. Cambridge Univ. Press.
8. Mehrotra, R. S. 1980. Plant Pathology. Tata McGraw Hill.
9. Pandey, B. P. 1999. Plant Pathology- pathogen and plant disease. S. Chand & Co.
10. Pathak, V. N., Khatri, N. K. and Pathak, M. 2000. Fundamentals of Plant Pathology. Agro-bios India.
11. Rangaswami, G. 1999. Diseases of Crop Plants of India. Prentice Hall India.
12. Tarr, S. A. J. 1972. The Principles of Plant Pathology. Winchester Press.
13. Wheeler, H. 1975. Plant Pathogenesis. Springer-Verlag.
14. Wood, R. K. S. 1978. Physiological Plant Pathology. Blackwell.

VPBO1C03: ANGIOSPERM ANATOMY, ANGIOSPERM EMBRYOLOGY, PALYNOLOGY & LAB TECHNIQUES (2+2+1+1=6 hours per week)

Angiosperm Anatomy

1. Cell wall and its development. Chemistry of cell wall-cellulose, hemicellulose, polysaccharides, cell wall proteins, water. Organisation of primary wall. Cytokinesis and growth. Plasmodesmata. Secondary wall chemical Constituents - lignin, suberin, callose; organization of secondary wall.
2. Node - nodal pattems: Unilacunar, trilacunar, multilacunar and split lateral. Phylogenetic considerations. Leaf trace and branch trace - origin, departure; effect on stele and pith. Secondary growth in leaf traces.
3. Cambium: Development of vascular cambium and cork cambium in root and stem; cell types in vascular cambium, infected vascular cambia, seasonal variations in cambial activity; role of cambium in wound healing and grafting. Conversion of fusiform initials into ray initials; cambium in arborescent monocotyledons (Liliflorae).
4. Development and differentiation: The structure of specialized cells. Vascular differentiation (procambium, residual meristem, Interfascicular and intrafascicular cambia); acropetal and basipetal differentiation in leaves, stem and roots. Sieve tube differentiation. Control of phloem differentiation. Tracheary elements differentiation. Ultra structure of phloem and xylem, brief account of transfer cells. Secondary wall thickening, cytoplasmic changes and autolysis. Control of differentiation. Genetic aspects - lnduction of vessel elements. Induction of secondary xylem structure in relation to function in water conduction.
5. Anomalous secondary growth: Concepts; modification of the common type of vascular cambium, unequal activity of the vascular cambium. Successive cambia. Anomalous placement of vascular cambium. Discontinuous, unidirectional and bidirectional activity of cambium. Anomalous secondary growth in storage roots (Beet root, sweet potato).
6. Stress anatomy: anatomy and pollution, anatomical response to water stress and mineral deficiency, effects of pollution, insecticides and herbicides.
7. Leaf anatomy: Unifacial, bifacial and centric leaf (onion); structure of epidermis, stomatal types; foliar sclerieds; oil cells; crystal idioblasts.
8. Anatomy in relation to taxonomy.

9. Wood anatomy-general account.

References

1. Easu, K. 1983. Plant Anatomy - Wiley Eastern Limited.
2. Fahn, A. 1977. Plant Anatomy. Pergamon Press.
3. Cutter, E. G. and Edward, E. 1978. Plant Anatomy: Experiment and Interpretations. Part I and II.
4. Mauseth, J. D. 1988. Plant Anatomy - The Nenjamin Cumming Publishing Co.
5. Forester, A. S. l960. Practical Plant Anatomy. D. Van Nostr and Company lnc.
6. Roberts, L. W. 1976. Cytodifferentiation in Plants. Cambridge University Press, Cambridge.

Angiosperm Embryology

1. Introduction to angiosperm embryology - structure of dithecous and monothecous anther.
2. Microsporogenesis: Structure and function of wall layers, role of tapetum in pollen development.
3. Male gametophyte: Pollen mitosis, division of generative cells, heterospory.
4. Megasporogenesis: Megaspore triad, dyad, coenomegaspore.
5. Embryosac - different types - ultra-structure of components - synergid and antipodal.
6. Embryosac theories of the morphological nature of embryo sac.
7. Pollination - Artificial pollination - ultra-structural and dis-ultra structural and histo-chemical stigma. Significance of pollen - pistil interaction. Role of pollen wall proteins and stigma. *In vitro* pollination and fertilization.
8. Fertilization: Role of synergids - filiform apparatus, heterospermy and triple fusion.
9. Structure and development of typical dicot and monocot embryos-structure and function of suspensor.
10. Endosperm: classification and type - ruminate endosperm - mosaic endosperm - endosperm haustoria - physiology and cytology of endosperm.
11. Polyembryony - classification - practical value.
12. Apomixis - general account, genetics of apomixis.
13. Parthenocarpy - seedless fruits.
14. Experimental embryology - embryo culture, anther culture, ovule culture.

15. Embryology in relation to taxonomy.

References

1. Bouman, F. 1978. Ovule initiation, ovule development and seed coat a structure in angiosperms. Today and Tomorrow Publishers, New Delhi.
2. Bhojwani, S. S. and Bhatnagar, S. S. 1974. The embryology of Angiosperms. Vikas Publication, New Delhi.
3. Davis, C. L. 1965. Systematic embryology of Angiosperms. John Wiley.
4. Eames, A. J. 1960. Morphology of Angiosperms. Mc Graw Hill.
5. Johanson, D. 1950. Plant Embryology. Waltham, Massachusetts.
6. John, B. D. (Ed.). 1984. Embryology of Angiosperms. Springer Verlag.
7. Maheswari, P. 1950. An introduction to the Embryology of Angiosperms. Mc Graw Hill.
8. Raghavan, V. 1976. Experimental embryogenesis in plants. Academic Press.
9. Wardlaw, C. W. 1976. Embryogenesis in Plants. Methusen, London.

Palynology

1. Introduction - contributions of Erdtman and P. K. K. Nair.
2. Development and structure of pollen wall. Pollen morphology and its application. Pollen evolution.
3. Aeropalynology - methods of aero spore survey and analysis.
4. Melittopalynology - nutritional and medical value of honey - unifloral and multifloral honey.
5. Recent advances in palynological studies-forensic-pollen allergy-oil exploration - paleo palynology.
6. Palynology in relation to taxonomy - eurypalynous and stenopalynous taxa.

References

1. Shripad, N. A. 2006. Palynology and its Application.
2. Kahinath Bhattacharya, et. al. 2006. A Text Book of Palynology.

Laboratory Techniques

1. Study of the following instruments - their uses and principles:
   a. Microscope: microscopic measurements - camera lucida, micrometry.
   b. Microtomes-Sledge, Rocking, Rotary.

2. Killing, fixing and staining of plant tissues:
    a. Important reagents and chemicals used in the preparation of fixatives and their properties.
    b. Fixatives - FAA, Carnoy's fluid, chromeacetic, Nawaschins fluid, Craf, Flemings- composition, preparation and specific uses.
    c. Dehydrating agents, clearing agents, mounting medía. Examples and brief description.
    d. Stains - classification, composition and specific uses - safranin, crystal violet, cotton blue, fast green, Orange G, hematoxylin, carmine.
    e. Brief account of vital staining.
    f. Staining techniques-Double staining.
        i. Safranin - Fast green
        ii. Crystal violet - Orange G
        iii. Methods of embedding plant materials in paraffin wax -TBA method; embedding for Electron microscopy.
        iv. Sectioning of embedded paraffin wax materials using Rotary Microtome.
        v. Double staining of microtome serial sections embedding in paraffin wax – Safranin - fast green; Crystal violet - Orange G/Erythrosin.
        vi. Whole mounts - general account
        vii. Maceration, smears
        viii. Histochemical tests –
            (1) PAS Test-insoluble polysaccharides
            (2) Sudan black-lipids
            (3) Fuelgen reaction-Nucleic Acids

References

1. Gray, P. 1958. Handbook of Basic microtechnique. Mcgraw-Hill.
2. Sass, J. E. 1967. Botanical Microtechnique, Oxford & IBH Publishing Co.
3. Baker, J. R. 1958. Principles of Biological Microtechnique.
4. Grimstone, A. V. and Skaer, A. V. 1972. A guide book to microscopical methods. Cambridge Univ. press.
5. Krishnamurthy, K. V. 1988. Methods in Plant Histochemistry.

VPBO1PL1: PRACTICALS OF PHYCOLOGY, BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS, MYCOLOGY AND LICHENOLOGY, MICROBIOLOGY, PLANT PATHOLOGY, ANGIOSPERM TAXONOMY, ANGIOSPERM EMBRYOLOGY, PALYNOLOGY AND LAB TECHNIQUES.

(0.5x10+1 for lab techniques=6 hours per week)

Phycology

1. Collection, preservation and preparation of algal herbarium (5 numbers).
2. Collection and study of the types mentioned below and their identification upto generic level using algal monographs:

   Chlorophyta: Pediastrum, Scenidesmus, Hydrodyctyon, Ulva, Cladophora, Pithophora, Bulbochaeta, Cephaleuros, Draparnaldiopsis, Bryopsis, Codium, Caulerpa, Halimeda, Desmids (Closterium, Cosmarium), Nitella.

   Xanthophyta: Botrydium.

   Bacillariophyta: Biddulphia, Coscinodiscus, Cymbella.

   Phaeophyta: Ectocarpus, Dictyota, Padina, Turbinaria.

   Rhodophyta: Batrachospermum, Gracilaria, Champia.

Bryology

1. Morphological and structural study of representative members of the following groups using whole mount preparations, dissections and transactions: Asterella, Targionia, Cyathodium, Lunularia, Pallavicinia, Dumortiera, Porella, Anthoceros, Sphagnum and Bryum.

Pteridology

1. Study of vegetative and reproductive features of Lycopodium, Ophioglossum, Angiopteris, Osmunda, Lygodium, Ceratopteris, Pteris, Asplenium, Blechnum, Cyathea, Gleichenia, Trichomanes, Salvinia and Azolla.
2. Study of the following fossils: Rhynia, Lepidodendron, Sphenophyllum, Calamites, Calamostachys, Zygopteris and Anachoropteris.
3. Spore germination and development of prothallus in Knop's Agar medium.
4. A study of Pteridophytes in their natural habitats.

Gymnosperms

1. Identification of petrifications, compressions, impressions: Lyginopteris,

Heterangium, Medullosa, Trignocarpus, Glossopteris, Caytonia, Pentaxylon and Cordaites.

2. Study of vegetative and reproductive structures of Zamia, Ginkgo, Pinus, Cryptomeria, Cupressus, Araucaria, Agathis, Podocarpus, Cephalotaxus, Ephedra and Gnetum.

Mycology

1. Critical study of the following types with the help of fresh/preserved materials by making suitable micropreparations giving emphasis on systematic position, details of vegetative and reproductive structures: Stemonitis, Saprolegnia, Phytophthora, Albugo, Mucor, Pilobolus, Xylaria, Saccharomyces, Chaetomium, Peziza, Puccinia, Auricularia, Polyporus, Ganoderma, Lycoperdon, Dictyophora, Geastrum, Cyathus, Aspergillus, Curvularia, Alternaria, Fusarium, Colletotrichum, Parmelia, Usnea.

Microbiology

1. Test for the presence of coliform bacteria in contaminated water.
2. Isolation of Eubacteria and Cyanobacteria from soil by dilution plate method.
3. Isolation of pure bacterial culture by streak plate method.
4. Staining of bacteria (negative staining, Gram staining and spore staining).
5. Demonstration of bacterial motility by hanging drop method.
6. Morphological studies on Scytonema, Aphanocapsa, Spirulina, Oscillatoria, Anabaena.

Plant Pathology

1. Lab study of the following diseases:

   Bunchy top of banana, Bacterial blight of paddy, Bud rot of coconut, Mahali of Arecanut, Powdery mildew of rubber, Abnormal leaf fall of rubber, tikka disease of Groundnut, Late blight of potato, Blister blight of tea, wheat rust, coffee rust, grey leaf spot of coconut, Phytophthora foot rot of pepper, rhizome rot of ginger and turmeric, angiospermic parasites – Viscum and Dendrophthoe.
2. Demonstration of technique of isolation and pure culture of pathogens.

Angiosperm Anatomy

1. Study of anomalous secondary growth in roots and stems of Aristolochia, Strychnos, Amaranthaceae, Nyctaginaceae, Bignoniaceae and Agavaceae.
2. Nodal anatomy of different types.
3. Leaf anatomy: epidermal peels and TS of lamina.

Embryology

1. Study of anther development of Datura.
2. Preparation of dissected whole mounts of microsporangium.
3. Study of megaspore mother cell, megaspore and embryosac.
4. Study of the receptivity of stigma and *in situ* germination of pollen.
5. Dissection of stages in the development of embryo and endosperm.
6. Pollen germination using hanging drop technique.
7. Demonstration of intra ovarian pollination.

Palynology

1. Analysis of honey for microscopic examination of pollen.
2. Calculation of percentage of viable pollen by using TZ test.
3. Study of pollen wall by acetolysis.

Lab Techniques

1. Measurement of microscopic objects - Micrometry.
2. Demonstration of Camera lucida drawing - calculation of magnification.
3. Double stained permanent sections - free hand section, Microtome serial sections.
4. Preparation of whole mounts, macerations and smears.
5. Submission of 10 permanent slides - which should include microtome serial sections, free hand sections, macerations, whole mounts and smears.

Practical records:

Submission of certified record of practicals at the time of terminal evaluation.

Field work:

3 days of field work for the *in situ* study of the types of the above areas of study and submission of a field report.

VPBO2C04: CELL BIOLOGY, MOLECULAR BIOLOGY AND BIOPHYSICS

(2.5 + 2.5 + 1 = 6 hours per week)

Cell Biology

1. The nucleus. Interphase nucleus – chromatin organization – nucleosomes, scaffold. Organization of eukaryotic chromosome. Heterochromatin – constitutive, facultative and condensed. Euchromatin. Satellite DNA. Chromosome banding and its significance.
2. Cell reproduction: Cell cycle. Specific events G1, S, G2 and M phases. Significance of G_0. Control of cell cycle. Significance. Gene expression during cell cycle. Mitotic Inducers.
3. Meiosis: types, synaptonemal complex, significance of meiosis. Genetic control and consequences of meiosis. Restriction points and check points. Cell cycle regulation of meiotic events – behavior of sex chromosomes in meiosis – suppression of DNA replication between Meiosis I and II. Meiotic defects and human diseases.
4. Programmed cell death – necessity, classes, signals. Genetic analysis of cell death. Proteins regulating apoptosis. Pathways leading to death – significance. Aging – cellular and extracellular. Cell signaling.
5. Cell interactions – communication, recognition and adhesion. Application.
6. Cellular differentiation and specialization. General characteristics, intrinsic interactions – Nucleo-cytoplasmic. Extrinsic interactions. Molecular mechanisms of cellular differentiations.
7. Cancer – carcinogenic agents. Phenotype of the transformed cell. Genetic basis of malignant transformation – oncogenes. Tumor suppressor genes. Cancer and cell cycle. Metastasis. Interaction of cancer cells with normal cells.

References

1. Cooper, G. M. 2000. The Cell – A Molecular Approach. ASM. Washington.
2. Karp, G. Cell Biology. 6th edition. John Wiley and Sons.
3. De Robertis, E. D. P. Cell and Molecular Biology. 8th edition. Lippincott Williams & Wilkins.
4. Pollard, T. D. and Earn Shaw, W. C. 2008. Cell Biology. Saunders elsevier.

Molecular Biology

1. Molecular biology of gene: Structure of DNA: Repetitive DNA; c-value paradox.

2. Replication of DNA: Enzymology of replication. Replication in prokaryotes and eukaryotes. Primosomes and replisomes. Telomerase and its function.
3. Gene expression: regulation of gene expression- Operon concept- Gene regulation in prokaryotes and eukaryotes- enhancers and silencers.
4. Protein synthesis: Transcription, post-transcriptional events. Inferons and their significance. Translation. Post translational events. Role of chaperons.
5. Mutation: Spontaneous and induced. Physical and chemical mutagens. Molecular mechanism of mutation. Mutation and cancer. Mutator and antimutator genes. DNA repairing mechanisms.
6. Molecular evolution: The origin of genomes. Evolution of new genes. Origin of eukaryotic genomes. Phylogenetics. Application of molecular phylogenetics.

References

1. Lewin, B. 1999. Genes. Oxford University press.
2. Brown, T. A. 2002. Genomes. John Wiley and Sons.
3. Snustad, D. P., Simmons, M. J. and Jenkins, J. B. 1997. Principles of Genetics. John Wiley and Sons.
4. Weaver, R. F. and Hedrick, P. W. 1992. Genetics. Wm. C. Brown Publishers.
5. Hawkins, J.D. 1991. Gene Structure and Expression. Cambridge University Press.

Biophysics

1. pH and buffer solutions- hydrogen ion concentrations and pH, dissociation of acids and bases. Measurement of pH using organic indicator molecule and potentiometric method. Functions of buffers in a biological system. Use of buffers in biological and biochemical research. pH and life. Henderson and Hasselbalch equation.
2. Chromatography: Principles of chromatography. Types of chromatography (Brief account).
3. Electrophoresis: Electrophoretic mobility, principles, PAGE, Agarose gel electrophoresis. Separation and detection of macromolecules by electrophoresis. Electrophoretic apparatus, technique and procedure.
4. Centrifugation - Theory of centrifugation. Centrifuge- Types, Methodology of centrifugation, applications.

5. Colorimetry and spectrophotometry: Beer-Lamberts law. Measurement of extinction. Calorimeters and spectrophotometers. Techniques and applications in biological and biochemical research. Comparison between colorimetry and spectrophotometry.
6. Radioblology: Autoradiography, principles, types. Methods and applications in biological research.
7. lmmunochemistry: Immune response. Antigens- Antibodies. Histo-incompatibility antigens; Structure of IgG. Immunochemical assays-RIA, ELISA.
8. Cryobiology: Freeze drying (lyophilization) - applications.

References

1. Hoppe, W., Lohmann, W., Markl, H. and Ziegler, H. (ed.). 1983. Biophysics. Springer Verlag.
2. Rogers, A. W. 1973. Techniques of Autoradiography. Elsevier.
3. Roy, R. N. 1996. A Text Book of Biophysics. New Central Book Agency Pvt. Ltd, Calcutta.
4. Sasidharan, A. 1984. Selected Topics of Biophysics. Frontier Area Publishers.
5. Slayter, E. M. 1970. Optical methods in Biology. Wiley-Intersciences.
6. Wong, C. H. 1965. Radiation Tracer Methodology in Biophysical Sciences. Prentice Hall.
7. Plummer, D. T. 2008. An Introduction to Practical Biochemistry. Tata McGraw Hill, New Delhi.

VPBO2C05: CYTOGENTICS, GENETICS, BIOSTATISTICS, PLANT BREEDING AND EVOLUTION (1+1.5+1.5+1+1=6 hours per week)

Cytogenetics

1. Cytogenetics of aneuplolds, euploids and structural heterozygotes: Effect of aneuploidy on phenotype. Transmission of monosomies and trisomics and their uses. Breeding behaviour and genetics of structural heterozygotes; translocation heterozygotes; Robertsonian translocation; B-A translocation. Karyotype- concepts and its importance. Structural chromosome aberrations- types and significance in evolution. Heteroploidy, aneuploidy, monosoly, trisomy (primary, secondary, tertiary and compensating). Nullisomy.Uses of aneuploidy in cytogenetics. Euploidy- autoploidy, alloploidy and segmental alopolyploic diploidization. Role of aneuploidy and euploidy in evolution.
2. Molecular cytogenetics: Multigenic families and their evolution; in situ hybridization-concept. Computer assisted chromosome analysis, chromosome micro-dissection and micro-cloning; flow cytometry.
3. Polytene and lamp brush chromosomes- cytogenetic importance.
4. Supernumerary chromosomes: B-chromosomes.

References

1. Alberts, B., Bray, D., Lewis, J., Roberts, K. and Watson, J. D. 1989. Molecular Biology of the Cell. Gart and Publishing Inc. New York.
2. Atherly, A. G., Girton, J. R. and McDonald, J. F. 1999. The Science of Genetics. Saunders College Publishing, Fort Worth, USA.
3. Burnham, C. R. 1962. Discussions in Cytogenetics. Burgess Publishing Co., Minnesota.
4. De Robertis, E. D. P. and De Robertis, E. M. F. 1987. Cell and Molecular Biology. Lee & Febiger, Philadelphia.
5. Dupraw, E. J. 1970. DNA and Chromosomes. Holt, Rinehart and Winston Inc., New York.
6. Hartl, D. L and Jones, E. W. 1987. Genetics: Principles and Analysis. Jones & Bartlett publishers, Massachusetts, USA.
7. Khush, G. S. 1973. Cytogenetics of Aneuploids. Academic Press.

8. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons, Inc. USA.
9. Lewin, B. 1997. Gene. Oxford University Press, New York, USA.
10. Lewis, R. 1997. Human Genetics: Concepts and Applications. WCB Mc Graw Hill, USA.
11. Malacinski, G. M and Freifelder, D. 1998. Essentials of Molecular Biology. Jones and Bastlet Publishers Inc., London.
12. Rieger, R., Michaelis, A. and Green, M. M. 1975. Glossary of Genetics and Cytogenetics -Classical and Molecular. Springer-Verlag, New York.
13. Swanson, C. P., Merz, T. and Young, J. W. 1967. Cytogenetics. Prentice Hall.

Genetics

1. Relevance of Mendelism in modem genetics. A critical evaluation of Mendelism on the basis of modem concept of genes.
2. Linkage and gene mapping. Three- point test cross; linkage map; interference; tetrad analysis and centromere mapping. Linkage in humans. Pedigree analysis. Genetic recombination and mapping of genes in bacteria and bacteriophages.
3. Mobile genetic elements: Transposable elements in bacteria. IS elements. Tn elements. Cmp site transposon. Cepia and P elements in Drosophila. Ac, DS and Mu elements in maize. Retrotransposons- Molecular characteristics and significance in development and evolution.
4. Extranuclear inheritance: Analysis of mitochondrial and chloroplast genomes and their utility. Cytoplasmic male sterility.
5. Quantitative genetics: Polygenic inheritance, heritability and its measurements. QTL mapping.
6. Population genetics: systems of mating. The Hardy-Weinberg principle. Estimation of gene frequencies. Factors affecting equilibrium: natural selection, mutation, migration and genetic drift.
7. Human genetics: Human pedigree analysis, Lod scores for linkage testing. Karyotype; genetic disorders.

References

1. Snustad, D. P., Simmons, M. J. and Jenkins, J. B. 1986. Principles of Genetics. John Willey and Sons.
2. Weaver, R. F. and Hedrick, P. W. 1992. Genetics. Wm. C Brown Publishers.
3. Goodenough, U. 1978. Genetics. Saunders College Publishing.
4. Stansfield, W. D. 1991. Schaum's Outline of Theory and Problems of Genetics. McGraw Hills.
5. Strickberger, M. W. 1985. Genetics. Macmillan.
6. Burnet, L. 1986. Essential Genetics. Cambridge University Press.
7. Friefelder, D. 2009. Microbial Genetics. Narosa Publishing House.
8. Gardner, E. J., Simmons, M. J. and Snustad, D. P. 1991. Principles of Genetics. John Wiley and Sons, New York, USA.
9. Singh, B. D. 1992. Fundamental of Genetics. Kalyani Publishers, New Delhi.

Biostatistics

1. The science of statistics and its applications in biological research.
2. Types and collection of data - Census; Sampling - theory and methods.
3. Tabulation and presentation of data - diagrammatic and graphic presentation.
4. Analysis of data - central tendencies.
5. Measures of dispersion - Range, quartile deviation, mean deviation, standard deviation and standard error. Relative measures of dispersion - coefficient of variation.
6. Tests of significance - formulation and testing of hypothesis- testing the probability of committing type 1 and type 2 errors, z test, t test, chi-square test.
7. Analysis of variance - one way classification and two way classification, F test, F value calculation, F table.
8. Correlation and Regression analysis - coefficient of correlation - significance testing. Rank correlation. Lines of regression - coefficient of regression.
9. Experimental designs - designing an experiment- CRD, RBD, LSD. Factorial experiments.
10. Probability - application of the principles of probability- theorems of probability- applications - Probability distributions- binomial, multinomial, normal and poisson distributions.

11. Statistical softwares - SPSS, SPAR, MINITAB.

References

1. Chandal, S. R. S. 2001. A Handbook of Agricultural Statistics. Achal Prakashan Mandir, Kanpur, India.
2. Das, M. N. and Giri, N.C. 1979. Designs and Analysis of Experiments. Wiley Eastern Ltd.
3. Elhance, D. N. and Elhance, V. 1996. Fundamentals of Statistics. D. K. Publishers.
4. Gupta, S. K. and Kapoor, V. K. 1980. Fundamentals of Mathematical Statistics. Sultan Chand & Sons, New Delhi.
5. Gupta, C. B. 1980. An Introduction to Statistical Methods. Vikas Publishing House Pvt. Ltd.
6. Kempthrone, O. 1957. An Introduction to Genetic statistics. John Wiley and Sons Inc. New York.
7. Mather, K. and Links, J. L. 1971. Biometrical Genetics. Chapman and Hall, London.
8. Panse, V. G. and Sukatme, P. 1995. Statistical Methods for Agricultural Workers. ICAR, New Delhi.
9. Rao, C. A. 1958. Advanced Statistical Methods in Biometrical Research. Wiley and Sons, New York.
10. Singh, P. and Narayanan, S. S. 1993. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.
11. Singh, R. K. and Chaudhary, B. D. 1985. Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi.
12. Daniel, W. W. 2009. Biostatistics- A foundation for Analysis in Health Sciences.

Plant Breeding

1. Introduction and objectives.
2. Organizations involved in plant breeding.
3. Breeding systems in sexually propagated plants- Floral Biology and its significance in plant breeding. Sterility and incompatibility systems.
4. Genetic resources- centers of crop genetic diversity. In situ and ex situ conservation; cryopreservation of germplasm.
5. Conventional methods of plant breeding:

6. Domestication of wild plats- changes under domestication.
7. Plant introduction- history, types, principles, plant introduction agencies in India- rules and regulations. Major achievements.
8. Selection- selection methods in sexually and vegetatively propagated species. Selection in segregating popultions. Major achievements.
9. Hybridization- history, objectives, techniques, consequences and major achievements.
10. Heterosis breeding- genetic basis of heterosis and inbreeding depression.
11. Modem methods of plant breeding:
12. Mutation breeding- history, methodology, applications, merits, demerits and achievements.
13. Polyploidy breeding- methodology, applications, merits, demerits and achievements.
14. Biotechnological approaches in plant breeding- Molecular markers and their uses- Transgenic plants- critical evaluation.
15. Breeding for special purposes: Resistance breeding- a brief account of disease resistance, pest resistance and stress resistance- achievements. Quality breeding- objectives and achievements.
16. Biometrical techniques in Plant Breeding- analysis of variability, heritability, genetic advance and combining ability.
17. IPR- Protection of plant variety and farmers' right act.

References

1. Allard, R. W. 1960. Principles of Plant Breeding. John Wiley and Sons, New Delhi.
2. Chahal, G. S. and Gosal, S. S. 2002. Principles and Procedure of Plant Breeding. Narosa Publishing House, New Delhi.
3. Jain, H. K. and Kharkwal, M. C. 2008. Plant Breeding- Mendelian to Molecular Approaches. Narosa Publishing House, New Delhi.
4. Roy, D. 2003. Plant Breeding- Analysis and Exploitation of Variation. Narosa Publishing House.
5. Hayward, M. D., Bosemark, N. O. and Romagasa, I. 1993. Plant Breeding- Principles and Prospects. Chapman & Hall.'
6. Gupta, S. K. 1986. Plant Breeding- Theory and Techniques. Agrobios (India), Jodhpur.
7. Khan, M. A. Plant Breeding. Biotech Books, New Delhi.

8. Stoskopf, N. C. 1993. Plant Breeding- Theory and Practice. Scientific Publishers (India), Jodhpur.
9. Sharma, J. R. 1994. Principles and Practices of Plant Breeding. Tata Mc Graw Hill.
10. Chopra, V. L. 1989. Breeding Field Crops. Oxford & IBH.
11. Mohanan, K. V. 2010. Essentials of Plant Breeding. PHI Ltd., New Delhi.
12. Mohanan, K. V. 2006. Essentials of Plantation Science. Penta Book Publishers, Calicut, Kerala.

Evolution

1. The concept of evolution- evidences of evolution- geological time scale and evolution.
2. Origin of life- theories and experimental evidences.- chemical evolution and biological evolution.
3. Evidences of evolution.
4. Theories of evolution - Pre-Darwinian, Darwinian and Post Darwinian theories.- Modem synthetic theory of evolution.
5. Reproductive isolation and the origin of species.
6. Evolution at the molecular level.

VPBO2C06: PLANT ECOLOGY, CONSERVATION BIOLOGY, PHYTOGEOGRAPHY AND FOREST BOTANY

(2.5+1.5+1+1= 6 hours per week)

Plant Ecology & Conservation Biology

1. Habitat Ecology: Salient features of terrestrial (Biomes), fresh water (Limnology), wet land and marine habitats.
2. Productivity and Energy flow: Concepts, limits and process of primary production; methods of productivity measurements: global trends in primary productivity, energy flow models.
3. Population characteristics: density, natality, mortality, distribution, biotic potential, carrying capacity, aggregation and dispersal, ecotone and edge effect.
4. The environment and its pollution- types (land, air and water). Effect on living organisms. Control with emphasis on biological methods. Environmental hazards.
5. Threats to the global environment- green house effect, ozone depletion, El-Nino and La Nina effects.
6. Environment impact assessment (EIA) and assessment of environmental hazards- remote sensing.
7. Problems of conservation; causes of threat to environment- human interference, deforestation, habitat destruction, overexploitation of resources.
8. Identification of threatened plants; red list categories- extinct, endangered, vulnerable, rare and out of danger. Extinction process. Hot spots, keystone species and flagship species.
9. Strategies for conservation: in situ and ex situ conservation, biosphere reserve, national parks, wildlife sanctuaries. Gene banks, cryopreservation, seed banks.
10. Afforestation- social forestry, agroforestry. International biological programme (IBP), Man and biosphere programme (MAB), IUCN, world environment day, wild life preservation act (1972), Indian forest (conservation) act (1980) and United Nations Environment Programme. Environment Protection Acts.
11. Environmental awareness- role of government and NGOs.-Gaia hypothesis
12. Biodiversity- significance at Local, National and Global levels. Deep ecology (Paradigm shift from anthropocentric ecology to ecocentric ecology. National heritages.

References

1. Negi, S. S. 2002. Hand book of National Parks and Sanctuaries in India.
2. Nair, M. P. and Sastry, P. K. 1987. Red data book of Indian plants.
3. Mehrotra, A. and Suri, B. K. 1994. Remote sensing for environment and forest management. New Delhi Indus Publishing Company.
4. Negi, S. S. 1992. Biosphere reserves in India.
5. Lucas, G. and Synge, H. 1978. IUCN Red data book. IUCN, Stockholm.
6. Dasman, R. F. 1968. Environmental Conservation.
7. Odum, E. P. 2005. Fundamentals of ecology.
8. Odum, E. P. Basic principles of ecology.
9. Misra, K. R. 1968. Ecology workbook.
10. Puri, G. S. 1983. Indian Forest Ecology. Volumes I and II. Oxford & IBH.
11. Clarke, G. L. 1965. Elements of Ecology.
12. Chhatwal, G. L. Encyclopedia of environmental biology.
13. Ray, P. K. 1995. Pollution and Health. Wiley-Eastern Ltd, New Delhi.
14. Michael, P. 1986. Ecological methods for field and laboratory investigations. Tata McGraw Hill, New Delhi.
15. Kershaw, K. A. 1973. Quantitative and Dynamic Plant Ecology. ELBS.

Phytogeography

1. Patterns of plant distribution: continuous distribution: circumpolar, circumboreal, circum austral, pan tropical.
2. Discontinuous distribution: Theory of land bridges, theory of continental drift, theory of glaciation.
3. Endemic distribution (neoendemic, paleoendemic), age and area hypothesis.
4. Phytochoria of world and India.

References

1. Good, R. 1953. The geography of flowering plants. Longmans, Green, London.
2. Bharucha, F. R. 1983. A text book of plant geography of India. Oxford University Press.
3. Puri, G. S. Indian Forest Ecology, Vol 1, 11. Oxford, New-Delhi.

Forest Botany

1. Forest- Definitions. Study of various types of forests in the world and in India.
2. Forest products-Major and minor with special reference to Kerala.
3. Influence of forests on environment. Consequence of deforestation and industrialization-sustainable utilization of bioresources.

References

1. Agarwal, A. P. 1953. Forests in India. Oxford & IBH.
2. Gregorv, G. R. 1971. Forest products, production, trade and consumption, quantity and value of raw materials requirements. Ford foundation, New-Delhi.
3. Puri, G. S. 1983. Indian Forest Ecology Vol. 1& 11. Oxford & IBH.
4. Champion, G. H. and Seth, S. K. 1968. A revised survey of the forest types of India.

VPBO2PL2: PRACTICALS OF CELL BIOLOGY, MOLECULAR BIOLOGY, BIOPHYSICS, CYTOGENETICS, GENETICS, BIOSTATISTICS, PLANT BREEDING, PLANT ECOLOGY, CONSERVATION BIOLOGY, PHYTOGEOGRAPHY AND FOREST BOTANY (0.5+0.5+0.5+0.5+1+1+0.5+0.5+0.5+0.25 + 0.25= 6 hours per week)

Cell Biology

1. Study of Mitosis in root tip cells.
2. Pre-treatment of root tips with colchicine/hydroxy quinoline/paradichlorobenzene and study of chromosomes in Chlorophytum/Zea mays/Crotalaria/Cyanotis.
3. Demonstration of isolation of plastids and mitochondria.
4. Chromosome banding

Molecular Biology

1. Working out problems from molecular genetics.
2. Isolation of plant DNA and its quantification by spectrophotometric/calorimetric method.
3. Demonstration of
    a) Isolation of nucleic acid and identification of histones by SDS-PAGE.
    b) Immunological techniques - ELISA and Western Blot.

Biophysics

1. Preparation of buffers and measurement of pH using pH meter.
2. Determination of isoelectric pH.
3. Paper chromatography: Separation of sugars.
4. Thin layer chromatography - separation of amino acid mixtures.
5. Calorimetric and spectrophotometric elimination of proteins by Biuret/Lowry's method.
6. Estimation of amino acid by ninhydrin method (colorimetric).

Cytogenetics

1. Induction of polyploidy using Colchicine; different methods of the application of Colchicine.
2. Effect of induced and spontaneous polyploidy on plant phenotype, meiosis, pollen and seed fertility and fruit set.
3. Preparation of karyotype and ideogram of plant meristematic cells.
4. Cytological studies in callus tissues
5. Study of meiosis in translocation heterozygotes (*Rheo discolor*)
6. Study of polytene chromosomes (Demonstration).

Genetics

1. Problems from linkage, tetrad analysis, quantitative genetics and population genetics.

Biostatistics

1. Problems from Mean, standard deviation, Coefficient of variation, tests of significance and correlation analysis and computer aided statistical analysis.

Plant Breeding

1. Study of floral morphology and flower structure in crop plants- rice, cashew, pulses, Solanum, Capsicum.
2. Practice of hybridization technique in self and cross pollinated plants mentioned in (2).
3. Biometrical techniques in Plant Breeding – analysis of variability.
4. Submission of certified report of visit to one plant breeding station in India.

Ecology and Conservation biology

1. Determination of food chains and food web in aquatic ecosystem.
2. Determination of the minimum size of the quadrat suitable for an area using species area curve method.
3. Determination of the Importance Value Index (IVI) of plant species in the community by quadrat, line and belt transect methods.
4. Comparative study of polluted and non-polluted aquatic ecosystems
5. Visit to a meteorological station, national park or wild life sanctuary, sewage treatment unit and major construction site.
6. Estimation of dissolved oxygen content in the water sample by Winkler's method.
7. Determination of primary production in water samples by light and dark bottle method (Winkler's method).
8. Determination of dissolved carbon dioxide content in water samples.
9. Determination of frequency of plant species of an area and heterogeneity of vegetation using transect method.

Phytogerography

1. Identification of the various floristic and vegetational regions of the world and India in maps.

Forest Botany

1. Study of the major and minor forest products of Kerala and their uses.

VPBO3C07: PLANT PHYSIOLOGY, METABOLISM AND BIOCHEMISTRY

(2+2+2 = 6 hours per week)

Plant Physiology

1. Water and plant cells: Properties of water, hydrogen bonding, polarity, cohesion and adhesion. The concept of water potential. Water movements in cells and tissues. Soil-plant atmosphere continum. Transpiration, stomatal movement, modern theories of stomatal mechanism. The ascent of xylem water and the uptake of water by roots. Absorption of mineral ions- solute absorption.
2. Plants and nitrogen: The nitrogen cycle. Biological nitrogen fixation, symbiotic nitrogen fixation in leguminous plants. Biochemistry of nitrogen fixation. Export of fixed nitrogen from nodules. Genetics of nitrogen fixation. Nitrogen assimilation, assimilation of nitrate. Nitrogen nutrition -agricultural and ecological aspects. Biosynthesis of amino acids- reductive amination and transamination. GDH and GS/ GOGAT pathway.
3. Photosynthesis: Absorption and fate of light energy, absorption and action spectra. Photoreceptors- chlorophylls, carotenoids, phycobilins. Bioenergetics and the light dependent reactions of photosynthesis. Photosynthetic electron transport and photophosphorylation. The two pigment systems, Z-scheme, water oxidizing clock. The photosynthetic carbon reduction cycle, C3, C2, C4 and CAM metabolism and ecological significance.
4. Tanslocation and distribution of photo assimilates. Phloem transport, Sources and sinks, mechanism of translocation. Phloem loading and unloading, distribution of assimilates. Translocation of xenobiotic chemicals.
5. Patterns in plant development: Growth, differentiation, and development. Genetic control and hormonal regulation of development. Seed germination- physiology of hormones in plant development- auxins, gibberellins, cytokinins, absciscic acid and ethylene. Role of vitamins and nutrients.
6. Photomorphogenesis: Phytochrome: chemistry and physiological effects. Mechanism of phytochrome and gene action. Cryptochromes and blue light effect.
7. Stress Physiology: Types of stress- water, temperature, salt, stresses caused by pests and pathogens and pollutants.

References

1. Hopkins, W. G. 2008. Introduction to Plant Physiology. John Wiley & Sons Inc.
2. Taiz, L. and Zeiger, E. 1991. Benjamin/Cumming Publishing Company Inc. New York.

Metabolism

1. Enzymes: General aspect, classification, Michaelis-Menton equation and its significance. Mechanism of enzyme action, co-enzymes, inhibition, regulation, allosteric enzymes, covalently modulated enzymes. Kinetics of enzyme catalysis. Isoenzymes.
2. Intermediary metabolism: Anabolism, catabolism, amphibolic pathways and anapleurotic reactions. Link–between primary metabolism and secondary metabolism. Bioenergetics and thermodynamics.
3. Catabolism of hexoses: Glycolysis- two phases, overall balance sheet, regulation; fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway- multifunctional pathway (significance). Tricarboxylic acid cycle: Formation of acetate, reaction of citric acid cycle, anapleurotic reactions of citric acid cycle. Regulation of citric acid cycle. Glyoxylate cycle. Amphibolic nature of TCA cycle.
4. Oxidation of fatty acids. Activation and entry of fatty acids, Beta oxidation of saturated and unsaturated fatty acids. Regulation.
5. Oxidation of amino acids and entry to TCA cycle.
6. Oxidative phosphorylation: Electron transfer reactions in mitiochondria. Electron carriers, multienzyme complexes, ATP synthesis. Regulation of oxidative phosphorylation. Shuttle systems- Alternate pathways - Thermogenesis.
7. Carbohydrate biosynthesis: Gluconeogenesis, biosynthesis of starch, glucose and other carbohydrates. Involvement of NDP- sugars. Regulation.
8. Lipid biosynthesis: Biosynthesis of fatty acids. Triacylglycerols, phospholipids and isoprenoids. Regulation.
9. Biosynthesis of nucleotides: PRPP and its significance. Purine and pyrimidine biosynthesis. Precursors and regulation. Conversion of NMP to NTP. Biosynthesis of deoxyribonucleotides.
10. Secondary metabolism: Main pathways and their relation to primary-metabolism.

References

1. Lehninger. 2008. Principles of Biochemistry, Macmillan, U.K.

2. Geoffrey Zubay. Biochemistry. Macmillan Publishing Company, New York.
3. Trevor Palmer. Enzymes- Biochemistry, Biotechnology and Clinical Chemistry. Norwood Publishing, Chichester.

Biochemistry

1. The molecular logic of life.
2. The chemical unity of diverse living organisms.
3. Weak interactions in aqueous systems and the fitness of the aqueous environment for living organisms.
4. Biomolecules: a- Carbohydrates- Classification, structure and functions of simple sugars and compound carbohydrates. Sugar derivatives of biological importance, b- Lipids. Classification- storage and structural lipids; lipids in membranes; the supramolecular architecture of membranes, c- Amino acids, peptides and proteins. Amino acids: classification based on polarity; properties. Covalent structure of proteins. Three dimensional structures of proteins. Protein- tertiary and quaternary structures. Denaturation and renaturation. Functions of protein, d- Nucleotides and nucleic acids. Chemistry- structures of nucleotides- Other functions of nucleotides.
5. Secondary metabolites: Secondary metabolites, their physiological roles. Significance- ecological and phylogenetic importance.

References

1. Lehninger. Principles of Biochemistry, Macmillon, U.K.
2. Geoffrey Zubay. Biochemistry. Macmillen Publishing Company, Newyork.
3. Sadasivam and Manickam. Biochemical Methods. New Age International Publishers. New Delhi.
4. David T. Plummer, An Introduction to Practical Biochemistry. Tata Mc Grow Hill.

VPBO3C08: ANGIOSPERM MORPHOLOGY, TAXONOMY AND PLANT RESOURCES (1+4+1 =6 hours per week)

Morphology

1. A study of the current ideas on the origin of Angiosperms with special reference to their ancestral stock, time and place of origin.
2. The concept of primitive angiosperm flower. Origin and evolution of flower, co-evolution of flowers vis- a-vis pollinators.
3. Origin and evolution of structure and morphology of stamens, nectarines and nectar.
4. Origin and evolution of carpels: different types- concept of foliar origin of carpels; types of ovary; evolution of placentation types- inferior ovary- foliar and axial concepts.
5. Role of floral anatomy in interpreting the origin and evolution of flower and floral parts

References

1. Eames, E. J. Morphology of Angiosperms. Mc Graw Hills Book Co. New York.
2. Barnard, C. T. 1961. The interpretation of Angiosperm flower. Aust. J. Sci. 24: 64-72.
3. Manilal, K. S. Vascularization of corolla in Compositae. J. lndian Bot. Soc. 59: 189-196
4. Meeuse, A. D. J. 1974. Some fundamental principles of interpretive floral morphology. Intemational Sci. Publ. Hissar.
5. Melville, R. 1960. New theory of Angiosperm flower. Nature 188: 14-18.
6. Puri, V. 1952. Inferior ovary. Phytomorpholgy 2: 122.
7. Spome, K. R. 1974. The Morphology of Angiosperms. Hutchinsons Uni. Press, London.

Taxonomy

1. Principles of Taxonomy- Scope and importance of Taxonomy; systems of classiication- artificial, natural and phylogenetic systems; phenetic versus phylogenetic systems; cladistics in taxonomy.
2. Conceptual basis of classification- essentialism, nominalism, empiricism, phenotics and cladistics. phylogenetic and alternative; concept of genus; concept of family; infraspecific categories.
3. Definitions and terms: primitive and advanced; homology and analogy; parallelism and convergence; monophyly and polyphyly.
4. Taxonomic hierarchy- concept of taxa- species, genus and family- infra specific categories.

5. Plant nomenclature: history of nomenclature; polynomial and binomial systems; detailed study of salient features and major provisions of the International Code of Botanical Nomenclature. Effective and valid publication, rank of taxa, rule of priority and its limitations, typification, author citation, rejection of names and names of hybrids. A brief account of International Code of Nomenclature of Cultivated Plants.
6. Concepts of character: definition, classification of characters- analytical and synthetic, qualitative and quantitative; unit and multiple, good and bad; correlation of characters; character weighting.
7. Modem trends in Taxonomy: cytotaxonomy, chemotaxonomy, biosystematics and numerical taxonomy. Molecular taxonomy- DNA bar coding in plants.
8. History and development of taxonomy in India. Classification of taxonomic literature- general indices, floras, icons, monographs, reviews-and journals; Herbarium- definition, steps involved in the development of herbarium- utility of herbarium and its maintenance- general account of regional and national herbaria with special reference to central National herbarium, Calcutta (CAL) and Madras Herbarium (MH). Botanical survey of India; Botanical gardens- types of gardens and importance of gardens in taxonomic studies- important national and international Botanical Gardens- Royal Botanical Garden, Kew; Indian Botanical Garden, Calcutta, National Botanical Garden, Lucknow, Tropical Botanic Garden, Trivandrum.

References

1. Cronquist A. Evolution and classification of flowering plants. Thomas and Nelson Co.
2. Cronquist. A. An integrated system of classification of flowering plants. New York.
3. Graf A.B. Tropica. Roehrs Company Publ. NJ, USA.
4. Harbome J.B. & Turner B.L. Plant chemosystematics. A.P., London.
5. Haywood W.H. & Moore D.M. Current concepts in plant taxonomy.
6. Rendle A.E. Classification of flowering plants.
7. Lawrance. G.H.M. Taxonomy of vascular plants. Oxford and IBH.
8. Sneeth P.H.A. Numerical taxonomy.W.H.Freeman Co., San Francisco.
9. Spome. K.R. The Morphology of Angiosperms. Hutchinson University Press, London.
10. Sivarajan V.V. Introduction to principles of plant taxonomy. Oxford and IBH.
11. Smith P.M. The Chemotaxonomy of plants. Edward Arnold, London.

12. Stace, C.A. Plant Taxonomy and Biosistematics.Edward Amord, London.
13. Takhtajan, A. L. Diversity and classification of flowering plants. Columbia University Press, New York. Woodland, D.W. Contempotary plant systematics. Prentice Hal, New Jersy.
14. Simpson M.G. Plant Systematics. Elsevier, Amsterdam.
15. Stebbins, G.L. Flowering Plants- Evolution above species level. Edward Amord, London.

Plant Resources

1. A study of history, occurrence, morphology of useful part and overall chemical composition of the following:
2. Cereals & millets: rice, wheat, maize, sorghum, finger millet, pearl millet.
3. Pulses: Bengal gram, cluster bean, common bean, horse gram, cow pea.
4. Sugar yielding plants: sugar cane, beet root.
5. Starch yielding tubers: potato, tapioca, arrow root, yam, taro.
6. Fats & Oils: ground nut, coconut, castor, gingelly, mustard, oil palm.
7. Beverages: tea, coffee, cocoa.
8. Spices and Condiments: pepper, ginger, turmeric, coriander, cumin, fennel, fenu-greek, cardamom, nutmeg, cloves, cinnamon.
9. Fibre yielding plants: cotton, jute, coir.
10. Rubber yielding plants: para rubber.
11. Timber yielding plants: teak, rose wood, Artocarpus, Ailanthes, Xylia.
12. A study of the following medicinal plants with reference to the chemical and pharmacognosic properties: neem, turmeric, Adhatoda, Rauwolfia, Catharanthes, Bacopa, nux-vomica, sweet flag, Saraca, wood apple, Indian myrobalans, liquorize.

References

1. Arora R. K. and Nayar, E. K. Wild relatives of crop plants in India. NBPGR Sci. Monograph No.7.
2. Bole, P. V. and Vaghani, Y. Field guide to common Indian trees. Oxford Uni. Press.
3. Chandel, K. P. S., Shukla, G. and Sharma, N. Biodiversity in medicial and aromatic plants in India - conservation and utilization. NBPGR, New Delhi.
4. Chripeels, M. J. and Sadava, D. Plants, food and people. W. Freeman & Co. San Francisco.

5. Conwqy, G. The doubly green revoluiion: food for all in the 21st century. Penguin Books.
6. CSIR. The useful plants of India. Publication and Information directorate, CSIR, New Delhi.
7. Kochar, S. L. Economic Botany of the Tropics. Macmillon India Ltd.
8. Nair, M. N. B. et al. (eds.) Sustainable management of non wood forest products. Faculty of \Forestry, Uni. Putra, Malaysia.
9. Padora, R. S. and Arora, R. K. Plant genetic resources and management. IPGRI Publication,
10. South Asia office, NBPGR, Pusa Campus, New Delhi.
11. Indian Science Academy. 1997. Plant wealth in India. Special issue of proceedings.
12. Sahni, K. C. The Book of Indian Trees. Oxford Uni. Press, Mumbai.
13. Sharma, O. P. Hill's Economic Botany. Tata Mc Graw Hill Co., New Delhi.
14. Swaminathan, M. S. and Kochar, S. L. (eds.). Plants and society. Macmillan Publication, London.
15. Thakur, R. S., Puri, H. S. and Husain, A. Major medicinal plants of India. Central Institute of Medicinal and Aromatic Plants, CSIR, Lucknow.

VPBO3C09: BIOTECHNOLOGY AND BIO INFORMAT ICS

(3+3= 6 hours per week)

Biotechnology

A. Plant Tissue Culture

1. Basic concepts and history.
2. General account of laboratory facilities and management.
3. Media for in vitro culture, composition and their preparation.
4. Callus culture- selection of explants and medium- types of callus- growth profile of callus.
5. Cell culture - isolation of single cells- mechanical and enzymatic methods- measurement of growth of cells in suspension culture- viability tests.
6. Large scale cultivation of cells using bioreactors for secondary metabolite production.
7. Organogenesis- direct and indirect- factors affecting organogenesis.
8. Organ culture - apical/ axillary meristems, embryo, ovary, ovule, endosperm, anther, pollen and root cultures.
9. Applications of plant tissue culture - clonal propagation, somaclones, somatic hybrids, synthetic seeds, secondary metabolites, germplasm conservation -cryopreservation.

B. Genetic Engineering

1. Molecular analysis of gene and gene products: southern, northern and western blots- restriction maps- RAPD and RFLP. Chromosome walking and jumping. FISH. PCR and its applications. DNA finger printing. DNA chips.
2. DNA sequencing: Enzymatic methods. Gilbert and Maxam method. Messing's shot gun method. Fluorescent detection and automation. The Human Genome Project.
3. Recombinant DNA Technology- Enzymes, vectors, gene-cloning strategies, construction and screening of gene and cDNA Libraries. Expression of cloned genes in bacteria and mammalian cells. Prospects and achievements.
4. Transgenic plants. Gene cloning strategies in plants. Vector dependent and vector independent methods. Identification and selection of transformed plants; the reporter enzyme technology.
5. Objectives and achievements- engineering for secondary metabolites; resistance against herbicides, pests, pathogens, stress - improved nutritional and status changes in plants.

Plants as bioreactors; phytopolymers and biodegradable plastics; antisense RNA technology; transgene inactivation. Terminator and traitor technologies.

6. Cloning: objectives. Creation of transgenic animals- other developments in cloning. Human cloning. Ethics of cloning.
7. Patenting of genes and GMOs. Gene piracy. Ethics and biosafety aspects, recDNA safety; IPR, biosafety protocols.

References

1. Walker, J. M. and Rapley, R. Molecular Biology and Biotechnology: Panima Publishing Corporation.
2. Glick, B. R. and Pasternack, J. J. Molecular Biotechnology Principles and Applications of Recombinant DNA. ASM Press Washington.
3. Brown, T. A. Gene Cloning and DNA Analysis Blackwell Science Pub:.
4. Primrose, S. B. Molecular Biotechnology. Panima Publishing Corporation.
5. Chrispeels, M. J. and Sadava, D. E. Plants, Genes and Agriculture. Jones and Bartlett Publishers.
6. de la Pemere, R. and Seuret, F. Brave New Seeds: The threat of GM crops to farmers. Global Issues Series.

Bioinformatics

A. Computer application.

1. Computer in Science with special reference to biology, the scope and prospects.
2. Information super highway (Internet) - Information net works: Internet, World Wide Web. Web browsers, HTTP, HTML and URLs. Biological networks.
3. Online publications with special reference to biology, -electronic journals, books, downloading and uploading.)- Open Archive Initiative (www.openarchives.org), biomedcentral, pubmedcentral, freedom of scientific information access, e-access debate- concepts and implications, Free Software Movement, Free Software Foundation, GNU/Linux, etc. Online archives, databases, the Public Library of Science (www.publiclibraryofscience.org).

References

Online resources freely available at Internet sites such as

www.publiclibraryofscience.org
www.openarchives.org

www.pubmedcentral.gov
www.biomedcentral.com
www.nature.com/nature/debates/e-ccess/index.html

B. Bioinformatics

1. Introduction: Importance and scope.

2. Biological Databases

a. Nucleic acid databases: EMBL, GenBank- structure of GenBank entries. Specialized genomic resources, UniGene.

b. Protein sequence databases: PIR, SWISS-PROT, TrEMBL.

Composite protein databases: NRDB, OWL.

Secondary databases: PROSITE, PRINTS, BLOCKS, IDENTIFY.

Structure classification databases- SCOP, CATH.

3. Database searching

a. Sequence database searching. EST searches. Different approaches to EST analysis. Merck/IMAGE, lncyte, TIGR. EST analytical tools. Sequence similarity, sequence assembly and sequence clustering.

b. Pair wise alignment technique: Comparison of sequences and sub-sequences. Identity and similarity. Substitution matrices, BLOSUM, DOTPLOT, BLAST.

c. Multiple alignment technique: Objective, Manual, simultaneous and progressive methods. Databases of multiple alignments. PSI-BLAST, CLUSTAL-W.

4. Protein structure Prediction:

a. Secondary structure prediction. Chou-Fasman, J Pred.

b. Tertiary structure prediction: Comparative modelling -Modeller, RasMol.

5. Emerging areas of Bioinformatics: DNA Microarrays, functional genomics, comparative genomics, pharmacogenomics, chemoinformatics, Medical informatics.

References

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

VPBO3PL3: PRACTICALS OF PLANT PHYSIOLOGY, METABOLISM, BIOCHEMISTRY, ANGIOSPERM MORPHOLOGY, TAXONOMY, PLANT RESOURCES, BIOTECHNOLOGY AND BIOINFORMATICS

(l+l+l+0.5+l+0.5+0.5+0.5= 6 hrs per week)

Plant Physiology

1. Determination of water potential by tissue weight change method.
2. Extraction of leaf pigments and preparation of absorption spectra of chlorophylls and carotenoids.
3. Demonstration of Hill reaction.
4. Separation of leaf pigments by paper chromatography and column chromatography.
5. Effects of light intensity on photosynthesis by Wilmot's bubbler.
6. Determination of sugars and amino acids in germinating seed by TLC.
7. Extraction of seed proteins based on solubility.
8. Biochemical analyses of leakages from seeds during germination.
9. Analyses of proline in water stressed plants.
10. Testing of seed viability by NBT test.
11. Changes in the reserve proteins during germination.

Metabolism

1. Extraction of enzyme: Any enzyme.
2. Effect of substrate on enzyme and determination of its Km value.
3. pH dependent activity profile of enzymes.
4. Ammonium sulphate precipitation of enzymes.
5. Desalting of proteins by gel filtration using Sophadex G25/ dialysis
6. Separation of isoenzymes by native PAGE.
7. Determination of enzyme / protein sub units by SDS PAGE.
8. Metabolism of germinating seeds - changes in metabolisable carbohydrates.

Biochemistry

1. Qualitative tests for monosaccharides, reducing and non reducing oligosaccharides, starch, amino acids and protein.
2. Quantitative estimation of reducing sugars and starch.

3. Qualitative tests for lipids. Emulsification, saponification, acrolein test, Boundouin's test.
4. Quantitative estimation of amino acids.
5. Quantitative estimation of protein by Biuret / Branford's /Lowry et al method.
6. Quantitative estimation of DNA and RNA (colorimetric / spectrophotometric)
7. Quantitative estimation of total phenolics.

Morphology

1. Preparation of cleared whole mounts of floral parts to show vasculature.
2. Examination of the following with the help of dissections and hand sections: Transmitting tissues/canals in style and stigma; Different types of ovaries; Different types of placentation, vasculature of androecium and gynoecium in special types of flowers.

Taxonomy

1. Familiarization with local flora and construction of keys - use of floras in identification up to species.
2. Study of diagnostic features of the families studied in the theory paper with special reference to their economic aspects.
3. Study of the following families with special reference to morphology of modified parts, economic importance, interrelationships and evolutionary trends:

a. Magnoliaceae, Ranunculaceae, Menispermaceae, Nymphaeceae, Polygalaceae, Caryoplyllaceae, Clusiaceae, Sterculiaceae, Meliaceae, Sapindaceae, Rosaceaea, Melastomaceae, Rhizophoraceae, Aizoaceae, Rubiaceae, Sapotaceae, Gentianaceae, Boraginaceae, Convolvulaceae, Scrophulariaceae, Pedaliaceae, Verbenaceae, Nyctaginaceae, Euphorbiaceae, Urticaceae, Casuarinaceae, Orchidaceae, Zingiberaceae, Amaryllidaceae, Commelinaceae, Araceaea, Cyperaceae and Poaceae.

4. Dissection of at least two members of each family in the laboratory, making suitable sketches, describing them in technical terms and identifying them constructing appropriate floral diagrams.
5. Field study of five days under the guidance and supervision of teachers at an ecologically different locality and submission of a field study report certified by the teacher concerned. The report should contain ecology of flora of the area studied. Each

student shall collect plant specimens following the standard means of plant collection for preparation of herbarium. Each student shall submit a minimum of 50 such herbarium specimens along with the field book for the Practical examination.

6. Problems in Bar Coding

Plant Resources

1. Morphological study of the source plants mentioned in the theory syllabus and identification of the plants and plant products.

Biotechnology- A. Tissue Culture.

1. Preparation and sterilization of culture media.
2. Culturing of Carrot /Tobacco/Datura.
3. Estimation of cell growth in callus culture by fresh wt. and dry wt.
4. Induction of multiple shoots using axillary and apical meristems as explants.
5. Plantlet regeneration from callus.
6. Identification of secondary metabolites in cultures.

Biotechnology- B. Genetic Engineering

1. Isolation of DNA.

Bioinformatics- A. Computer Application

1. Acquiring basic computer operation and internet browsing skills in Windows and Linux platforms.
2. Acquiring basic word processing/ data entry skills using popular (both commercial and open source) packages such as MS-Word, K-Word, Open Word, PageMaker.
3. Acquire graphic processing skills using popular packages such as Photoshop, Corel Draw, Chem Draw.
4. Preparation of scientific presentations using packages such as MS-PowerPoint.
5. Use of statistical packages such as SPSS, Biostat, Origin, MS-Excel.

B. Bioinformatics

1. Acquisition of basic skills in Internet browsing
2. Use of web browsers and search engines.
3. Use of biological and bioinformatic websites Agris, Agricola, BIOSIS, CABWeb.
4. Visit to Bioinformatics websites: NCBI, SWISS PROT, PIR, PDB.

VPBO4E01: Elective I: To be selected by the centre from the list appended.

(4 hours per week)

VPBO4E02: Elective II: To be selected by the centre from the list appended.

(4 hours per week)

VPBO4EPL1: Practicals of Elective I. **(3 hours per week)**

VPBO4EPL2: Practicals of Elective II. **(3 hours per week)**

VPBO4PR: DISSERTATION **(10 hour per week)**

VPBO4V: VIVA VOCE

List of electives for M. Sc. Botany CSS Programme

VPBO4E01	Environmental biology and biodiversity conservation
VPBO4E02	Plant tissue culture
VPBO4E03	Genetic engineering
VPBO4E04	Genomics and proteomics
VPBO4E05	Pathology of plantation crops and spices
VPBO4E06	Genetic engineering and bioinformatics
VPBO4E07	Molecular plant taxonomy
VPBO4E08	Biotechnology in crop improvement
VPBO4E09	Plant cell and molecular biology

Elective I.

ENVIRONMENTAL BIOLOGY AND BIODIVERSITY CONSERVATION

1. Population ecology: Properties (concepts of rate, intrinsic rate of natural increase, carrying capacity, population fluctuations and cyclic oscillations, density independent

and density dependent mechanisms of population regulation, patterns of dispersion, Allee principle of aggregation and refuging, home range and territoriality, energy partitioning and optimization, *r* and K selection.

2. Community ecology: Types of interaction between two species, coevolution, evolution of cooperation, group selection, interspecific competition and coexistence, positive and negative interactions, concepts of habitat, ecological niche and guild.
3. Human population: Expansion and its causes, rich and poor nations, consequences, dynamics, Cairo conference 1994.
4. Major global environmental challenges: Acid rain, Ozone depletion, climate disruption, deforestation, land degradation and desertification, freshwater degradation and shortage, marine fisheries decline, loss of biological diversity and excess nitrogen.
5. Global initiatives: Stockholm conference (1972), Rio (1992), Ramsar convention (1971), Kyoto (1997), Johannesburg (2002), Stockholm (2011).
6. Environmental Law- International and National: The Environment Protection Act & Rules 1986: Water (Prevention & Control of Pollution) Act 1974: Biodiversity Act (2002).
7. Thoughts on ecology: Contributions of Buddha, Rabindranatha Tagore, Mahatma Gandhi, Rachel Carson, Gro Herlem Brundtland, Vandana Siva, Edward O Wilson, Aldo Leopald.
8. Biodiversity: a). Genetic diversity, agrobiodiversity and cultivated taxa, causes of decline, value of wild species, conservation practices- traditional (*upavana vinoda*, sacred groves, *sthalavrikshas)* and modem *(in situ* and *ex situ)*, b). Biodiversity information management and communication- libraries, databases (taxonomic database working groups for plant sciences, data bases on biodiversity): distribution of biodiversity information, meta databases, virtual libraries.
9. Ecosystem capital- use and restoration: Global perspective on biological systems: conservation, preservation and restoration. Biomes and ecosystems under pressure (forest biomes, ocean ecosystems).
10. Habitat studies: Wetlands (Ramsar sites), mangroves and forest types of Kerala.
11. Brief study of the following: Cybernetics, ecological foot print, sustainable development, deep ecology, Gaia hypothesis, conservation ethics, peoples' movements

for biodiversity conservation, role of NGOs and educational institutions in biodiversity conservation, trade related IPR, ecotourism.

12. Climate change and its impacts- brief study.
13. Disaster management- basic aspects.

PRACTICALS

ENVIRONMENTAL BIOLOGY AND BIODIVERSITY CONSERVATION

1. Studies on the following and submission of reports: Waste water treatment plant, local environmental peculiarities (such as hillocks and forest patches), wet land ecosystem, alien invasive plants, degraded ecosystem, different forest types,_effluent treatment system.
2. Physical and chemical analysis of soil and water: Particle size analysis of soil, estimation of particle density using relative density or volumetric flask: Air capacity analysis of soil by field method: Soil pH analysis of soil using pH meter. Water analysis for pH using pH meter, estimation of BOD by Winkler's method (dark and light bottles).
3. Study of community structure: Charting and mapping of vegetation, Raunkiaer's life forms, biological spectrum, profile diagram (soil).
4. Study of ecological succession: Different types of ecological successions.

References

1. Champion H. G. and Seth S. K. A Revised Classification of Forest Types of India. Govt. of India, New Delhi.
2. Gadgil Madhav. Ecological Journeys. Permanent Black, Delhi.
3. Jaiswal P. C. Soil Plant and Water Analysis. Kalyani Publishers, Ludhiana.
4. Krishnamurthy K. V. An Advanced Text Book on Biodiversity Principles and Practice. Oxford IBH.
5. Misra R. Ecology Workbook. Oxford IBH.
6. Odum E. P. and Barrett G. W. Fundamentals of Ecology. Thomson Books, Bangalore.
7. Palmer J. A. Fifty Thinkers on the Environment. Routledge, London.
8. Puri G. S. Indian Forest Ecology. Oxford IBH.

9. Pushpangadan P. and Nair K. S. S. Biodiversity and Tropical Forests- The Kerala Scenario. STEC, Thiruvananthapuram. Sarngdharacharyar. (Translated by Vishnu B.). *Vruksha ayurvedam* Janapriya Pusthakasala, Kottayam.
10. Sivadasan M. and Mohanan K. V. Biodiversity and Ecology: Concepts and Facts. Department of Botany, University of Calicut, Kerala.
11. Speth Gustave James and Haas M. Peter. Global Environmental Governance. Pearson Longman, New Delhi.
12. Vijayalakshmi K. and Shyam Sundar K. M. Vrkshayurveda- An Introduction Indian Plan Science. Lok Swasthya Parampara Samvardhan Samithi, Madras.
13. Wright T. Richard. Environmental Science- Towards a Sustainable Future. Prentice Hall Learning Pvt. Ltd., New Delhi.

ELECTIVE II.

PLANT TISSUE CULTURE

1. Tissue culture- plant tissue culture- techniques and significances of embryo, endosperm and haploid plant culture. Techniques and significances of cell and protoplast culture.

2. Tissue culture as a biotechnological tool- clonal propagation, somatic embryogenesis, synseed production and exploitation of somaclonal variations.
3. Culture media- liquid, semisolid, raft- MS, WPM, White's, Nitsch & Nitsch, SH- a comparative study. Media for special purposes- modifications, additives- antioxidants, organic supplements, adsorbants.
4. Hormones- role of hormones in phytomorphogenesis *in vitro* and *in vivo*- mode of action of hormones- synergistic action.
5. Commercial clonal propagation- requirements, management- production planning- man power- contamination- endophytes as contaminants in tissue cultures- in process quality control.
6. Hardening of TC plants- primary and secondary- green house- poly house- shade house- pots. Media for hardening- management of TC plants.
7. Bioreactor technology for plant micropropagation- photoautotrophic micropropagation.
8. Secondary metabolite production- objectives and achievements.
9. Commercial tissue culture production of trees: Eucalyptus, Teak, Bamboo; crops: Banana, Potato, Papaya; flower crops: Orchids, Anthurium, Gingers.
10. Virus indexing of tissue cultured plants- ELISA, PCR based indexing- methodology and importance.
11. Value addition in TC plants- inoculation of VAM and other endophytes.
12. Certification of TC plants.
13. Farmer's acceptance of TC plants- lab to land awareness.
14. Costing- cost benefit analysis- cost reduction measures and low cost alternatives.
15. Marketing of TC plants.
16. Major tissue culture ventures in India and abroad- success stories.

PRACTICALS

PLANT TISSUE CULTURE

1. Media preparation- culture initiation- clonal multiplication- rooting- hardening and filed transfer in the case of one plant species.

2. Callus induction and organogenesis in the case of one plant species.
3. Synseed production in the case of one plant species.
4. Suspension culture and its microscopic examination for morphological features and viability in the case of one plant species.
5. Preparation of commercial TC planting material production plan for a crop species.
6. Visit to a commercial TC firm and submission of a report.
7. Preparation of a project report for a commercial TC unit.

References

1. Bajaj, Y. P. S. (ed.). High Tech Micropropagation. Springer.
2. Biotech Consortium India Ltd. Summary Report on Market Survey on Tissue Cultured Plants.
3. DBT, Govt. of India. National Certification System for Tissue Culture Raised Plants.
4. Dutta, G. S. and Ibaraki, Y. (ed.). Plant Tissue Culture Engineering. Springer.
5. George, E. F., Hall, M. A. and Klerk Geert -Jan De. Plant Propagation by Tissue Culture. Springer.
6. George, E. F. and Sherrington, P. D. Plant Propagation by Tissue Culture. Exegetics Limited.
7. IAEA. Low-cost Options for Tissue Culture Technology in Developing Countries.
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12. Razdan, M. K. Plant Tissue Culture. Science Publishers Inc., U.S.A.
13. Robert, N. T. and Dennis, J. G. (eds.) Plant Tissue Culture, Development and Biotechnology. CRC Press. ' '
14. Ziv, M. 2000. Bioreactor technology for plant micropropagation. Horticultural Reviews 24: 1 -30.

ELECTIVE III.

ADVANCED ANGIOSPERM TAXONOMY

1. Need and importance of taxonomy. Aspects of tyaxonomy (identification, nomenclature, classification, systematics, molecular systematics, phases of taxonomy

(exploration, consolidation, experiment or biosystematics, encyclopedic or holotaxonomy).

2. Plant identification: Methods, taxonomic keys- dichotomous (indented, bracketed), polyclave.
3. Plant nomenclature; ICBN- BRIEF HISTORY, St. Louis Code (outline, principles, rules and recommendations, provisions for the governance of the code).
4. History and systems of plant classification:
   a) Ancient Greeks, Middle ages, Herbalists, Pre and Post Linnaean. Evolutionary and Phylogenetic systems
   b) Types of classification; systems developed by Bessy, Engler, Hutchinson, Cronquist.
5. Botanical garden: role, special types. Major botanical gardens of the world and India.
6. Taxonomy as a synthetic subject: taxonomy in relation to morphology, cytology, palynology, phytochemistry and serology.
7. Numerical taxonomy: Principles, steps for the construction of taxonomic groups. Merits and demerits.
8. Brief study of the following: phonetic method, phyletic method. Floral imaging (digital photography).
9. Phytogeny of angiosperms: Evolutionary trends; transitional- combinational theory.
10. Electronic herbarium and digital database preparation (DELTA).
11. Geographical distribution of plant families, endemic families, dispersal of plants.
12. Contributions of van Rheede, J D Hooker, Wiliam Roxburgh, Nathaniel Wallich, Richard Henry Beddome, E K Janaki Ammal, K M Mathew, Cecil J Saldanha, V V Sivarajan.
13. Study of the following families in detail giving importance to morphology of the modified parts, economic importance, interrelationships and evolutionary trends: Magnoliaceae, Cruciferae, Caryophyllaceae, Dipterocarpaceae, Tiliaceae, Malphigiaceae, Celastraceae, Rhamnaceae, Moringaceae, Droseraceae, Rhizophoraceae, Begoniaceae, Plumbaginaceae, Ebenaceae, Oleaceae, Lentibulariaceae, Bignoniaceae, Polygonaceae, Aristolochiaceae, Piperaceae, Loranthaceae, Dioscoriaceae, Pandanaceae, Typhaceae, Eriocaulaceae.

PRACTICALS

1. Preparation of checklist of a particular area.
2. Phenology of at least 10 species.
3. Programming DELTA of at least 20 species with images.
4. Study of at least two plants each of the above listed families.
5. Preparation of key to at least 10 species of any families studied in PG core course.
6. Preparation of 50 herbarium sheets of plants of the above families.
7. Study tour to a forest or any other special ecosystem in South India and submission of tour report.

References

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3. Sivarajan, V. V. and Robinson. Introduction to the Principles of Plant Taxonomy. Oxford IBH.
4. Greuter, W. et al. International Code of Botanical Nomenclature. St. Louis Code. Koeltz Scientific Books, Konigstein.
5. Jain, S. K. and Rao, R. R. A hand book of Field and Herbarium Methods. Today & Tomorrow Publications, New Delhi.
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7. David, P. H. and Heywood, P. H. Principles of Angiosperm Taxonomy. Oliver & Boys, London.
8. Good, R. The Geography of Flowering Plants. Longman, London.
9. Hutchinson, J. Genera of Flowering Plants. Cambridge University Press, London.
10. Mayr, E. This is Biology. University Press, Hyderabad.
11. Naik, V. N. Taxonomy of Angiosperms. Tata Me Graw Hill, New Delhi.
12. Mabberley, D. J. The Plant Book. Cambridge University Press, London.

ELECTIVE IV.

GENETIC ENGINEERING

1. Structure of genes in prokaryotes and eukaryotes. Genetic code and codons. Gene expression.

2. Recombinant DNA technology: Tools of rDNA technology, methods of creating rDNA molecules, restriction mapping, isolation and separation of genetic material, southern, northern, western, southwestern and northwestern blotting techniques.
3. Gene transfer techniques in plants- Agrobacterium mediated transfer, gene gun method, electroporation, micro injection, chemical methods.
4. Molecular markers- RAMPO, SSCP, RFLP, RAPD, AFLP, EST markers, Repetitive DNA, Microsatellite and Minisatellite.
5. DNA sequencing- chemical and enzymatic methods. Importance of DNA sequencing.
6. Gel electrophoresis- techniques for visualization and reading sequences.
7. Polymerase Chain Reaction- history, methodology of PCR. Variations from Basic PCR- reverse transcriptase PCR, nested PCR, inverse PCR- applications of PCR.
8. DNA profiling- history, methodology of genetic fingerprinting- applications.
9. Genetic engineering for crop improvement - transgenic plants.
10. Cloning of genes and production of vaccines, drugs, growth hormones and chemicals.
11. Gene therapy- types of gene therapy. Getting transgenes in to patients- viral and non viral approaches. Success of gene therapy.
12. Abatement of pollution through genetically engineered microorganisms- an emerging approaches towards environmental cleanup programmes.
13. Nanotechnology and its applications in genetic engineering.

PRACTICALS

1. Working out problems in genetic engineering.
2. Isolation of plant DNA and its quantification by spectrophotometer.
3. Isolation of plasmid DNA from E. coli.
4. Gel electrophoresis- gel preparation, casting, elution and staining.
5. Visualization of DNA by agarose gel electrophoresis and gel reading.
6. Construction of coding sequence of DNA using amino acid sequence.

References

1. Hartl, D. L. and Jones, E. W. Genetics- Analysis of genes and genome. Jones and Bartlett Publishers.
2. Desmond, S. T. N. An Introduction to Genetic Engineering. Cambridge Pub.

3. Brown, T. A. Gene Cloning and and DNA Analysis. Blackwell Science Pub.
4. Dubey, R. C. A Text Book of Biotechnology. Chand Pub.
5. Singh, B. D. Biotechnology. Kalyani Publishers.
6. Walker and Rapley. Molecular Biology and Biotechnology. Panima Pub.
7. Chrispeels, M. J. and Sadava, D. E. Plants, Genes and Agriculture.
8. Lewin, B. Genes. Oxford University Press.
9. Mason, A. C. Principles of Gene Manipulation and Genomics.
10. Rissler, J. and Mellon, M. The Ecological Risks of Engineered Crops. MIT Press, Cambridge.
11. Avice, J. C. The Hope, Hype and Reality of Genetic Engineering.
12. McYan, R. P. Genetics and Genetic Engineering. Saras Publications.
13. Narayana, L. M. Molecular Biology and Genetic Engineering.
14. Khadpekar, N. R. The Age of Nanotechnology. ICFAI University Press, Hyderabad.
15. Nalwa, H. R. Encyclopedia of Nanoscience and Technology.

ELECTIVE V.

GENOMICS AND PROTEOMICS

1. Comparative and functional genomics: whole genome sequencing- organisms picked for genome sequencing- protein functions from genome sequence- protein sequencing

and annotated genome online.

2. Organising a large scale sequencing project: Hierarchical or 'BAC to BAC' genome sequencing- whole genome shotgun sequencing- resequencing- sequence data banking and annotation.
3. Pattern matching: basic tools of bioinformatics- sequence alignment- defining the optimum alignment- pattern matching in three dimensional structures- classification and assignment of protein function.
4. Development of databanks in molecular biology: nucleic acid sequence databases- genome browsers- databases of genetic diseases- OMIM- databases of structure.
5. Classification of protein structure: Boutique databases- databases of metabolic pathways- expression and proteomics databases- molecular biology databases and servers.
6. Microarrays: analysis of microarray data- expression patterns in different physiological states- the dauxic shift in *Saccharomyces cerivisiae*- sleep in rats and fruit flies- expression pattern changes in development- variation of expression patterns during the life cycle of *Drosophila melanogaster*- flower formation in roses- evolutionary changes in expression- application of microarrays- development of antibiotic resistance in bacteria.
7. Proteomics: protein nature and types- protein structure- separation and analysis of proteins- PAGE and Mass spectroscopy- classification of protein structures- SCOP- changes in folding patterns in protein evolution.
8. Protein structure prediction and modeling: homology modeling- available protocols- directed evolution and protein design- directed evolution of Subtilisin E- enzyme design- protein complexes and multisubunit proteins.
9. Systems biology: Introduction- pictures networks as graphs- dynamic stability and robustness- sources of ideas for systems biology- Shannon's definition of entropy- randomness of sequences- static and dynamic complexity- computational complexity- metabolic net works and protein interaction networks- protein-DNA, protein-protein, protein-nucleic acid interactions- regulatory networks- lac operon- signal transduction and transcriptional control- structure of regulatory networks- genetic regulatory networks in *Saccharomyces cerivisiae.*

10. Ethical consequences of genomic variation.

PRACTICALS

1. Annotation projects in plants- rice (RGAP)
2. Interpretation of automated DNA sequence data from chromatogram.
3. DNA sequence alignment using any standalone software.
4. Protein structure elucidation from DNA sequence data and prediction of secondary and tertiary structure using protein databases.
5. Data mining for unique phenotypes in plants/ animals/ humans.
6. Microarray data analysis.
7. PAGE for total protein analysis.
8. Familiarising conformation of proteins.
9. Online homology modeling of a given protein.

References

1. Anolles, G. C. Evolutionary Genomics and Systems Biology. Willey Black well.
2. Lesk, A. M. Introduction to Protein Science. Oxford University Press.
3. Lesk, A. M. Introduction to Genomics. Oxford University Press.
4. Lee, M. T. Analysis of Microarray Gene Expression Data. Springer.
5. Subramanian, C. Analyzing Genome. Dominant.

ELECTIVE VI.

PATHOLOGY OF PLANTATION CROPS AND SPICES

1. Principles of plant pathology.
2. Major pathogens of crop plants.

3. Major pests of crop plants.
4. Fungicides- contact, semi systemic and systemic- antibiotics- chemistry, mode of application and mode of action- effects and side effects.
5. Bactericides- chemistry, mode of application and mode of action.
6. Pesticides- chemistry, mode of application and mode of action.
7. Biocontrol agents of disease management- fungal and bacterial products- mode of application and mode of action.
8. Botanicals as plant protectants- major sources, active principles, mode of application and mode of action.
9. Integrated pest and disease management.
10. Etiology and control measures of the following diseases: Bud rot of coconut, stem bleeding of coconut, nut fall of arecanut, foot rot of black pepper, anthrachnose of black pepper, fungal soft rot of ginger, bacterial wilt of ginger, rhizome rot of cardamom, capsule rot of cardamom, abnormal leaf fall of rubber, pod rot of cocoa.

PRACTICALS

1. Isolation of fungal and bacterial pathogens of the above diseases, growing them in appropriate nutrient media and identification of the pathogens and preparation of drawings and photographs.
2. Field collection and preservation of the infected parts in the case of the above diseases and preparation of morphological and microscopic drawings and photographs and identification of the diseases at field and lab levels.
3. Study of disease cycle of a pathogen in any one of the above crop plants and demonstration of Koch's postulates and preparation of an illustrated report.
4. Visit to two crop research stations and first hand acquaintance with the major plant protection activities in the station and submission of reports/ or lab placement training in the plant protection division of a crop research station for a period of 30 days and submission of a report.

References

1. Rangaswami, G. Diseases of Crop Plants in India. Prentice Flail of India, New Delhi.
2. Singh, R. P. and Singh, U. S. Molecular Methods in Plant Pathology. CRC, Lewis.
3. Agrios, G. N. Plant Pathology. Academic Press INC., NY.

4. Mehrotra, R. S. Plant Pathology. Tata Mc Graw Hill Publication, New Delhi.
5. Johnson, L. F. and Curl, E. A. Methods for Research on the Ecology of Soil Borne Plant Pathogens. Burgress Publishing Company, U.S.A.
6. Dhingra, O. D. and Sinclair, J. B. Basic Plant Pathology Methods. Academic Press, NY.
7. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International Publishers, New Delhi.
8. Pelczar, Jr., Michael, J. Microbiology. Tata Mc Graw Hill Publication, New Delhi.
9. Nair, L. N. Topics in Mycology and Plant Pathology. New Central Book Agency (P) Ltd., Kolkata.
10. Waller, J. M., Lenne, J. M. and Waller, S. J. Plant Pathologists' Pocket Book. CABI Publication, NY.
11. Riker, A. J. and Riker, R. S. Introduction to Research on Plant Diseases. John S. Swift Co., St. Louis, MO.

ELECTIVE VII.

GENETICS AND CROP IMPROVEMENT

1. General account of origin, variability, floral biology, propagation, breeding techniques, crop management and major R&D bottle necks in the case of the following crops: rice, wheet, maize, jowar, tea, coffee, rubber, cardamom, coconut, arecanut, oil palm, cocoa, cashew, pepper, ginger, turmeric, vanilla.
2. Detailed account of crop research institutes under CGIAR, ICAR and Commodity Boards.
3. Crop genetic resources- conservation and utilization. Centres of origin of cultivated plants- primary and secondary centres of diversity. Gene banks- international and national networks of gene banks.
4. Systems of reproduction and mating systems in crop plants.
5. Conventional methods of plant breeding- plant domestication, introduction, selection and hybridization.
6. Modem methods of plant breeding- mutation breeding, polyploidy breeding, distant hybridization and biotechnological approaches.
7. Resistance breeding- breeding for biotic and abiotic stress resistance.
8. Genetics of photosynthesis.
9. Genetics of nitrogen fixation.
10. Patenting of life forms- IPR, farmers' rights and plant breeders' rights.
11. Production of improved seeds- seed certification- procedure for variety release.
12. Farming systems- intensive, organic and integrated- sustainable agriculture.
13. Genetically modified crops- major achievements- merits and demerits- biosafety.

PRACTICALS

1. Morphological and floral studies of major crops.
2. identification of crop species/ subspecies/ varieties of the above crops.
3. Identification of the major pests and diseases of the above crop plants and submission of specimens.
4. Study of chemical composition and use of major pesticides, weedicides, fungicides and other plant protection formulations.
5. Visit to two major plant breeding stations of South India and submission of a certified

report/ or placement training at a plant breeding institute for 30 days and submission of a certified report.

References

1. Dalbholkar, A. R. Elements of Biometrical Genetics. Concept Publishing Company.
2. Frankel, O. H. and Bennet, E. Genetic Resources in Plants. Black Well.
3. Sadhu, M. K. Plant Propagation. New Age International Publishers.
4. Allard, R. W. Principles of Plant Breeding. John Wiley & Sons.
5. Jain, H. K. and Kharkwal, M. C. Plant Breeding. Narosa Publishing House.
6. Chahal, G. S. and Gosal, S. S. Principles and Procedures of Plant Breeding. Narosa Publishing House.
7. Roy, D. Plant Breeding. Narosa Publishing House.
8. Hayward, M. D., Bosemark, N. O. and Romagosa, I. Plant Breeding- Principles and Prospects. Chapman and Hall.
9. Gupta, S. K. Plant Breeding. Agrobios India.
10. Khan, M. A. Plant Breeding. Biotech Books.
11. Sharma, J. R. Plant Breeding. Tata McGraw Hill.
12. Joshi, R. M. Biosafety and Bioethics. Isha Books.
13. Pagano, M. and Gauvreau, K. Principles of Biostatistics. Duxbury.
14. Sharma, J. R. Statistical and Biometrical Techniques in Plant Breeding. New Age International Publishers.
15. Panse, V. G. and Sukhatme, P. V. Statistical Methods for Agricultural Workers. ICAR.
16. Rangaswamy, R. A Text Book of Agricultural Statistics. New Age International Publishers.
17. Jasra, P. K. Biostatistics. Krishna Prakasan Media (P) Ltd.
18. Mohanan, K. V. Essentials of Plant Breeding. PHI Learning Pvt. Ltd.
19. Mohanan, K. V. Essentials of Plantation Science. Penta Books Publishers & Distributers.

ELECTIVE VIII.

GENETIC ENGINEERING AND BIOINFORMATICS

Genetic Engineering

1. Techniques in Molecular Biology: DNA markers and DNA probes- DNA sequencing methods (Maxam & Gilbert Sanger et al., capillary)- RNA sequencing- Sequenator- *In situ* hybridization (DIRVISH & FISH), PRINS, colony hybridization, dot & slot blots: blotting (Southern, Northern, Western, South Western & North Western), RFLP, RAPD, STS & PCR - variants in PCR, Real time quantitative PCR, LCR): DNA and RNA fingerprinting, genomic library, cDNA library and gene bank: chromosome walking, protein sequencing- MALDI, Human Genome Project.
2. Recombinant DNA Technology: Tools in genetic engineering: prokaryotic and eukaryotic vectors: shuttle, expression, dominant selectable, amplifiable, integrating and broad host range vectors: positive and negative selection: enzymes involved: gene cloning and gene fanning: single cell protein: shotgun cloning: gene library: comparison of cloning vectors.
3. Gene transfer in prokaryotes and eukaiyotes: Recombinant viral method, DBA mediated gene transfer, protoplast fusion, micro-cell fusion: metaphase chromosome transfer: liposome mediated gene transfer: microinjection and electroporation, biolistics and organelle engineering.
4. Transgenesis in plants: Somaclones: plant cell-bacterium hybrids: biociders: biological control: pathogen resistance: herbicide resistance: stress resistance: homozygous cultivars: enrichment of storage proteins: improvement of photosynthesis: post harvest preservation: selection of auxotrophs: secondary metabolite production.
5. Genetic engineering: Single cell proteins: protein engineering: fusion proteins & designer enzymes: production of biopharmaceuticals: commodity and inductrial chemicals. IPR and patenting: biological risks, GM food and terminator technology: biosafety and biohazards: physical and biological containment: genetic screening and privacy: ethical, economic and legal issues.

Bioinformatics

1. Data bases & Tools: Introduction, need of informatics tools and exercises, significance of databases in informatics projects. Nucleotide and protein sequence databases:

GenBank, DDBJ, EMBL, PIR, Primary and secondary databases, format of databases, gene bank flat file. Protein Data Bank flat file: FASTA format, PIR format: Structure file formats, PDBSUM, PDB Lite, MMDB, SCOP, Pfami: Database of structure viewers. Specialized databases: NCBI, Pubmed, OMIM, Medical databases, KEGG, EST databases. Overview of other popular tools for bioinformatics exercises.

2. Sequence alignment and database searches: Introduction, evolutionary basis of sequence alignment, modular nature of proteins, optimal alignment methods, substitution scores, PAM, BLOSUM, Gap penalties, statistical significance of alignments, database similarity searching, FASTA, BLAST, Low Complexity Regions, Repetitive Elements. Practical aspects of Multiple Sequence Alignment- Progressive Alignment Methods, CLUSTALW, Motifs and Patterns, PROSITE, 3DPSSM, Hidden Markov Models and Threading Methods. Conceptual numericals.
3. Phylogenetic analysis: Introduction, rooted and unrooted trees, elements of phylogenetic models, phylogenetic data analysis, alignment, substitution model building, tree building and tree evaluation, building data model (alignment), determining the substitution model, tree building methods, searching for trees, rooting trees, evaluating trees and data, phylogenetic softwares (CLUSTALW, PHYLIP, etc.). Conceptual numericals.
4. Predictive methods: Predictive methods using nucleotide sequences: Framework, Masking repetitive DNA, Database searches. Codon Bias Detection, Detecting Functional Sites in DNA (promoters, transcription factor binding sites, translation initiation sites). Gene Parsing, finding RNA Genes, Web based tools (GENSCAN, GRAIL, GENEFINDER). Predictive methods using protein sequences: Protein identity based on composition, physical properties based on sequence, secondary structure and folding classes, specialized structures or features, tertiary structure. Related web based softwares (JPRED, PROSEC, NNPREDICT, SOPMA).
5. Plasmid mapping and primer design: Restriction mapping, utilities, DNA strider, Mac Vector and OMIGA, gene construction kit, Vrctor NTI, Web based tools (MAP, REBASE): Primer design- need for tools. Primer design programmes and software (PFQME3). Conceptual numericals.

6. Genome bioinformatics: Sequencing methods (qualitative). Bioinformatics tools and automation in Genome Sequencing. Analysis of Raw genome sequence data. Utility of EST data base in sequencing. Bioinformatics in detection of polymorphisms, SNPs and their relevance. Bioinformatics tools in microarray data analysis, tools for comparative genomics.
7. Molecular visualization: Generation or retrieval: structure visualization, conformation generation. Graphical representation of molecular structures: small molecules (low molecular weight- peptides, nucleotides, disaccharides, simple drug molecules) and macromolecules: proteins, DNA, RNA, membranes). Use of visualization software available in public domain like VMD, Rasmol, Pymol, Spdb viewer. Chime, Cn3d. Rotameric structures of proteins (conformational flexibility). Canonical DNA forms (DNA Sequence Effects). Systematic methods of exploring conformational space.
8. Insilico modeling and drag design: Scope and applications of insilico modeling in modern biology. Comparative modeling, constructing an initial model, refining the model, manipulating the model, molecule superposition and structural alignment, concept of energy minimization, different types of interactions and formulation of force fields. Basic MD algorithm, its limitations, treatment of long range forces. Molecular modeling in drug discovery, deriving bioactive conformations, molecular docking, quantitative structure- activity relationship (QSAR), deriving the
9. Pharmacophoric pattern, receptor mapping, estimating biological activities. Ligand-Receptor interactions: Docking, Calculation of Molecular Properties using Energy Calculations. Conceptual numericals.

PRACTICALS

Genetic Engineering

1. Genomic DNA isolation by CTAB method from plant tissues.
2. Isolation of bacterial genomic DNA.
3. Molecular weight determination of DNA by Agarose gel electrophoresis.
4. Reseticton fragment analysis of DNA.
5. Plasmid DNA isolation.
6. Estimation of DNA concentration by spectrophotometric method.
7. Estimation of RNA concentration by spectrophotometric method

8. Lac induction by X- Gal method.

Bioinformatics

1. Exercises on Windows, Linux, UNLX, Networking, Internet search and Graphics.
2. Use of software for identification- accessing existing databases on WWW: software for identification of species.
3. Use of softwares to elucidate structure of biomolecules: docking of molecules aand molecular designing/' modeling. Analytical softwares related to Genomics and Proteomics.
4. Use of similarity, homology and alignment softwares. Soft ware of microarray analysis- design, processing and analysis.

References

1. Lewin, B. Genes. Humana Press.
2. Flynne, W. G. Biotechnology and Bioengineering. Nova Science Publishers.
3. Lipps, G. Plasmids: Current Research and Future Trends. Caister Academic Press.
4. Torr, J. D. Genetic Engineering- Current Controversies. Greenhaven Press, San Diego, USA.
5. Engdahl, S. Genetic Engineering- Contemporary Issues. Greenhaven Press, San Diego, USA.
6. Magnien, E. and De Nettancourt, D. Genetic Engineering of Plants and Microorganisms Important to Agriculture. Springer Verlag.
7. Fox, M. W. Beyond Evolution: The Genetically Altered Future of Plants, Animals, the Earth ... and Humans. Lyons Press.
8. HO, R. J. Y. and Gibaldi, M. Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes in to Drugs. Wiley-VCH. ’
9. Ausubel, F. M. *et al.* Short Protocols in Molecular Biology. John Wiley & Sons.
10. Wilson, J. and Hunt, T. Molecular Biology of the Cell: Problems Book. Garland Science.
11. Lodish, H. Students’ Solutions Manual for Molecular Cell Biology. W.H. Freeman Co.
12. Innis, M. A., Gelfand, D. H. and Sninsky, J. J. PCR Applications: Protocols for Functional Genomics. Academic Press. Mitra S. Genetic Engineering. Macmillan India Ltd.
13. Reed, R. *et al.* Practical Skills in Biomolecular Sciences. Benjamin Cummings.

14. Baxevanis, A. D. Bioinformatics. Wiley Interscicnce.
15. Mount, D. W. Bioinfomiatics. Cold Spring Harbor.
16. Lesk, A. Introduction to Bioinformatics. Oxford.
17. Brown, S. M. Bioinfomiatics. NYU Medical Center, NY, USA.
18. Krane, D.E. and Raymer, M. L. Fundamental Concepts of Bioinformatics. Pearson.
19. Bourne, P. E. and Weissig, H. Structural Bioinfomiatics. Wiley-Liss.
20. Doolittle, R. F. Computational Methods for Macromolecular Sequence Analysis. Academic Press.
21. Salzberg, S. L., Searls, D. B., Kasif, S. Computational Methods in Molecular Biology. Elsevier.
22. Rastogi, S. C., Mendiratta, N. And Rastogi, P. Bioinfomiatics, Methods and Applications. PHI.
23. Cohen, N. C. The Molecular Modeling Perspective in Drug Design. Academic Press.
24. Markoff, A. Analytical Tools for DNA, Genes & Chromosomes. New Age.
25. Tramontano, A. Introduction to Bioinfomiatics. Taylor & Francis.
26. Higgins, D. and Taylor, W. Bioinfomiatics. Oxford.
27. Campbel, A. M. and Heyer, L. J. Discovering Genomics, Proteomics and Bioinfomiatics. Pearson Education.

ELECTIVE IX.

PLANT PHYSIOLOGY

1. Water and plant cells: Water in plant's life; properties. Diffusion and facilitated diffusion. Absorption and short distance transport, pressure driven bulk flow and long distance transport. Osmosis driven by water potential gradient. Water absorption by roots via apoplastic, symplastic and transmembrane pathways. Role of aquaporins. Water movement through xylem. Mechanism and theories of transport. Cavitation and embolism. Soil-plant-atmosphere continuum. Physiology of stomatal function- blue light effect.
2. Plants and inorganic nutrition: Nutrient elements- classification based on biochemical functions. Physiological roles. Nutrient uptake: interaction between roots and microbes. Ion uptake by roots: diffusion, facilitated diffusion and apparent free space. Apoplastic and symplastic pathways. Membrane potential. Passive and active transport. Transport proteins: carriers- Michaelis-Menten kinetics. Channels: Voltage dependent K+ channels, voltage gated channels, Calcium channels, vacuolar malate channels. ATPase ctivity and electrogenic pumps. Patch clamp studies. Application of Nemst equation. Active transport and electrochemical potential gradients.
3. Assimilation of mineral nutrients: Nitrogen and bio geocycle nitrate assimilation, reduction, biological nitrogen fixation. Symbiosis: Nitrogenase activity, assimilation of ammonia, pathways and enzymes. Transport of amides and ureides. Sulphur assimilation: Bio geocycle, reduction of sulphates. Importance of Phosphorus, Iron, Magnesium, Calcium and Potassium assimilation. Energetics of nutrient assimilation. Molecular physiology of micronutrient acquisition.
4. Photosynthesis: Light absorption and energy conversion. Electron transport system in chloroplast membranes. ATP synthesis in chloroplast. Photosynthetic carbon reduction, carbon oxidation and photorespiratory cycles. C4 and CAM metabolism. Physiological and environmental consideration of photosynthesis. Distribution of photoassimilates-export. Starch and sucrose synthesis. Allocation and partitioning: Phloem loading and unloading. Concept of osmotically generated pressure flow. Importance of plasmodesmata in symplastic transport.
5. Respiration: Glycolytic reactions. Pyruvate entry in to mitochondria and citric acid

cycle. Electron transfer system and ATP synthesis. Transporters involved in exchange of substrates and products. ATP synthesis, unique electron transport enzymes of plant mitochondria. Interaction between mitochondrial and other cellular components. Metabolites and specific transporters. Lipid metabolism.

6. Growth, differentiation and development: Analysis of plant growth: production of cells, growth velocity profile. Cytological and biochemical events. Differentiation: secondary cell wall formation, multinet growth hypothesis of cell wall. Development: initiation and regulation of development, genes involved in the control of development, role of protein kinases. Types of development: flowering- floral induction, evocation and morphogenesis. Floral organ identity genes. Biochemical signaling: Theories of flowering. Control of flowering- phytochrome, cryptochrome and biological clock. Factors affecting flowering: Photoperiodism and thermoperiodism.
7. Fruit development and ripening: physiology of ripening- cell wall architecture and softening, enzymes involved in biochemical changes.
8. Seed development: deposition of reserves during seed development, desiccation of seeds- hormones involved- desiccation tolerance. Classification of seeds. Seed dormancy.
9. Germination physiology: Imbibition, germination and reserve mobilization- metabolism of carbohydrates, lipids, proteins and phytins. Physiology of seed dormancy.
10. Plant growth regulators: auxins, gibberellins and cytokinins- biosynthesis, physiological roles. Ethylene- biosynthesis, mode of action, physiological roles, commercial importance. Abscisic acid- biosynthesis and metabolism, physiiological effects, role in dormancy and senescence. Hormonal balance concept.
11. Photoreceptors: Phytochromes- photochemical and biochemical properties; functions. Mechanism of of phytochrome regulated differentiation. Signal transduction. Cryptochromes.
12. Senescence and programmed cell death: Apotosis and necrosis. Programmed cell death in relation to reproductive development and stress response. Metabolism during senescence.
13. Stress physiology: Water deficit and drought resistance. Heat stress and heat shock, chilling and frost. Salinity stress. Stresses due to oxygen deficiency and heavy metal

pollution.

PRACTICALS

1. Determination of moisture content of plant materials.
2. Separation of plant pigments by paper chromatography and thin layer chromatography and study of their absorption spectra.
3. Quantitative estimation of chlorophyll using spectrophotometry.
4. Study of amylase activity and effect of gibberellic acid in germinating cereal seeds.
5. Estimation of protein by dye binding method.
6. Proline estimation under various levels of abiotic stresses.
7. Estimation of phenol content in plant tissues as affected by biotic stresses.
8. Study of the effect of plant hormones on seedling growth.

References

1. Anderson, J. W. and Boardall, J. Molecular Activation of Plant Cells- An Introduction to Plant Biochemistry. Blackwell Scientific Publishers.
2. Beck, C. B. An Introduction to Plant Structure and Development. Cambridge University Press.
3. Bowley, J. D. and Black, E. S. Physiology of Development and Germination. Plenum Publishing Corporation.
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ELECTIVE X.

MOLECULAR PLANT TAXONOMY

1. Systems of classification- natural, phylogenetic and biological systems.
2. Importance of cytology, biochemistry and molecular biology in taxonomic analysis.
3. Scope and importance of molecular plant taxonomy.
4. The material basis of systematics: The concept of characters, correlation of characters, character weighing, character variations.
5. Isolation and speciation: Geographical or ecological isolation-a pre-requisite for reproductive isolation. Sympatry as the test of biological species, Mechanisms of reproductive isolation- post-mating mechanisms, Incompatibility, Post-zygotic mechanisms, Speciation.
6. Biological classification- Cladistic versus phenetic approach. Definition and history of cladistics. Methodology, formal classification, impact of cladistics.
7. Techniques in molecular taxonomy: Acquisition of Molecular data, DNA Sequence data, Polymerase chain reaction, DNA sequencing reaction, Types of DNA sequence data, Analysis of DNA sequence data.
8. Molecular markers in Plant taxonomy: Restriction site analysis (RFLPs), isoenzymes, Simple sequence repeats (SSR) or Microsatellite DNA, Random amplified polymorphic DNA (RAPDs), Amplified fragment length polymorphism (AFLPs), Internal transcribed spacer, Inter simple sequence repeats (ISSR), Single nucleotide polymorphisms (SNPs).
9. Softwares for Molecular Taxonomy.

PRACTICALS

1. Extraction of DNA
2. RAPD, ISSR profiling
3. Molecular Phylogenetic analysis
4. Demonstration and application of Softwares
5. Construction of phylogram using NTYSS.

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ELECTIVE XI.

BIOTECHNOLOGY IN CROP IMPROVEMENT

1. Introduction: History and present status of biotechnology in Indian and global context.
2. Plant genetic resources: Definition, components of plant genetic resources, classification of plant genetic resources, plant genetic resources activities, exploration, conservation, evaluation, documentation and utilization. Agencies involved in plant genetic resources activities: IPGRI and NBPGR. Erosion of plant genetic resources - Role of biotechnology in conservation of plant genetic resources.
3. Crop Genetics: General account of origin, genetic variability, breeding techniques and achievements in the area of (a) Rice, (b) Coconut, (c) Rubber, (d) Arecanut (e) Cashew (f) Pepper (g) Ginger.
4. Organizational set up, research activities and achievements of ICAR, CSIR.
5. Organizational set up, research activities and achievements of national institutes: IARI, CCMB, IISc, BARC, CPCRI, IISR, RRII and CTCRI.
6. Plant type concept: Introduction, History, designing and breeding of model plant types eg. Wheat
7. Protoplasts in gene transfer systems: Methods of isolation, culture and fusion of protoplasts, selection of heterokaryons, somatic hybrids and cybrids, somaclonal variation.
8. Plant cell cultures as an *in vitro* system for crop improvement: Cell culture systems - use of markers in cell line selection-incorporation of desirable agronomic traits such as salt tolerance, drought tolerance, disease resistance and herbicide tolerance in commercial crops.
9. Haploids in crop improvement: Anther, pollen and ovary culture for production of hapoid plants and homozygous lines- use of pollens for (a) identifying plants with useful genes (b) overcoming hybridization barrier, (c) handling back cross generations (d) stabilization of recombinants.
10. Micropropagation: Fundamental and applied aspects of the methodology - operation of commercial units in Indian and global context - advantages and disadvantages.
11. Immobilzation techniques: Definition and concept of immobilization - enzyme and whole cell immobilization - adsorption, cross linking, ionic bonding, entrapment-

advantages and disadvantages - industrial application of the technique.

12. Post harvest protection: Antisense RNA technology (ACC synthase and polugalacturonase) in tomato, banana and water melon- extending shelf life of fruits and flowers and post harvest production of cereals, millets and pulses.
13. Bioreactor technology: Large scale production of commercially important compounds using plant cells, hairy roots and microorganisms - types of bioreactors, tubular, membrane, tower, fluidized bed, packed bed, photobioreactores, bubble columns, air-lift bioreactors - operational procedures and optimization of culture conditions by monitoring parameters such as temperature, DO, pH, turbidity.
14. Application of biotechnology: Improvement of crop planls wilh enhanced essential amino acids, storage proteins, edible oil, improved growth rate and yield of wood in forest trees - stress tolerance in plants, drought and salinity - use of antifreeze gene for frost tolerance - environmental protection.
15. Release and multiplication of varieties: Channels of variety release - production of improved seeds - classes of seeds - seed certification - the India Seed Act (1966).
16. Intellectual property rights : Definition - protection of intellectual property right (a) copy right (b) trade mark (c) designs (d) IC layout designs (e) Geographic indication (f) patents - objectives of patent system - basic principles and general requirements of patent laws - patent system in India - patent information and service by patent office - patent procedures. -Infringement problems - harmonization of patent laws - patenting biotechnological innovations - legal protection to microorganisms, higher plants and animals - IPR in relation to crop improvement. PPVFR Act (2001) - merits and demerits.
17. Globalization and Indian agriculture: Plant variety protection - purpose of plant variety protection - UPOV: functions, organization and features. Responsibilities of member countries.

PRACTICALS

1. Determination of seed vigour and viability using (a) paper piercing test (b) GADA test (c) Tetrazolium test (d) Seedling growth rate and seedling dry weight test (e) speed of germination test.
2. Determination of pollen viability using (a) in vitro germination test (b) Tetrazolium test

(c) *in vitro* germination and pollen tube growth test.

3. Isolation and fusion of protoplast from pollen grains and cell cultures.
4. Initiation and establishment of hairy root cultures using *Agrobacterium rhizogenes.*
5. Anther and pollen culture of Datura species.

Visit to one crop improvement research institute and submission of a detailed report.

ELECTIVE XII.

PLANT CELL AND MOLECULAR BIOLOGY

1. Structure and organization of cell and cell organelles- general account.
2. Organization and expression of plant genes.
3. Light regulation of plant gene expression.
4. Phytochrome control of plant development.
5. Molecular genetics of photosynthesis.
6. Photochemical reaction centres: structure and organization.
7. Mitochondrial genome and male sterility.
8. Genetics of nitrogen fixation; Bacterial and cyanobacterial nitrogen fixation; symbiotic nitrogen fixation.
9. Storage proteins and their genes.
10. Molecular aspects of incompatibility.
11. Transposons in plants.
12. Adaptation of plants to stress.
13. Biochemistry of endogenous rhythm.
14. Plant hormones: Current status.
15. Lectins and cell-cell recognition problems.
16. Plant cell culture and regeneration with special reference to legumes and cereals.
17. Protoplasts and somatic cell hybridization.
18. Plant cell mutants and somaclonal variation.
19. Genetic engineering of plant cells (i) Engineering of plant genes of photosynthesis (ii) Conferring Herbicide Resistance (iii) Nitrogen fixation (iv) Storage proteins (v) Vitamins.
20. Techniques in Plant Molecular Biology: Buffers, Cell fractionation; Centrifugation (preparative and analytical ultracentrifugation); Chromatography; Electrophoresis; Spectrophotometry (UV and visible, Dual wavelength spectrophotometry); Radioisotope techniques; Transmission and scanning electron microscopy; Cell and protoplast culture; DNA isolation from nuclei, chloroplasts, and mitochondria.

PRACTICALS

1. Buffers, Cell Fractionation

2. Preparative and analytical centrifugation
3. Chromatography - paper and thin layer
4. Electrophoresis
5. Spectrophotometry (UV and Visible, Dual Wavelength Spectrophotometry)
6. Cell and Protoplast Culture
7. Plant Cell Transformation
8. DNA Isolation - plant tissues.

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