FATIMA MATA NATIONAL COLLEGE
KOLLAM, KERALA
(Autonomous)

MSc Degree in Botany

(Semester System)

Course Structure and Syllabus

Board of Studies in Botany
March 2015

COURSE STRUCTURE

Sem.	Paper code	Title of the paper	Hrs/ Sem	Hrs/Week		ESA Hrs	Maximum Marks		
				T	P		CA	ESA	Total
I	15PBO11	Phycology, Mycology & Plant Pathology	108	6	2	3	30	70	100
	15PBO12	Bryophyta, Pteridophyta& Gymnosperms	108	6	2	3	30	70	100
	15PBO13	Microbiology, Histology, Microtechnique&Histochemistry	108	6	3	3	30	70	100
	15PB014	Practical I	126		7	4	30	70	100
	15PBO15	Submissions					5	20	025
	15PBO16	Viva Voce					00	25	025
	Total for Semester I		**450**	**18**	**7**	**13**	**125**	**325**	**450**
II	15PBO21	Plant Breeding, Horticulture & Reproductive Botany	108	6	1.5	3	30	70	100
	15PBO22	Environmental Biology, Forest Botany, Phytogeography & Conservation Biology	108	6	2	3	30	70	100
	15PBO23	Cell and Molecular Biology & Genetics	108	6	3.5	3	30	70	100
	15PB024	Practical II	126		7	4	30	70	100
	15PBO25	Submissions					5	20	025
	15PBO26	Viva Voce					00	25	025
	Total for Semester II		**450**	**18**	**7**	**13**	**125**	**325**	**450**
III	15PBO31	Taxonomy of Angiosperms, Economic Botany Ethnobotany & Evolution	108	6	2.5	3	30	70	100
	15PBO32	Biophysics & Bioinformatics	108	6	2.0	3	30	70	100
	15PBO33	Research Methodology, Biostatistics& Plant Biotechnology	108	6	2.5	3	30	70	100
	15PB034	Practical III	126			4	30	70	100
	15PBO35	Submissions					5	20	025
	15PBO36	Viva Voce					00	25	025
	Total for Semester III		**450**	**18**	**7**	**13**	**125**	**325**	**450**
IV	15PBO41	Special Paper –I- Plant Physiology, Biochemistry & Enzymology	144	8	4	3	30	70	100
	15PBO42	Special Paper –II Elective - Biotechnology	144	8	3	3	30	70	100
	15PBO43	Practical IV	126		7	4	30	70	100
	15PB044	Submissions					5	20	025
	15PBO45	Viva Voce					00	25	025
	15PBO46	Dissertation	36	2				100	100
	Total for Semester IV		**450**	**18**	**7**	**10**	**95**	**355**	**450**
Grand Total							**470**	**1330**	**1800**

T-Theory, P-practical, ESA-End Semester Assessment, CA-Continuous Assessment(internal)

SCHEDULE OF WORKLOAD

Sem.	Paper Code	Subject	Total Hrs.		T Hrs./Week	P Hrs./Week
			T	P		
I	15PBO11	Phycology	54	27	3.0	1.5
		Mycology	36	09	2.0	0.5
		Plant Pathology	18	00	1.0	0.0
	15PBO12	Bryophyta	27	09	1.5	0.5
		Pteridophyta	45	18	2.5	1.0
		Gymnosperms	36	09	2.0	0.5
	15PBO13	Microbiology	36	09	2.0	0.5
		Histology	27	09	1.5	0.5
		Microtechnique&Histochemistry	45	36	2.5	2.0
II	15PBO21	Plant Breeding	63	09	3.5	0.5
		Horticulture	18	09	1.0	0.5
		Reproductive Botany	27	09	1.5	0.5
	15PBO22	Environmental Biology	54	36	3.0	2.0
		Forest Botany	09	00	0.5	0.0
		Phytogeography	18	00	1.0	0.0
		Conservation Biology	27	00	1.5	0.0
	15PBO23	Cell & Molecular Biology	54	36	3.0	2.0
		Genetics	54	27	3.0	1.5
III	15PBO31	Taxonomy of Angiosperms	72	36	4.0	2.0
		Economic Botany	09	09	0.5	0.5
		Ethnobotany	09	00	0.5	0.0
		Evolution	18	00	1.0	0.0
	15PBO32	Biophysics	27	09	1.5	0.5
		Bioinformatics	81	27	4.5	1.5
	15PBO33	Research Methodology	18	00	1.0	0.0
		Biostatics	27	09	1.5	0.5
		Plant Biotechnology	63	36	3.5	2.0
IV	15PBO41	Plant Physiology	45	36	2.5	2.0
		Biochemistry	54	18	3.0	1.0
		Enzymology	45	18	2.5	1.0
	15PBO42	Biotechnology	144	54	8.0	3.0
		Dissertation	18	00	2.0	0.0

Elective Special Papers

15PBO41: Plant Physiology, Biochemistry and Enzymology

15PBO42: Biotechnology

The special paper comprises detailed studies in certain areas of a subject. Normally a department shall offer one of the above subjects as special paper. There shall be provision for change of subject for special paper, if necessary, in the ensuing years.

Minimum Pass Requirements

- The minimum pass requirement for PG degree courses from the academic year 2015-16 onwards shall be:
  40% for CE and 40% for ESE for each theory paper and aggregate minimum of 50% for theory, project, project based viva and comprehensive viva of PG Degree courses under Semester pattern.

Study Tour

Study tour in the 2nd, 3rd and 4th semesters of the PG programme is compulsory.

- 2nd Semester: Visit to any Botanic garden
- 3rd Semester: Minimum three one day field trips or 3 to 4 day study tour for flora awareness.
- 4th Semester: Visit to at least two regional and two national research institutions.

CA Mark Details- Theory

Distribution of marks in Continuous Assessment	
Test	15
Assignments	5
Seminars	5
Attendance	5
TOTAL	30

CA Mark Details- Practicals

Distribution of marks in Continuous Assessment	
Test	15
Assignments/ Seminars	5
Attendance	5
Performance, punctuality and skill	5
TOTAL	30

Submissions

Semester I: 15PBO15			
		CA	**ESA**
1	Submission Algae (2)	1	4
2	Submission Fungi (2)	1	4
3	Submission Bryophytes (2)	1	4
4	Submission Pteridophytes (2)	1	4
5	Submission Gymnosperms (2)	1	4
Total		5	20

Semester II: 15PBO25			
		CA	**ESA**
1	Visit to Botanic Garden Report	0	5
2	Ecology Tour Report	0	5
3	Documentation of Conserved Plants (2 plants RET)	5	10
Total		5	20

Semester III: 15PBO35			
		CA	**ESA**
1	Taxonomy Tour Report	0	6
2	Report of Herbarium visit	0	4
3	Research Proposal	0	10
4	Submission of Economic Botany specimens (5)	5	5
Total		5	20

Semester IV: 15PBO44			
		CA	**ESA**
1	Research Station Visit Report	0	5
2	Tissue Culture Specimens 5 Nos.	5	10
3	Bioinformatics Lab Visit Report	0	5
Total		5	20

Dissertation/ Project work

Topic of the dissertation may be chosen from any area of botany and may be laboratory based, field based or both or computational, with emphasis on originality of approach. It may be started during 2nd/3rd semester and shall be completed by the end of the 4th semester. It should be duly signed by the research guide and the head of the Department and submitted for evaluation. The dissertation to be submitted should include:

- ✓ Introduction
- ✓ Objectives of the study
- ✓ Materials and methods
- ✓ Results and discussion
- ✓ Summary and conclusion
- ✓ References

The findings of the research may be presented before the external examiners (power point presentation).

Mark Distribution for Dissertation	
Content & Presentation of Data	80 Marks
Viva Voce	20 Marks
TOTAL	100 Marks

Scheme for Practical Examinations				
	Duration	CA	ESA	Total
Practical I (15PBO14) includes all the topics under papers 15PBO11, 15PBO12 & 15PBO13	4 hrs	30	70	100
Practical II (15PBO24) includes all the topics under papers 15PBO21, 15PBO22 & 15PBO23	4 hrs	30	70	100
Practical III (15PBO34) includes all the topics under papers 15PBO31, 15PBO32 & 15PBO33	4 hrs	30	70	100
Practical IV (15PBO43) includes all the topics under papers 15PBO41 & 15PBO42	4 hrs	30	70	100

Practical examinations are conducted at the end of each semester. Certified records of practical works done and submissions, if any, should be submitted at the time of each practical examination.

SCHEME OF EXAMINATION AND MARK DISTRIBUTION

Sem.	Paper code	Title of the paper	Hrs/ Sem	ESA Hrs	Maximum Marks		
					CA	ESA	Total
I	15PBO11	Phycology, Mycology & Plant Pathology	108	3	30	70	100
	15PBO12	Bryophyta, Pteridophyta& Gymnosperms	108	3	30	70	100
	15PBO13	Microbiology, histology, Microtechnique&Histochemistry	108	3	30	70	100
	15PB014	Practical I	126	4	30	70	100
	15PBO15	Submissions			05	20	025
	15PBO16	Viva Voce			00	25	25
	Total for Semester I		**450**	**13**	**125**	**325**	**450**
II	15PBO21	Plant Breeding, Horticulture & Reproductive Botany	108	3	30	70	100
	15PBO22	Environmental Biology, Forest Botany, Phytogeography & Conservation Biology	108	3	30	70	100
	15PBO23	Cell and Molecular Biology & Genetics	108	3	30	70	100
	15PB024	Practical II	126		30	70	100
	15PBO25	Submissions			05	20	025
	15PBO26	Viva Voce			00	25	25
	Total for Semester II		**450**	**13**	**125**	**325**	**450**
III	15PBO31	Taxonomy of ngiosperms, Economic Botany, Ethnobotany & Evolution	108	3	30	70	100
	15PBO32	Biophysics & Bioinformatics	108	3	30	70	100
	15PBO33	Research Methodology, Biostatistics Plant Biotechnology	108	3	30	70	100
	15PB034	Practical III	126	4	30	70	100
	15PBO35	Submissions			05	20	025
	15PBO36	Viva Voce			00	25	25
	Total for Semester III		**450**	**13**	**125**	**325**	**450**
IV	15PBO41	Special Paper –I- Plant Physiology, Biochemistry & Enzymology	144	3	30	70	100
	15PBO42	Special Paper –II Elective - Biotechnology	144	3	30	70	100
	15PBO43	Practical IV	126	4	30	70	100
	15PB044	Dissertation	36			100	100
	15PBO45	Submissions			05	20	025
	15PBO46	Viva Voce			00	25	025
	Total for Semester IV		**450**	**10**	**95**	**355**	**525**
Grand Total					**470**	**1330**	**1800**
ESA-End Semester Assessment, CA-Continuous Assessment(internal)							

DISTRIBUTION OF MARKS IN EACH SEMESTER EXAMINAION

Semester	Continuous Assessment		End Semester Assessment		Total Marks
	Theory	Practical	Theory	Practical	
I	90	30	210	70	400
II	90	30	210	70	400
III	90	30	210	70	400
IV	60	30	140	70	300
	Dissertation				100
	Submissions 4 x 25				100
	Viva Voce 4 x 25				100
Grand Total					**1800**

DISTRIBUTION OF MARKS IN PRACTICAL EXAMINATION

Practical	Total Marks	Examination	Record/Submissions
I	90	50	Record- 10, Permanent Slides-10
II	90	60	Record- 10
III	90	50	Record- 10, Herbarium/ Field Note- 10
IV	60	60	Record- 10

PATTERN OF QUESTIONS

Question Type	Total Number of Questions	Number of Question to be answered	Marks for each Questions	Total Marks
Very short answer type (One word to Maximum of 2 sentences)	10	10	1	10
Short answer (Not to exceed one paragraph)	10 sets ('a' & 'b')	10 (either 'a' or 'b')	2	20
Short essay (Not to exceed 120 words)	6 sets ('a' & 'b')	6 (either 'a' or 'b')	5	30
Long essay	2 sets ('a' & 'b')	2 (either 'a' or 'b')	10	20
Total	30	22		70

SEMESTER- I

PAPER 15PBO11. PHYCOLOGY, MYCOLOGY& PLANT PATHOLOGY
144 hrs (Theory: 108 hrs; Practical: 36hrs)

A. PHYCOLOGY- 54hrs (3hrs/wk)

1. Principles and modern trends in taxonomy of algae; Contributions of Indian Algologists. (4 hrs)
2. Classification of Algae (Lee, 2008). Characteristic features of major divisions (6 hrs)
3. Thallus organization and its morphological variations; Ecological and evolutionary trends. (6 hrs)
4. Cell structure - Prokaryotic, mesokaryotic and eukaryotic organizations (4 hrs)
5. Structure, reproduction and life cycle of the following types (30 hrs)
   Hydrodictyon, Ulva, Pithophora, Draparnaldiopsis, Bulbochaete, Cephaleuros, Codium, Halimeda, Acetabularia, Nitella, Sphacelaria, Padina, Turbinaria, Porphyra, Amphiroa, Gracilaria, Ceramium, Spirulina, Scytonema
6. Economic Importance of Algae –Algae as bio-fertilizers, as food, their uses in industry, water blooms and their ecological role. (4 hrs)

Practicals-27 hrs (1.5 hrs/wk)

1. Morphology and Reproductive features of types mentioned above
2. Field trip and a record of collected algal specimens should be submitted

References

1. Bhattia A (2004) Treatise on Algae. S. Chand &Company, New Delhi.
2. Bilgarmi K.S and Saha L.C (1996) A text book of Algae. CBS Publishers, New Delhi.
3. Bold H.C & Wynne M.J(1995) Introduction to Algae. Prentice Hall of India, New Delhi.
4. Kumar H.D. (1985) Algal cell biology. East West Press, New Delhi.
5. Kumar H. D. (1999) Introductory Phycology. East West Pvt. Ltd., New Delhi.
6. Lee R.E. (2008) Phycology. Cambridge University Press.
7. Pandey B.P. (2004) Algae. S. Chand & Company Ltd. New Delhi.
8. Prescott G.W (1969) The Algae: A review. Nelson Publ.
9. Round F.E (1984) The Ecology of Algae. Cambridge University Press, London.
10. Sharma O.P (2002) Text book of Algae. Tata McGraw Hill Publ. Comp. Ltd., New Delhi.

11. Sharma P.D (2003) A Text book of Botany-Lower plants. Rastogi Publications, Meerut.
12. Smith G.M (1976) Cryptogamic Botany Vol.1.Tata Mc Graw Hill Publ. Co. Ltd., New Delhi.
13. Vashishta B.R (1999) Algae. S. Chand & Company, New Delhi.

B. MYCOLOGY- 36 hrs (2hrs/wk)

1. Principles and modern trends of classification of Fungi (Ainsworth 1973, Alexopoulose *et al.*1996, Carl Woese, 1990). Contributions of Indian Mycologists. (3 hrs)

2. Structure, reproduction and phylogeny of-

Kingdom Protista

1. Phylum Acrasiomycota
2. Phylum Dictyosteliomycota
3. Phylum Myxomycota
4. Phylum Plasmodiophoromycota

Kingdom Straminopila

1. Phylum Hyphochytriomycota
2. Phylum Labrinthulomycota
3. Phylum Oomycota

Kingdom Fungi

1. Phylum Chytridiomycota
2. Phylum Zygomycota
3. Phylum Ascomycota
4. Phylum Basidiomycota
5. Phylum Deuteromycota

(6 hrs)

4. Thallusstructure,reproduction and life cycle of the following types-

(20 hrs)

Phytophthora, Albugo, Pilobolus, Penicillium, Aspergillus, Uromyces, Polyporus, Lycoperdon, Geaster, Dictyophora, Nidularia, Schizophyllum, Colletotrichum, Alternaria, Helminthosporium, Cercospora.

4. Economic importance of fungi with special reference to secondary Metabolites; Fungi as biocontrol agent. (2 hrs)

5. Classification, thallus structure,reproduction, ecological significance and economic importance of Lichens- *Usnea, Graphis.* (2 hrs)

Practical -9hrs (0.5 hr/wk)

1. Study of the morphology and reproductive structures of the types mentioned in the syllabus.

References

1. Ainsworth G.C., Sparrow F.K. and Sussman A.S. (1973) The Fungi. Academic Press, New York.
2. Alexopoulose C.J., Mims C., Blackwell M. (1996) Introductory Mycology. John Wiley & Sons, New York.
3. Bessy E.A. (1979) Morphology and Taxonomy of Fungi. Vikas Publishing House, New Delhi.
4. Burnett J.H (1968) Fundamentals of Mycology. Edward Arnold Ltd., London.
5. Chopra G.L. (1998) A text book of Fungi. S. Nagin & Co. Meerut.
6. Dube H.C. (1996) An Introduction to Fungi. Vikas Publishing House, New Delhi.
7. Moore-Landeeker E. (1996) Fundamentals of Fungi. Prentice Hall, New Jersey.
8. Hale M.E. (1983) Biology of Lichens. Edward Arnold, London.
9. Hudson H.J. (1986) Fungal Biology. Hodder Arnold H & S, London.
10. Moore D.*et al* (1986) Developmental Biology of higher Fungi. Cambridge University Press, London.
11. Mehrothra R.S. and Aneja K.R. (1990) An Introduction to Mycology. Wiley Eastern Ltd. New Delhi.
12. Sharma O.P. (2007) Text book of Fungi. Tata McGraw Hill, Publishing Co. Ltd., New Delhi.
13. Sharma P.D. (2004) The Fungi for University students. Rastogi Publications, Meerut.
14. Srivastava J.P. (1998) Introduction to Fungi. Central Book Depot, Allahabad.
15. Sumbali G. (2005) The Fungi. Narosa Publishing House, New Delhi.

C. PLANT PATHOLOGY-18 hrs (1hr/wk)

1. History of Plant pathology, General principles and concepts of host-parasite interaction. (2 hrs)
2. Defense mechanisms - Systemic Acquired Resistance and Induced Systemic Resistance, major signaling pathways of plant defense mechanism. (4 hrs)
3. Epidemiology and quarantine. (1 hr)

4. Principles and methods of Plant disease control: Fungicides and pesticides, natural pesticides, sanitation,disease resistance. Biological control:biocontrol agents,bio-inoculants, natural enemies, bio-traps. (2 hrs)

5. Study of the following plant diseases with reference to symptoms causal organism, disease cycle and control measures.

a. Paddy	: Brown spot and false smut
b. Coconut	: Root wilt
d. Rubber	: Powdery mildew
e. Coffee	: Rust
f. Tea	: Red rust
g. Sugarcane	: Red rot
h. Vanilla	: Bean rot
i. Mango	: Leaf spot
j. Ladies finger	: Yellow vein mosaic
k. Pepper	: Quick wilt (9 hrs)

Practical

1. Identification and documentation of all plant diseases mentioned in the syllabus.

References

1. Agrios G.N. (1997) Plant pathology. Academic Press, New Delhi.
2. Bilgrami K.S. & Dube H.C. (1990) A text book of modern plant pathology. Vikas Publishing House, New Delhi.
3. Butler E.J. & Jones (1949) Plant Pathology. Mc Millan, London.
4. Chatterjee P.B. (1997) Plant Protection Techniques. Bharatibhavan, Patna.
5. Chattopadhayay S.B. (1991) Principles and procedures of plant protection Oxford & IBH, New Delhi.
6. Manners J.G. (1982) Principles of Plant Pathology. Cambridge University Press, London.
7. Marshall H. (1999) Diseases of plants. Anmol Publications Pvt. Ltd., New Delhi.
8. Mehrotra R.S. (2000) Plant pathology. Tata McGraw Hill, Publishing Co. Ltd., New Delhi.
9. Mundkur B.B. (1982) Text book of Plant diseases. Macmillan India Ltd., New Delhi.
10.Pathak V.N., Khatri N.K. and Pathak M. (1996) Fundamentals of Plant pathology. Agrobotanical publishers (India), Bikaner.
11. Rangaswamy G. and Mahadevan A. (2002) Diseases of crop plants in India. Prentice Hall of India, New Delhi.

12. Sharma P.D. (2005) Plant pathology. Narosa Publishing House, New Delhi.
13.Singh R.S. (2000) Introduction to the principles of Plant pathology. Oxford IBH, New Delhi.
14. Swarup *et al.* (1999) Plant diseases. Anmol Publications Pvt. Ltd., New Delhi.

PAPER 15PBO12. BRYOPHYTA, PTERIDOPHYTA AND GYMNOSPERMS
144hrs (Theory: 108 hrs; Practical: 36hrs)

A. BRYOPHYTA -27hrs (1.5 hrs/wk)

1. General characters and recent systems of classification; Contributions of Indian Bryologists. (2 hrs)
2. A general account of morphological and anatomical features, reproduction, life history and phylogeny of:
Sphaerocarpales, Marchantiales, Jungermanniales, Calobryales, Anthocerotales, Sphagnales, Andreales, Funariales, Polytrichales.
(10 hrs)
3. Life cycle study of the following types:
Lunularia, Targionia, Cyathodium, Reboulia, Pallavicinia, Porella, Notothylas, Sphagnum, Polytrichum (12 hrs)
4. Origin and evolution of Bryophytes, Brief account on Fossil Bryophytes (2 hrs)
5. Bryophytes as indicators of water and air pollution. (1 hr)

Practical -9hrs (0.5 hr /wk)

1. Morphological and anatomical studies of the types mentioned in the syllabus.

References

1.Cavers F. (1976) The interrelationship of Bryophyta. S.R. Technic House, Asok Rajpath, Patna.
2. Chopra R.N. (1998) Topics in Bryology. Allied Printers, New Delhi.
3. Chopra R.N. and Kumara P.K. (1988) Biology of Bryophytes. Wiley East New Delhi.
4. Parihar N.S. (1980) An introduction to Embryophyta Vol. I. Bryophyta. Central Book Depot, Allahabad.
5. Puri P. (1981) Bryophytes: Morphology, Growth and differentiation. Atma Ram and Sons, New Delhi.
6. Rashid A. (1998) An introduction to Bryophyte. Vikas Publishing House, New Delhi.
7. Shaw J. and Goffinet B. (2000) Bryophyte Biology, Cambridge University Press.
8. Smith G.M. (1976) Cryptogamic Botany Vol. II. Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.
9. Watson E.V. (1968) The structure and life of Bryophytes. Cambridge University Press, London.

B. PTERIDOPHYTA-45hrs (2.5 hrs/wk)

1. General characters, classification and life cycle of Pteridophytes; Contributions of Indian Pteridologists. (3 hrs)
2. Comparative morphology,structure, ecology and phylogeny of the following groups: Psilopsida, Lycopsida, Sphenopsida, Pteropsida. (8 hrs)
3. Structure, reproduction and life cycle of the following types:
   Isoetes,Ophioglossum,Angiopteris,Osmunda,Ceratopteris,Blechnum, Lygodium,Adiantum,Dicranopteris,Acrostichum,Salvinia,Azolla (24 hrs)
4. Telome theory-basis, elementary proves- origin of sporophylls in Lycopsida, Sphenopsida and Pteropsida- origin of root- merits and demerits of telome theory; Evolutionary trends in the gametophytes of Pteridophytes. (4 hrs)
5. Conservation of Pteridophytes;Pteridophytes as ecological indicators. (2 hrs)
6. Principles of Paleobotany, Fossil pteridophytes:
   Rhynia,Lepidocarpon,Sphenophyllum,Zygopteris (4 hrs)

Practical 18hrs (1hr/wk)

1. Structural details of the vegetative and reproductive pars of the types mentioned in the syllabus.
2. Fossil types mentioned above.

References

1. Arnold C.A. (1947) An introduction to Paleobotany. Mc. Graw Hill, New York.
2. Bierhost D.W. (1971) Morphology of vascular plants .Mac millan, London.
3. Eames E.J. (1983) Morphology of vascular plants. Standard University press.
4. Parihar N.S. (1980) An introduction to Embryophyta Vol. II. Pteridophyta Central Book Depot, Allahabad.
5. Rashid A. (1999) Pteridophyta. Vikas Publishing House, New Delhi
6. Scott D.H. (1962) Studies in Fossil Botany. Hafner Publishing Co., New York.
7. Shukla A.C. and Misra S.P. (1975) Essentials of Paleobotany. Vikas Publishing House, New Delhi.
8. Sharma O.P. (2006) Text book of Pteridophyta. Macmillan India Ltd., New Delhi.

9. Smith G.M. (1976) Cryptogamic Botany Vol. II. Tata McGraw Hill Publishing Co. Ltd. New Delhi.
10. Sporne K.R(1986) Morphology of Pteridophytes. Hutchinson University Library, London.
11. Stewart W.N (1983) Paleobotany and evolution of plants. Cambridge University Press, London.
12. Sundara Rajan S (1999) Introduction to Pteridophyta. New Age Publications, New Delhi.

C. GYMNOSPERMS 36hrs.(2hrs/wk)

1. General characters, affinities, distribution and classification (Chamberlain, 1934; Sporne, 1965); phylogeny and economic importance of Gymnosperms.

(6 hrs)

2. Structural details of vegetative and reproductive parts, phylogeny and inter relationships of the following orders:

Cycadofilicales, Caytoniales, Bennettitales, Pentoxylales, Cycadales, Ginkgoales, Coniferales, Gnetales.

(16 hrs)

3. Structure,reproduction and life cycle of the following types:
Zamia,Auracaria,Cupressus,Podocarpus,Agathis,Gnetum (12 hrs)
4. Fossil Gymnosperms (Brief account) (2 hrs)

Practical 9hrs (0.5 hr/wk)
1. Structural details of the following fossil types: *Heterangium*,*Medullosa*.
2. Anatomy of stem (TS,RLS,TLS),leaf and reproductive structures of the types mentioned in the syllabus.

References

1. Bhatnagar S.P and Moitra A (1997)Gymnosperms.New Age Publications, New Delhi.
2. Biswas C. and Johri B.M (1999) The Gymnosperms. Narosa Publishing House, New Delhi.
3. Chamberlain C.J (1955) Gymnosperms-structure and evolution. Dover Publications, Inc. New York.
4. Chamberlain C.J (2000) Gymnosperms CBS Publishers, New Delhi.
5. Coulter and Chamberlain 1964.Morphology of Gymnosperm Central Book Depot, Allahabad.
6. Ramanujan C.G.K (1976) Indian Gymnosperms in time and space. Today and Tomorrows printers and publishers, New Delhi.

7. Sharma O.P (1997) Gymnosperms, Pragati Prakasan, Meerut.
8. Sporne K.R (1986) Morphology of Gymnosperms, Hutchinson University Library, London.
9. Vashishta P.C (1999) Gymnosperms, S. Chand &Company, New Delhi.

PAPER. 15PBO13.MICROBIOLOGY, HISTOLOGY, MICROTECHNIQUE AND HISTOCHEMISTRY

162 hrs (Theory:108 hrs;Practical:54hrs)

A. MICROBIOLOGY- 36hrs (2hrs/wk)

1. Brief history of microbiology. Experiments of Pasteur and Tyndall. Koch's postulates. Methods of sterilization. (4 hrs)
2. Changing concepts in microbial taxonomy- molecular taxonomy- Jackard's similarity coefficient. (2 hrs)
3. Brief account of major classes of microorganisms. (4hrs)
4. Growth and nutrition of microorganisms. (2 hrs)
5. Microbial diseases in plants, animals and humans (any two). (4 hrs)
6. Microbes in Agriculture: Rhizosphere, Nitrogen fixation, Mycorrhiza**,** Cyanobacteria (2 hrs)
7. Industrial Microbiology: Major industrial products from microbes: Beverages, Antibiotics, Secondary metabolites, Recombinant products (2 hrs)
8. Environmental Microbiology: Anthropogenic wastes. Municipal Wastes, Xenobiotics, Xenobiotic degrading consortia, Bioremediation (2 hrs)
9. Immunology
    a. Immunity-mechanism; Innate and adaptive immune system: cells and molecules involved in innate and adaptive immunity.
    b. Antigens, antigenicity and immunogenicity. B and T cell epitopes.
    c. Structure and function of antibody molecules, generation of antibody molecules, generation of antibody diversity, monoclonal antibodies, antibody engineering.
    d. Antigen antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cell, B&T cell receptors.
    e. Humoral and cell mediated immune responses, primary and secondary immune modulation, the complement system, Toll like receptors cell mediated effector functions.
    f. Inflammation, hypersensitivity and auto immunity, immune response during bacterial (tuberculosis) parasitic (malaria) and viral (HIV) infections, congenital and acquired immune-deficiencies, vaccines. (14 hrs)

Practical 9hrs (0.5 hr /wk)

1. Practicals involving preparation of media, principles of isolation, pure culturing aspects and maintenance of culture.
2. Methods of study: Hanging drop for demonstrating bacterial motility; differential staining – gram and acid fast.

3.Isolation of Rhizobium from root nodule of Legumes.
4.Test for coliforms in contaminated water.
5.Isolation of pure bacterial culture by streak plate method.

References

1. Atlas M and Bartha R(2000) Microbial Ecology, Longmann New York.
2. Black J, G (1999) Microbiology–Principles and Explorations, Prentice Hall, London.
3. Brock T.D (1996) Biology of microorganisms Prentice Hall, London
4. Casida L.E (1997) Industrial microbiology .New Age Publishers, New Delhi
5. Dubey R.C and Maheswari D.K (2010) A Text book of Microbiology, S. Chand& Company, New Delhi.
6. Karp G(2008) Cell and Molecular biology-concepts and experiments. John Wiley & sons, New York.
7. Roitt I (1997) Essential Immunology .Black Well Science Ltd, London.
8. Kumar H.D and Kumar S(1999) Modern concepts of Microbiology, Vikas Publishing House, New Delhi.
9. Lodish B *et al. (*2008)Molecular Cell Biology 6th Ed. W.H. Freeman & Co. New York.
10.Lydyard P.M. *et al.*(1999) Instant notes in Immunology .Viva Books, New Delhi.
11. Pelezar M.J, Chan E.C.S and Kreig N.R (1993). Microbiology-concepts and Applications. McGraw Hill, Inc. New York.
12. Rao A.S(2001) Introduction to Microbiology. Prentice Hall of India, New Delhi.
13. Sharma P.D (2005) Environmentalmicrobiology.Narosa publishers, New Delhi.
15. Stainer R.Y*et al.* (1990) The microbial world. Prentice Hall of India, New Delhi.

B. <u>HISTOLOGY-</u> 27hrs (1.5 hrs/wk)

1. Origin, structure and function of cambia and their derivatives (6 hrs)
2. Seasonal variation in cambial activity, role of cambium in wound healing and grafting (2 hrs)
3. Anomalous cambial activities in *Bignonia, Amaranthus, Mirabilis, Bougainvillea, Piper, Aristolochia, Thunbergia, Pothos* (6 hrs)
4. Structure of wood- Soft wood, hard wood, Sap wood, Heart wood and role of extractives in wood quality. Wood anatomy of the following wood yielding plants of Kerala:

Artocarpus integrifolia, Tectona grandis, Dalbergia latifolia, Ailanthus malabarica (6 hrs)

5. Nodal anatomy, root –stem transition, transfer cells. (2 hrs)
6. Floral anatomy. (1 hr)
7. Histochemical and ultra structural aspects of development, differentiation and morphogenesis. (3 hrs)
8. Anatomy in relation to Taxonomy. (1 hr)

Practical 9hrs (0.5 hr/wk)

1. Anomalous structures of types mentioned in the syllabus
2. Nodal anatomy and root-stem transition.
3. Maceration of herbaceous and woody stems- separation of different cell types.

References

1. Chandurkar P.J (1966) Plant anatomy. Oxford & IBH Publication Co., New Delhi.
2. Cutler D.F(1978) Applied Plant Anatomy. Orient Longman, New Delhi.
3. Cutler E.G(1978) Plant Anatomy (Vol. I, II.) Edward Arnold, London.
4. Eames A.J& Mac Daniels L.H(1979)An introduction to Plant Anatomy. Mc. Graw Hill New York.
5. Esau K (1974) Plant Anatomy. Wiley Eastern Ltd., New Delhi.
6. Esau K(2002)The anatomy of seed plants. John Wiley &Sons, New York.
7. Fahn A(1989) Plant Anatomy, Pergamon press, Oxford, New York.
8. Foster A.S(1960) Practical Plant Anatomy. Van Nostrand & East West, New Delhi.
9. Metcalfe C.R. and Chalk L(1950) Anatomy of the Dicotyledons and Monocots(Vol.I, II), Oxford University Press, London.

C. MICROTECHNIQUE AND HISTOCHEMISTRY- 45 hrs (2.5 hrs/wk)

1. Scope of Histochemistry and Cytochemistry in Biology. (2 hrs)
2. Tissue processing steps (10 hrs)

   Killing and fixing –reagents and fixative formulations, chemistry of fixation; Dehydration–reagents; Infiltration and embedding;Sectioning and mounting

3. Tissue processing techniques for light microscopy, electron microscopy, hand and serial sections, squashes, smears and maceration (9 hrs)
4. Microtomy: Rotary, Sledge, Freezing,Cryostat and Ultratomes (5 hrs)
5. Biological stains: Classification and chemistry of biological stains; general and specific; vital stains and flurochromes. (5 hrs)
6. Micrometry, camera lucida,photomicrography. (3hrs)
8. Detection and localization of primary metabolites (5 hrs)

   Carbohydrates (PARS reaction),
   Proteins (Coomassie brilliant blue staining)
   Lipids(Sudan Black method) .

9. Detection and localization of secondary metabolites: alkaloids, terpenoids, phenolics (3 hrs)
10. Enzyme histochemistry- General design and applications. (3 hrs)

Practical 36hrs (2hrs/wk)

1. Preparation of double stained free hand sections and identification of the tissues with reasons (Normal or Anomalous secondary thickening).
2. Preparation of serial sections from the given block.
3. Free hand sections showing localization of soluble components –Proteins, Sugars and Lipids.
4. Preparation of squashes and smears; Maceration of tissues for separating cell types
5. Measurement of microscopic objects (algal filaments,spore,pollen etc.)
6. Students should submit 10 permanent slides (4hand sections, 3 serial and 3 slides from squash, smear, wholemount and histochemical localization)

References

1. Gahan P.B(1984) Plant histochemistry and Cytochemistry. Academic Press, London.
2. Gary P(1964) Hand book of Basic microtechnique. John Wiley & Sons, New York.
3. Harris R(1991)Electron Microscopy in Biology- a practical approach. IRL press, Oxford, UK.
4. Johanson W.A(1982) Botanical Histochemistry.-Principles and Practice Freeman Co.
5. Johanson W.A(1984) Plant Microtechnique. Mc Graw Hill, . New York.
6. Sass J.E(1964) Botanical microtechnique. Oxford & IBH Publishing Co. Calcutta.
7. Kierman J.A(1999) Histological and Histochemical Methods. Butterworth Publ. London.
8. Pearse A.G.E (1960) Histochemistry.Vol. I &Vol. II, J & A. Churchill, London.
9. Ruzin Z.E(1999) Plant Microtechnique and Microscopy. Oxford Press, New York.

SEMESTER II

PAPER. 15PBO21. PLANT BREEDING, HORTICULTURE AND REPRODUCTIVE BOTANY

(Theory 108 hrs; Practical 27 hrs)

A. PLANT BREEDING63 hrs (3.5 hrs/wk)

1. Definition, Objectives. Importance of floral biology in plant breeding. (3 hrs)
2. Methods of crop improvement
   a. Plant Introduction: Definition, types and procedure. Sources of germplasm.Centres of genetic diversity. Concepts of de Candolle and Vavilov.Primary, secondary and microcenters.Genetic erosion.Preservation and utilization of germplasm. Gene banks. NBPGR. (4 hrs)
   b.Selection: Principles, genetic basis and methods: Mass selection, pure line selection, clonal selection. (6 hrs)
   c. Hybridization: Objectives. Procedure.Major achievements. Problems and causes of failure of hybridization. Handling of hybrids - Bulk method and pedigree method of selection. Distant hybridization - Role of interspecific and intergeneric hybridization in crop improvement. (7 hrs)
3. Role of incompatibility and sterility in crop improvement. (3 hrs)
4. Backcross breeding: Theory and procedure. (5 hrs)
5. Inbreeding: inbreeding consequences. Heterosis-Definition.Genetic and physiologic basis.Application in plant breeding. Steps in the production of single cross, double cross, three waycross, synthetic cross, multilines. Idiotype breeding: Concept, Achievements: (Wheat–Asana, Donald. Rice–Super Rice). (7 hrs)
6. Polyploidy breeding: induction of autopolyploidy and allopolyploidy. Role of chromosome manipulation. Chromosome addition and substitution lines. Achievements. (6 hrs)
7.Mutation breeding: Principles, objectives, procedure. Induction of mutations: Physical and chemical mutagens - Recurrent irradiation, Split dose irradiation, Combination treatment.Achievements. (6 hrs)
8.Resistance breeding: Principles. Methodology. Basis of resistance: structural biochemical, physiological and genetic. Gene for gene systems of plants. Vertical and horizontal resistance. Artificial production of epiphytotic conditions and screening procedures for resistance. (7 hrs)
9. Seed production and certification. (4 hrs)
10.Centres of crop breeding: International and National (with special reference to

Kerala). (3 hrs)

11. Plant breeder's rights Act. National Biodiversity Policy. (2 hrs)

Practicals9hrs (0.5 hr/wk)

1. Emasculation; preparation of the inflorescence for crossing
2. Estimation of pollen sterility and fertility percentage
3. Pollen germination: *in vitro* and *in vivo* viability tests
4. Developmental stages of anther, ovule, embryo and endosperm.

References

1. Allard R W(1999) Principles of Plant Breeding . John Wiley &Sons. Inc. New York.
2. Hagberg A and Akerberg E(1962) Mutation and polyploidy in plant breeding Heimeman Educational Books Ltd. London.
3. Chopra V.l(1989) Plant Breeding .Oxford IBH, New Delhi.
4. Roy D(2000) Plant Breeding. Narosa Publishing House , New Delhi.
5. Briggs F.W and Knoles, P. F(1967) Introduction to Plant Breeding. Reinhold Publishing Corporation , New York.
6. Jensen N. F(1988) Plant Breeding methodology. Wiely Inter- Science Publ. New York.
7. Mandal A. K(2000) Advances in Plant Breeding . CBS Publishers, New Delhi.
8. Sing B. D(1999) Plant Breeding . Kalyani Publishers, New Delhi.

B. HORTICULTURE18 hrs (1 hr/wk)

1. Concept and Scope – Familiarization of famous gardens in the world and in India. (2 hrs)

2. Tools and Implements- spade, pick axe, weed cutter, trimmer, sprayer (rocker & power sprayer, hand shear, budding knife, garden tiller, lawn mower. (1 hr)

3. Plant growing structures – Greenhouse, Glasshouse and Mist chamber. (1 hr)

4. Plant propagation: Seed propagation and vegetative propagation- natural and artificial. Artificial methods of vegetative propagation: Cuttage, layerage, graftage, budding, micropropagation. (3 hrs)

5. Cultural practices – Thinning, training, trimming and pruning. (1 hr)

6. Fertilizers: NPK, biofertilizers, green manure, compost, vermicompost. (2 hrs)

7. Outdoor horticulture: Components and designs of gardens. Types of gardens: Vegetable/ medicinal/ floral/ Home gardens/ public gardens/ vertical gardens/ roof gardens/ Lawns andlandscapes. (3 hrs)

8. Commercial horticulture: Nurseries, Orchards; Floriculture: Production of cut flowers. Floral decorations (Brief account only).Indoor plants. (2 hrs)

9. Arboriculture: Pruning, bracing, feeding and transplanting. Bonsai: Principles and procedure. (2 hrs)

10.Plantprotection. Control of disease and pests. (1 hr)

Practicals 9 hrs (0.5 hr/wk)

1. Budding – 'T' Budding and Patch Budding
2. Layering – Any two methods.
3. Grafting – Any two methods.

References

1. George A(2009) Horticulture- Principles and practices. Phi Learning Publishers, New Delhi.

2. Kumaresan V(2001) Horticulture. Saras Publications, Nagercoil, Tamilnadu

3. Chadha K.L. (2001) Handbook of Horticulture, ICAR, New Delhi.

4. Christopher E. P (1981) Introductory Horticulture, McGraw Hill, New Delhi.

5. Edmond J. B(1977) Fundamentals of Horticulture. Tata McGraw Hill, New Delhi.

6. Reiley E and Shry C. (2000)Introductory Horticulture. Thomas Delmer. New York.

7. Preece J.E and Read P.E (1993). The Biology of Horticulture: an introductory text book. Wiley Eastern.

8. Manibhushan Rao K (1991) Text book of Horticulture. Macmillan India, New Delhi.

C. REPRODUCTIVE BOTANY- 27 hrs (1.5 hrs/wk)

1. Asexual reproduction:Vegetative apomixes, Adventive embryony, Non recurrent apomixis, diplospory, apospory, parthenogenesis, androgenesis, gynogenesis, automixis, semigamy, agamic complex. (5 hrs)

2. Sexual reproduction: Development of flower -Transition from vegetative to flowering stage, gender expression in monoecious and dioecious plants. (2 hrs)

3. Microsporogenesis:Male gametophyte - pollen fertility and sterility Types of male sterility: Gametic and zygotic sterility. Somatoplasticsterility.Cytoplasmic and genetic sterility.Pollenstorage.Pollen viability and germination. (5 hrs)

4.Megasporogenesis: Embryosacdevelopment and types. (4 hrs)

5.Pollination:Primary and secondary attractants of pollination, ultra structural and histochemical details of style and stigma,significance of pollen-pistil interactions. (3 hrs)

6.Fertilization:Barriers to fertilization, genetics of incompatibility, methods to

overcome incompatibility- intra ovarianpollination and in vitro fertilization, embryo rescue. (4 hrs)

7.Embryo, endosperm and seed development, Polyembryony, Parthenocarpy. (4 hrs)

Practical 9 hrs (0.5 hr/wk)

1. Study of pollen types using acetolysed/non-acetolysed pollen
2. Developmental stages of anther, ovule, embryo and endosperm.

References

1. Maheswari P (1980) Recent Advances in the Embryology of Angiosperms.
2. Johri B.M(1984) Embryology of Angiosperms. Springer Verlag. Berlin.
3. Pandey A.K(1997) Introduction to Embryology of Angiosperms. CBS Publishers and Distributors, New Delhi.
4. Bhojwani S.S. and Bhatnagar S.P (2000)The Embryology of Angiosperms, Vikas Publishing House Pvt. Ltd. New Delhi.
5. Pandey S.N and Chadha A (2000) Embryology. Vikas Publishing House Pvt. Ltd. New Delhi.
6. Fosket D.E(1994) Plant, Growth and Development: A Molecular Approach, Academic Press.
7. Raghavan V (2000) Developmental Biology of Flowering Plants, Springer, Netherlands.
8. Raghavan V(1997) Molecular Embryology of Flowering Plants. Cambridge University Press.
9. O'Neill S.D & Roberts J.A(2002) Plant Reproduction, Sheffield Academic Press.

PAPER 15PBO22. ENVIRONMENTAL BIOLOGY, FOREST BOTANY, PHYTOGEOGRAPHY AND CONSERVATION BIOLOGY
(Theory 108 h; Practical 36 h) (Theory 6 h/wk; Practical 2 h/wk)

A. ENVIRONMENTAL BIOLOGY- 54 hrs (3 hrs/wk)

1. Introduction to various approaches to the study of ecology based on levels of organization and habitat- interaction between environment and biota. Ecological niches, Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. (5 hrs)

2. Physical environment; biotic environment; biotic and abiotic interactions. Concepts and dynamics of Ecosystems: Types – Aquatic (fresh water, marine, estuarine) and terrestrial. Components of ecosystem, application of Law of thermodynamics, food chain, food web, trophic levels, ecological pyramids and recycling - energy flow and transaction. Productivity and Biogeochemical cycles.Development and evolution of ecosystems.Ecosystem management. (12 hrs)

3.Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations. (4 hrs)

4.Nature of communities; community structure and attributes; levels of species diversity and its measurement; edge effect and ecotone. (4 hrs)

5.Major terrestrial biomes. (3 hrs)

6.Species interactions - types of interactions, interspecific competition, herbivory, carnivory, symbiosis. (4 hrs)

7.Study of climate, their distribution and adaptation to the environment. Deserts (dry and cold) Tundra, Grassland, Savannah, Temperate forests, Tropical rain forests, Mangrove. (3 hrs)

8. Ecological concepts of species: Autecological level (genecology), Synecological level (Ecosystem level). Ecads (Ecophenes), Ecotypes, Ecospecies. (4 hrs)

9. Ecological succession: Types; mechanisms; changes involved in succession; concept of climax (4 hrs)

10.Applied ecology: Environmental pollution; global environmental change; biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Current environmental issues in India, Environmental education and awareness. (6 hrs)

11.Disaster management, Environmental laws, Global environmental problems- ozone depletion, green house effect, global warming, acid rain, nuclear hazards – Climate change, Eutrophication. (5 hrs)

Practicals 36 hrs (2 hrs/wk)

1. Analysis of vegetation - Quadrate /line transects to find frequency and interpret the vegetation in terms ofRaunkiaer's frequency formula.
2. To find out the dissolved oxygen content in the given water sample (pond, lake, well etc).
3. To find out the primary production in the given water sample using light and dark bottle method.
4. Estimation of carbonate and bicarbonate content in water samples.
5. Estimation of total organic carbon content in the given soil sample
6. Visit to a local area to document environmental assets river/ forest/grassland/hill/mountain
7. Visit to a local polluted site-Urban/Rural/Industrial/Agricultural

References

1. Odum F. E(1971) Fundamentals of Ecology. W.B. Saunders and Company.
2. Sharma P. D(1997) Enviornmnetal Biology, Rastogi Publications, New Delhi.
3. Agarwal K.C(2001) Environmental Biology, Nidi Publ. Ltd. Bikaner
4. Brunner R.C(1989) Hazardous Waste Incineration, McGraw Hill Inc.
5.Jadhav H & Bhosale V.M(1995) Environmental Protection and Laws. Himalaya Pub. House, Delhi.
6. Trivedi R. K. and Goel P.K(2003)An Introduction to air pollution, Techno-Science, ABD publishers, Jaipur.
7. Cunningham W.P, Cooper T.H, Gorhani E & Hepworth M.T(2001) Environmental Encyclopedia, Jaico Publ. House, Mumbai.

B.FOREST BOTANY9 hrs (0.5 hr/wk)

1. Forests-definition,study of various forests of the world and India.(1 hr)
2 .Forest products-Major and Minor with reference to Kerala. (2 hrs)
3. Influence of forest on environment. (2 hrs)
4. Consequence of deforestation and industrialization. (2 hrs)
5. Sustainable use of bioresources. (2 hrs)

References

1. Puri G.S.1983. Forest Ecology, Oxford & IBH, New Delhi.
2. LalJ.B. 2011.Forest Ecology, Natraj publishers, Dehradun.
3. Chaubey O.P, Sharma A, Prakash R. 2014. Forest Ecology in India. Aavishkar publishers, Jaipur.
4. Puri G.S. 1960. Indian forest ecology: a comprehensive of vegetation and its environment in Indian subcontinent. Oxford book and stationary Co., New Delhi.

5. Champion G.H. & Seth K.A. 1935. A revised survey of forest types of India. Manager of publication, New Delhi.
6. Bor N.L 1953. Manual of Indian Forest Botany. Oxford University Press, Calcutta.
7. Chaudhari A.B and Naithani H.B. 1985. Environment and resources of tropical and temperate forests of India. International book distributors, Dehradun.

C.PHYTOGEOGRAPHY18 hrs (1 hr/wk)

1. Define-Phytogeography-static and dynamic phytogeography (2 hrs)
2. Geological history and evolution of plant life. (4 hrs)
3. Factors of plant distribution.Theories concerning present and past distributions-continental drift,glaciations,existence of land bridges and their effect on plant distribution. (4 hrs)
4. Phytogeographic regions of the world (Vegetable belts) (4 hrs)
5. Soil, climate, flora and vegetation of India. (4 hrs)

References

1. Good R (1964)The geography of flowering plants. Lengmans.
2. Bharucha F.R(1984)A text book of plant geography of India. Oxford University Press.
3. Puri G.S (1983) Indian Forest Ecology, Vol. I & II, Oxford & IBH.
4. Schatz G.E(1996) Malagasy/Indo-Australo-Malesian Phytogeographic Connections.http://www.mobot.org/MOBOT/Madagasc/biomad 1.html.
5. The international Biogeography Society .http.//www.biogeography.org/
6. Tree of Life .URL:http://tolweb.org/tree/phylogeny.html.

D.CONSERVATION BIOLOGY 27 hrs (1.5 hrs/wk)

1. Concept, aim and principles of conservation. (1 hr)
2. Convention on Biological Diversity-Objectives-Definition of biodiversity-Roles of IUCN, MAB, Red data book, Threatened categories of plants.Conservation strategies:In-situ and Ex-situ conservation-Sustainable development.Biosphere reserves, Wild life sanctuaries and National parks in India with special reference to Kerala. (4 hrs)
3. Agriculture and Industrialization and conservation of resources:Historical background of role of agriculture and industry in development, Novel agricultural technologies, Wind mills for irrigation,Solar energy for drawing ground water,Biogas for cooking and slurry left to be used as fertilizers.Impact of industrialization on agricultural development. (4 hrs)

4. Urbanization and Conservation:Environmental problems of urban and rural areas.Natural resources and depletion -planning for environmentally compatible human settlements and strategy for sustainable industrial development. (4 hrs)

5. Conservation and energy: Causes of energy crisis-Conservation of energy source in industry, agriculture & in the transport sector. (3 hrs)

6. Renewable and Non-renewable energy:Development of non-polluting energy systems-Solar energy, Wind energy,energy recovery from solid wastes-Convention energy,Non-convention energy source. (4 hrs)

7. Conservation of physical resources. (Mention all physical factors of environment). (2 hrs)

8. Afforestation-Social forestry,agroforestry,International Biological programme (IBH), Man and Biosphere (MAB), IUCN, World environment day, wild life preservation act (1972), Indian forest conservation act(1980), United Nations Environmental Programme,Environment protection Act. (5 hrs)

Practicals

1. One day visit to ecologically significant location (National parks/Mangroves/Estuaries/Freshwater lake).

2. Each student should plant and maintain at least two plants in the college botanic garden or premises, belonging to IUCN category, and document the same (in the Record).

References

1. Dasman R.F (1976). Environmental conservation, John Wiley and Sons, New York.

2. Malcom L, Hunter J.R and Gibbs J(2007). Fundamentals of Conservation Biology, Blackwell Publishing.

3. Pullin A. S(2002). Conservation Biology, Cambridge University Press.

4. Dyke F.V (2008) Conservation Biology, Foundation, concept, applications, Springer.

5. Mac Donald and Katrina Service (2007) Key Topics in Conservation Biology, Blackwell publishing.

6. Fielder P.I and Kareiva P.M (1998) Conservation Biology for the coming decade, Chapman and Hall.

PAPER 15PBO23.CELL AND MOLECULAR BIOLOGY, GENETICS
Theory 108 hrs; Practical 54 hrs (theory 6 hrs/week; Practical 3 hrs/week)

A. <u>CELL AND MOLECULAR BIOLOGY</u> 54 hrs (3 hrs/wk)

1. A brief account on the structural and functional organization of the cell and cell organelles. Prokaryotic and eukaryotic cells.Cytoskeleton- its role in cell organization and mobility. (4 hrs)

2.Ultra structure of the cell membrane, nuclear envelope, nuclear pore complex, chloroplast, mitochondrion, Endoplasmic reticulum, lysosomes and ribosomes. Nucleus – structural and functional organization. Mitochondrial and Chloroplast genome organization and function. Nucleolus – origin, ultra structure and function. (7 hrs)

3**.** Chemistry of chromosomes – DNA – organization, histone and non-histone proteins, RNA and organization of these in the three dimensional configuration of the chromosome. A study on thestructure and function of the kinetochore – NOR and other secondary constrictions, satellites, heterochromatic segments and telomeres. (6 hrs)

4.Numerical variations of chromosomes – origin and meiotic behavior of haploids, aneuploids and polyploids.Structural variations of chromosomes – Deletions, duplications, inversions and translocations, meiotic behavior in the above types. (4 hrs)

5**.** Cell Divisions. Stages in cell cycle – G1, S, G2 – Interphase, Prophase, Metaphase, anaphase and Telophase.Mitotic apparatus.Cytokinesis. Meiosis – General description. Synaptonemal complex, structure and function with significance of the various stages of meiosis I and II.Theories and mechanisms of crossing over. Molecular mechanism of crossing over.(6 hrs)

6. Cell differentiation - General characteristics, molecular mechanism of cell differentiation. (3 hrs)

7. Cellular communication-regulation of hematopoiesis, general principles of cell communication, cell adhesion and role of different adhesion molecules, gap junctions, extracellular matrix, intergrins. (4 hrs)

8. Cell signaling- Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and two component systems, light signaling in plants, bacterial chemotaxis and quorum sensing (5 hrs)

9. Cancer- genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and cell cycle, virus induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth (4 hrs)

10. Molecular tools for studying genes and gene activity. (4 hrs)

a. Molecular marker technologies

b. Molecular cloning methods

13. Technique of DNA Analysis: Preparation of DNA and RNA Probes; Principles of hybridizations and hybridization based techniques (Colony, Plaque, Southern and*in situ* hybridization); Autoradiography;.DNA Fingerprinting (4 hrs)

14**.** DNA sequencing, chemical synthesis of nucleotides (3 hrs)

Practical 36hrs(2 hrs/wk)

1. Mitosis – All stages - *Allium cepa*, *Vicia faba* ; Calculation of Mitotic Index
2. Meiosis – All stages - *Rhoeo, Chlorophytum, Crotalaria, Datura* (at least two should be recorded)
3. Isolation and purification of genomic DNA.
4. Isolation of total RNA (Demonstration only)
5. Isolation and Partial purification of Proteins.

References

1. De Robertis and De Robertis (1998) Cell and Molecular Biology. B. I. Waverly Pvt Ltd. New Delhi.
2. Strickberger M. W(1985) Genetics. Macmillian India, New Delhi.
3. Gerald Karp (1984) Cell Biology.McGraw Hill, New Delhi.
4. Jurgen Schulz-Scaffer (1985) Cytogenetics- Plants Animals and Humans. Springer Verlag, Berlin.
5.Cooper G. M(1997) The Cell – A Molecular approach. ASM Press, Washington.

B. GENETICS (54 hrs; 3 h/week)

I. Classical genetics

1. Mendelian Genetics – Critical Evaluation (2 hrs)
2. Sex determination, Dosage compensation, Barr body, Lyon's hypothesis. (2 hrs)
3. Linkage, recombination and linkage maps – Bateson's concept of coupling and repulsion. Morgan's concept of linkage, linear arrangement of genes, linkage groups, complete and partial linkage and recombination linkage maps, three point test crosses, interference coefficient of coincidence and negative interference. (4 hrs)
4. Microbial Genetics – Genetic recombination in viruses – lysogenic and lytic cycles in bacteriophages. Benzer'sexperiment in the rII locus of T4 phage, retro viruses, reversetranscriptase, onco viruses, and oncogenes. Bacterial recombination - transformation experiment of Griffith, Avery *et al.* Conjugation – F+, F- and Hfr F- conjugations. Conjugation mapping– F– duction (sexduction). Transduction-generalized and specialized.

Recombination in fungi (tetrad analysis in *Neurospora*). Complementation tests. (6 hrs)

5. Biochemical Genetics – Contributions of Garrod, Beadle and Ephrussi, Beadle and Tatum. (1 hr)

6. Gene concept – Factor concept of Mendel, Presence absence theory of Bateson. Gene –Enzyme relationship, One gene - One enzyme hypothesis. Benzer's concepts of Cistron, muton and recon.Brief description of the following types of genes- smart genes (luxury genes),housekeeping genes, transposons overlapping genes, split genes, homeotic genes, pseudogenes, orphan genes, selfish genes, gene cluster, gene families. (3 hrs)

II Molecular Genetics

1. DNA as the genetic material, DNA constancy, C - Value paradox, structure of B-DNA, A-DNA, RL-Helix and Z – DNA. (2 hrs)

2. DNA replication – Stage, unit and mode of replication, Semi conservative mode of replication.Messelson – Stahl experiment. System of replication – template, deoxy nucleotide triphosphate pool, enzymes and protein factors. Mechanism of replication, unidirectional and bidirectional replication. Molecular assembly at the replication fork, leading and lagging strands, Okasakifragments. DNA polymerases of prokaryotes and eukaryotes, topoisomerases, gyrases, ligases and nucleases. DNA polymerase function, proof reading and repair. Comparison of eukaryotic and prokaryotic DNA replication. Replication of ØX174 DNA. (6 hrs)

3. DNA damage and repair- Photoreactivation repair, excision repair, recombinational repair, SOS repair. Genetic diseases caused by defects of DNA repair system – Blooms syndrome, Xerodermapigmentosum, Retinoblastoma. (2 hrs)

4. Mutation – Types of mutations, methods of detection (CIB method, attached X method). Molecular mechanism of spontaneous and induced mutations, site directed mutagenesis. Environmental mutagenesis and toxicity testing, high radiation belts of Kerala. Mutagenic effects of food additives and drugs. Ames test. (4 hrs)

5. Genetic code – Genetic code word dictionary. Features of the genetic code and its exceptions. (2 hrs)

6. Protein synthesis - Central dogma, Transcription, organization of transcriptional units. Prokaryotic and eukaryotic RNA polymerases and their function. RNA processing and translation. (2 hrs)

7. Gene Regulation – Gene Regulation in viruses - Cascade model of expression of early middle and late genes in viruses. Gene Regulation in Prokaryotes – Operon concept, positive and negative control attenuation, anti termination. Gene Regulation in Eukaryotes – Heterochromatinisation and DNA methylation- DNA methylases, DNA rearrangements.Transcriptional

regulation – signal transduction - upstream and downstream.Regulatory sequences and transacting factors, activators and enhancers.DNA binding by transcription factors. Britten and Davidson model for eukaryotic gene regulation. Post transcriptional regulation – RNA processing – split genes, hn RNA, introns and exons, capping, polyadenylation, splicing, snRNAs and spliceosomes. Post transcriptional silencing, MicroRNAs, RNA inhibition. Translational regulation and Post Translational regulation –Cleavage and processing of proteins.Genetic imprinting. Environmental regulation of gene expression. (8 hrs)

8. Gene synthesis – Khorana's artificial synthesis of the gene for alanine. Transfer RNA and tyrosine transfer RNA of yeast. (2 hrs)

III. Population Genetics and Developmental Genetics

1. Population genetics – Systems of mating and their genetic effects. Hardy Weinberg law and itsapplications. Factors affecting gene frequencies – mutation, migration, selection, genetic polymorphism and selection. Genetic drift, founder effect, genetic load. Consanguinity and its genetic effect. (4 hrs)

3. Developmental genetics- Genetic control of development in plants and animals with stress to developmental genes in *Arabidopsis* and *Drosophila.* Role of cytoplasm in development. (2 hrs)

4. Principles of Human Genetics (2 hrs)

Practicals27 hrs (1.5 hrs/wk)

Work out problems in linkage chromosome mapping, microbial genetics, molecular genetics and population genetics.

References

1. Goodenough U. (1984) Genetics. Holt Saunders, New York.
2. Karp G. (2013) Cell and Molecular Biology: Concepts and experiments. Willey & Sons.
3. Lewin B. (2000) Genes VII. Oxford University Press, New York.
4. Lodish *et al.* (2000) Molecular and Cell Biology. W. H. Freeman and Co, New York.
5. Sinnot E. W. *et al.*(1958) Principles of Genetics. Mc Graw Hill, New Delhi.
6. Strickberger M. W (1985) Genetics. Macmillian India, New Delhi.
7. Gardner, Simmons M.J, Snustad D.P (2006) Principles of Genetics, John Willey & Sons.

SEMESTER III

PAPER 15PBO31

TAXONOMY OF ANGIOSPERMS, ECONOMIC BOTANY, ETHNOBOTANY AND EVOLUTION

(Theory 108 H; Practical 45 H) (Theory 6 H/wk; Practical: 2.5 H/wk)

A. TAXONOMY OF ANGIOSPERMS 72 hrs (4 hrs/wk)

1. Principles of taxonomy as applied to the systematics and classification of Angiosperms - species concept, taxonomic structure. (2 hrs)
2. Classification – brief study of Artificial (Linnaeus), Natural (Benthem and Hooker) and Phylogenetic (Bessey and Takhtajan) systems. (4 hrs)
3. Detailed study of modern system of classification – Angiosperm Phylogeny Group (APG) classification system. (2 hrs)
4. Plant nomenclature, Evolution of ICBN, contents of ICBN, author citation, type concept and different types – publication of names, rule of priority, nomina conservanda and definition of nomenclature terms- autonym, homonym, basionym, tautonym and nomennudum. (3 hrs)
5. History and development of taxonomy in India. Classification of taxonomical literature, general indices, floras, icons, monographs, reviews and journals; Herbarium – definition, steps involved in the development of herbarium, utility of herbarium and their maintenance, general account of National and regional herbaria with special reference to Central National Herbaria, Calcutta (CAL) and Madras Herbarium (MH), Botanical Survey of India, Botanical gardens and importance of botanical garden in taxonomic studies, important National and International Botanical gardens, Royal Botanical Garden, Kew, Indian Botanical Garden, Calcutta, National Botanic Research Institute, Lucknow and Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Trivandrum. (4 hrs)
6. Construction of taxonomic keys (indented and bracketed) and its utilization. (2 hrs)
7. Role and organization of Botanical Survey of India. (1 hr)
8. Modern concepts and trends in plant taxonomy. Elementary treatment of
   i. Cytotaxonomy, ii. Chemotaxonomy, iii. Numerical taxonomy (taximetrics), iv. Molecular taxonomy, v.Biosystematics. (5 hrs)
9. Critical study of the current ideas on the origin of angiosperms with special reference to their ancestral stock, time and place of origin. (2 hrs)
10. Study of the following angiosperm families giving importance to morphological peculiarities if any (Special emphasis should be given on morphological and phylogenetic interrelationships, recent revisions and

rearrangements between and within the families, and its critical analysis): (47 hrs)

Ranunculaceae	Magnoliaceae	Capparidaceae	Bixaceae
Polygalaceae	Caryophyllaceae	Portulacaceae	Dipterocarpaceae
Sterculiaceae	Meliaceae	Rhamnaceae	Vitaceae
Sapindaceae	Fabaceae	Rosaceae	Rhizophoraceae
Combretaceae	Melastomaceae	Passifloraceae	Cucurbitaceae
Apiaceae	Rubiaceae	Asteraceae	Plumbaginaceae
Ebenaceae	Oleaceae	Asclepiadaceae	Boraginaceae
Solanaceae	Lentibulariaceae	Bignoniaceae	Verbenaceae
Lamiaceae	Nyctaginaceae	Aristolochiaceae	Piperaceae
Lauraceae	Loranthaceae	Euphorbiaceae	Urticaceae
Causuarinaceae	Orchidaceae	Zingiberaceae	Cannaceae
Amaryllidaceae	Liliaceae	Commelinaceae	Araceae
Cyperaceae	Poaceae.		

Practicals36 hrs (2 hrs/wk)

1. Study of representative members of all the prescribed families as evidenced by record of practical work (to be submitted during the practical examination).
2. Identification of fresh and herbarium specimens using flora and other supportive documents like monographs.
3. Visit to a recognized herbaria (The report of the same should be submitted separately).
4. Field work for familiarizing the local flora under the supervision of teachers, and documentation of the proceedings.
5. Study Tour of minimum three days should be conducted to biodiversity rich zones of Western Ghats, for familiarizing the floristic wealth (The report of the same should be submitted for valuation).
6. Preparation of dichotomous key (minimum 5 keys)
7. A minimum of 10 abbreviations of authors' names to be presented in the record.
8. A minimum of 50 herbarium specimens giving representation of minimum of 40 families to be submitted for valuation.

References

1. Ambasta S.P. (1986) The useful plants of India, Publication and Information Directorate, CSIR, New Delhi.
2. A.P.G. I. (1998) An ordinal classification for the families of flowering plants. Ann. Missouri Bot. Gard. 85: 531-553.

3. A.P.G. II. (2003) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Bot. J. Linnean Soc. 141: 399-436.
4. A.P.G. III. (2009) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. Bot. J. Linnean Soc. 161: 105-121.
5. Judd W.S, Campbell C.S, Kellog E.A & Stevens P.F (1999), Plant Systematics.Sinauer Associates, Inc., Massachusetts, USA.
6. Lawrence G.H.M (1964) Taxonomy of Vascular Plants, Mac Millon Co., New York.
7. Rendle A.B (1967) Classification of flowering plants, Cambridge University Press.
8. Sharma O.P (1990) Plant Taxonomy, Oxford Publishers, New Delhi.
9. Singh G. (1999), Plant systematics: Theory and Practice, Oxford IBH.
10. Davis P.H & Heywood (1963), Principles of Angiosperm Taxonomy, Oliver-Boyd.
11. Gamble J.S (1935), Flora of Presidency of Madras, London.
12. Gibbs R.D, Chemotaxonomy of flowering plants.
13. Hooker J.D (1879), Flora of British India. Reeve &Co., London.
14. Hutchinson J. (1959), Families of flowering plants, Cambridge University Press.
15. Lawrence G.H.M (1955), An Introduction to plant Taxonomy, Central Book Depot.
16. Sivarajan V.V (1991) An introduction to Principles of Taxonomy, London.
17. Sivarajan V.V (1999), Principles of plat Taxonomy, Oxford and IBH Publishing Co.
18. Stace C. (1985), Plant Taxonomy and Biosystematics, London.
19. Takhtajan A.L (1969) Flowering plants. Origin and Dispersal, Oliver and Boyed.

B. ECONOMIC BOTANY 9 hrs (0.5 hr/wk)

1. Detailed study of occurrence, mode of cultivation, process, product, biochemical and nutritional values of the following crop plants with their botanical details.

a) Cereals and Millets : Rice, Maize.
b) Pulses : Soya bean, Winged bean and Sword bean
c) Sugar yielding plants : Sugarcane and Sugar beet
d) Beverage crops : Coconut, Cocoa, Coffee and Tea
e) Spices and condiments: Pepper, Ginger, Turmeric, Cardamom and Nutmeg
f) Tuber crops- : Potato, Sweet potato and Tapioca

g) Fruits : Mango, Banana, Citrus, Guava, Grapes and Cashew nut

h) Vegetables : Tomato, Brinjal, Cucumber, Cabbage, Drum stick and Bitter gourd

i) Medicinal plants : *Rawolffia serpentina, Adhathoda vasica, Aristolochia india, Phyllanthus amarus*.

j) Narcotics : Cannabis, Opium

k) Timber yielding plants: Rose wood, Teak Wood

Practicals 9 hrs (0.5 hr/wk)

Identification of economically important plants and plant parts, and submission of five botanical specimens/ products of economicimportance.

References

1. Pandey A. et al. (2005)Wild relatives of Crops plants in India-collection and conservation, NBPGR Sci. Monograph No. 7.

2. Ambasta S.P. (1986)CSIR, The useful plants of India, Publication and Information Directorate, CSIR, New Delhi.

3. Kochar L.S. (1981) Economic Botany in the Tropics, Macmillan.

4. Hill A.F. (1952) Economic Botany, Tata McGraw Hill.

5. Sen S. (1992) Economic Botany, New Central Book Agency, Calcutta.

C. ETHNOBOTANY9 hrs (0.5 hr/wk)

1. Plants and civilization
2. Ethnobotany- relevance in Modern medicine
3. Ethnic societies of Kerala and their traditional herbs
4. Ethnobotanical documentation
5. Medicines derived from herbal drugs
6. Status of ethnobotanical studies in Kerala

References

1. Jain S.K (1987) A manual of Ethnobotany, Indus Intl. Publishers, New Delhi.

2. Jain S.K (2001) Medicinal Plants, National Book Trust, India

3. Wood M. (1997) The book of herbal wisdom: using plants as medicines, North Atlantic Books, California.

4. Cunnigham A. (2001) Applied Ethnobotany: people, wild plant use and conservation, Earthscan, UK.

5. Martin G.J (2004) Ethnobotany: a methods manual, Earthscan, UK

6. Jain S.K and Mudgal V (1999) A hand book of Ethnobotany. Indus Inst. Publishers, New Delhi.

D. EVOLUTION18 hrs (1 h/wk)

1. Origin and evolution of life (including aspects of pre-biotic and molecular evolution) (2 hrs)
2. Concepts and theories of evolution. Classical and synthetic theories of evolution. (4 hrs)
3. Forces and mechanism of evolution. (3 hrs)
4. Speciation (3 hrs)
5. Isolation mechanism. (2 hrs)
6. Evolution above species level. (2 hrs)
7. Molecular evolution. (2 hrs)

References:

1. Strickberger M.W (1996) Evolution, Jones and Bartlett Publishers, New York
2. Savage J.M (1969) Evolution, Oxford &IBH, New Delhi.
3. Sproule A (1998) Charles Darwin: Scientist who have changed the world. Orient Longman, New Delhi.
4. Blackle (1983) Evolutionary principles, Oxford & IBH, New Delhi.
5. Briggs D &Walters S.M (1984), Plant variation and evolution, Cambridge University Press, London.
6. Echrlich & Holm (1974) Process of evolution, Oxford &IBH, New Delhi.
7. Wooley P (1983) Molecular theory of evolution, Springer-Verlag, Berlin.

PAPER 15PBO32. BIOPHYSICS& BIOINFORMATICS
(Theory 108 hrs; Practical 36 hrs)

A. BIOPHYSICS 27 hrs (1.5 hrs/wk)

1.Chemical bonds:Ionic bond, Covalent bond, Vander Vaal's forces, hydrogen bonding and hydrophobic interactions.Bonding in organic molecules. Effect of bonding on reactivity.Polarity of bonds.Bondlength.Bond angle, Dissociation and association constant. (3 hrs)

2.Bioenergetics: Concepts of free energy, Thermodynamic principles in Biology. Energy rich bonds.Coupled reactions and group transfers. Biological energy transducers. (4 hrs)

3. Microscopy: Principles and applications of bright field, phase contrast, fluorescence, confocal microscopy,TEM, SEM,cytophotometry, flow cytometry. (3 hrs)

4. Chromatography: Principle and applications of gel filtration, Ion exchange and affinity chromatography, thin layer chromatography, gas chromatography, HPLC, HPTLC,LCMS, GCMS. (4 hrs)

5. Electrophoresis: Types of electrophoresis-Vertical and horizontal, paper electrophoresis, capillary electrophoresis, 2D gel electrophoresis, Pulsed field gel electrophoresis, Electro focusing. (3 hrs)

6. Sedimentation and filtration:Sedimentation, centrifugation, ultra centrifugation, ultrafiltration (3 hrs)

7. Principles of biophysical methods used for analysis of biopolymers: UV, visible, IR,NMRX-ray diffraction, fluorescence, ORD/CD (4 hrs)

6. Principles and applications of tracer techniques in biology:Radioactive isotopes, radiation dosimetry autoradiography, liquid scintillation. (3 hrs)

Practicals 9 hrs (0.5 hr/wk)

Students are expected to get a good exposure on all the devices used in modern analytic methods by conducting study trips to two research institutions and to present a report.

1. Separation of pigments by column chromatography
2. Separation of amino acids by paper chromatography
3. Separation of alkaloids, phenols and pigments by TLC

References

1. Casey E.J (1962) Biophysics: Concepts and Mechanics**.**
2. Daniel M(1999) Basic Biophysics for Biologists. Agro Botanica, Bikaner.
3. David Freifelder(1976)Physical Biochemistry- Application to Biochemistry and Molecular Biology.

4. Slayter. F.M(1970) Optical Methods in Biology. Wiley Inter Science.
5. Narayanan, P (2000) Essentials of Biophysics. New Age International Publishers, New Delhi.
6. Roy R.N(1999) A Text Book of Biophysics. New Central Book Agency (P) Ltd., Calcutta.
7.Water Hoppe, Wolfgang Lohmann, Hubert Markl and Hubert Zieghr (Eds.) (1983) Biophysics. Springer Verlag, New York.
8. Upadhyay and Nath(2009)Biophysical Chemistry –Principles and techniques. Himalaya Publishing House.

B. BIOINFORMATICS81 hrs (4.5 hrs/wk)

1. Introduction to Bioinformatics: History of Bioinformatics. Basics of Internet, Computational Biology and Bioinformatics. (6 hrs)

2. Biological databases- Types of data and databases, DBMS. Classification of biological databases- primary and secondary, biomolecular, model organism and biodiversity databases. Nucleotide sequence database (EMBL, GENBANK, DDBJ)- Protein sequence database (PIR, SWISS-PROT, TrEMBEL), Secondary Databases (PROSITE, PRINTS, BLOCKS), Protein Structure Database (PDB) (12 hrs)

3.Information retrieval from databases - search concepts, Tools for searching, homologysearching. (6 hrs)

4.Structural Bioinformatics – Molecular visualization using Rasmol, Protein Structure Prediction - Secondary Structure prediction. Bioinformatics tools for secondary structure prediction and Tertiary structure prediction (Comparative modeling, *Ab Initio* prediction, Homology modeling) (8 hrs)

5.Sequence Analysis - Global and Local Alignment, pairwise analysis, Scoring Matrices (an introduction), Multiple Sequence Analysis.Tools used in Bioinformatics - BLAST, ClustalX, ClustalW. (10 hrs)

6.Molecular Phylogeny - Gene and Species tree. Molecular evolution and Kimuras theory, Phylogenetic Trees, Terminology in Phylogenetic tree. Cladogram and Phylogram, Significance of Molecular Phylogeny.Software used in Phylogeny- Treeview, Phylip. (10 hrs)

7.Computer Aided Drug Design and Molecular Docking, Breif study about Docking tools, AutoDock, GOLD (6 hrs)

8.Genomics - Types (Structural and Functional), Genome Annotation, Gene Finding, Comparativegenomics, Single nucleotide Polymorphism Gen-SNIP. (8 hrs)

9.Proteomics - Protein expression analysis, Mass spectrometry in protein identification, Protein Sorting, Metabolomics, Systems Biology-an introduction (6 hrs)

10. Use of Linux and Bio-PERL in Bioinformatics (4hrs)

11.Applications of Bioinformatics- Transcriptomics, Metabolomics, Pharmacogenomics, combinational synthesis (Brief Accounts) (5 hrs)

Practicals 27 hrs (1.5 hrs/wk)

1. Blast search with Protein Sequence (*Magnolia latahensis*sequence)
2. Blast search with Nucleic Acid Sequence (Neanderthal man's PaleoDNA)
3. Phylogenetic tree creation with CLUSTAL X, W and MUSCLE
4. Creation of phylogentic trees for selected families of Eudicots
5. Molecular docking (using either Free or commercial Software)

References

1. Lesk A.M(2002) Introduction to Bioinformatics, 1st Edition, Oxford University Press, Oxford, UK.
2. Jin Xiong (2007) Essential Bioinformatics, Cambridge University Press India, Pvt LTD
3. Higgs (2005) Bioinformatics and Molecular Evolution, Ane Books India Pvt LTD.
4. Kumar S.A, Mohan T.C.K, Murugan K and Subramaniyan S (2011) General Informatics and Bioinformatics. Ane Books India Pvt. LTD.
5. Claverie J.M. and Notredame C. (2003) Bioinformatics for Dummies. Wiley Editor. Vyas, S.P. and Kohli, D.V., Methods in Biotechnology and Bioengineering.
6. Patterson B.K (2000) Techniques in Quantification and Localization of Gene Expression.
7. Mount D.W(2001) Bioinformatics-Sequence and Genome Analysis, 1st Edition, Cold Spring Harbor Laboratory Press, New York, USA.
8. Evens W.J. and Grant G.R (2005) Statistical Methods in Bioinformatics: An Introduction.
9. Liu B.H (1997) Statistical Genomics: Linkage Mapping and QTL Analysis
10. Pierre Baldi and Soren Brunak(2001) Bioinformatics: The Machine Learning Approach.MIT Press.

PAPER 15PBO33.RESEARCH METHODOLOGY, BIOSTATISTICS& PLANT BIOTECHNOLOGY

(Theory 108 hrs; Practical 45 hrs)

A.RESEARCH METHODOLOGY-18 hrs (1 hr/wk)

1. Introduction to Research methodology. (1hr)
2. Research design: objectives, defining a problem, derivation of hypothesis, review of literature. (2 hrs)
3. Experimental design: methodology – analytical, biochemical, molecular(3.5 hrs)
4. Data analysis: use of statistical tools, interpretation of results (3.5 hrs)
5. Thesis preparation: title, abstract, materials and methods, results and discussion (4 hrs)
6. Writing a research paper: using biological literature, deciding on a title, presenting the methodology, drafting and revising the content according to the journal requirements, citing sources in the text, preparingthe reference section. (4 hrs)

References

1. Marder M.P (2011) Research Methodology, Cambridge University Press, UK.
2. Wilson B. E Jr. (1990)An introduction to Scientific Research, Dover Publications, New York.
3. Kothari C.R and Garg G(2013) Research Methodology; Methods and Techniques. New Age International Publishers, New Delhi.
4. Ahuja R. (2001) Research Methods. Rawat Publications, Jaipur.
5. Basten G. (2010) Introduction to Scientific Research Projects. (available free @ bookboon.com)

B. BIOSTATISTICS- 27 hrs (1.5 hrs/wk)

1. Sampling methods and errors (2 hrs)
2. Processing and presentation of data – tables, graphs (2 hrs)
3. Measures of central tendency- mean, median and mode. (3 hrs)
4. Measures of dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation. (4 hrs)
5. Probability – basic concepts, theorems of probability. (2 hrs)
6. Experimental designs – randomized block designs, split plot design, latinsquare (2 hrs)
7. Test of significance – t- test, chi square test (4 hrs)
8. Correlation and regression analysis (4 hrs)
9. F-test, ANOVA, Least Significant Difference (LSD), Broad sense heritability (4 hrs)

Practicals 9 hrs (0.5 h/wk)

1. Calculation of central tendency and dispersion of data from plant science
2. Work out problems on tests of significance-t-test, chi square test, ANOVA
3. Preparation of bar diagram/ frequency curve using EXCEL or SPSS.

References

1. Attwood T.K and Parry-Smith D.J(2004) Introduction to Bioinformatics, Pearson Education (Singapore) Pvt. Ltd.
2. David Edwards (Ed.) (2007) Plant Bioinformatics: Methods and Protocols, Humana Press, New Jersey, USA.
3. Pagano M, Gauvreau K (2007) Principles of Biostatistics. Thomson India Edition, New Delhi.
4. Rex A. Dwyer (2004) Genomic Perl: From Bioinformatics Basics to Working Code,Cambridge University Press, 1st South Asian Edition.
5. Rosenkrantz W.A (2009). Introduction to Probability and Statistics for Science, Engineering

C. PLANT BIOTECHNOLOGY63 hrs (3.5 hrs/wk)

1. Definition. Impact of biotechnology - an overview. (2 hrs)

2. Plant tissue culture techniques: Choice of explant, culture media and culture conditions, hormonal regulation of growth and differentiation, micropropagation; shoot tip, nodal segment, meristem cultures: callus culture, callus mediated organogenesis, cell suspension culture, cell line selection. (10 hrs)

3. Somatic cell genetics and somaclonal variations. (3 hrs)

4. In vitro mutagenesis: Mutagens. Methods of treatment. Selection for biotic (fungi, bacteria and viruses) and abiotic (drought, salinity, herbicides) tolerance. (4 hrs)

5. Somatic embryogenesis. Artificial seeds.Applications. Protoplast culture, Somatic hybridization and its impact on plant breeding. Use of protoplasts in genetic transformations. (7 hrs)

6. Haploid production: anther and ovule culture. Dihaploids and polyhaploids. Applications. (5 hrs)

7. Production of secondary metabolites. Cell immobilization.Bioreactor technology. Conservation of germplasm: in vitro strategies, cryopreservation and international exchange of germplasm. (5 hrs)

8. Genomic and organellar DNA isolation. Methods of gene identification. Vector mediated and vectorless methods. Polymerase chain reaction (PCR). Restriction digestion and ligation; Restriction mapping.Genomic and cDNA libraries. (10 hrs)

9. Methods of gene transfer in plants. Agrobacterium and CaMV mediated gene transfer; direct gene transfer using PEG, microinjection, electroporation,

microprojectile (biolistics) method, liposmemediated DNA delivery, Transposons as vectors. Use of mixed vectors, Transient and stable gene expression in transgenic plants. (8 hrs)

10. Analysis and expression of cloned genes. DNA markers; Restriction fragment length polymorphism (RFLP) ; Random amplified polymorphic DNA (RAPD). Amplified Fragment Length Polymorphism (AFLP), Ligase Chain Reaction (LCR), Antisense RNA. (5 hrs)

11. Genetic engineering: Methods and applications. Transgenic biology.Allopheny. Applications of gene cloning and transformation techniques in plants. Gene targeting and sequence tags. (2 hrs)

12.Genetically modified organisms and foods (GMO/GMF) - Social and ethical considerations. IPR issues.Patents.Biopiracy. (2 hrs)

Practicals36 hrs (2hrs/wk)

1. Preparation of culture medium (MS, N&N, SH, B5), sterilization and inoculation.
2. Shoot multiplication, Callus culture and organogenesis of important crops/medicinal plants/ornamentals.
3. Isolation and estimation of genomic DNA.
4. Demonstration of Agarose gel electrophoresis.
5. Encapsulation of seeds/embryos in calcium alginate.
5. Students have to submit a record of the above.

References

1. Brown C. M(1987) Introduction to Biotechnology. Blackwell Scientific Publications, Oxford, London.
2. Brown C.M, Campbell I. and Priest F.G (1990) Introduction to Biotechnology. Blackwell Scientific Publications, Oxford, London.
3. Brown T.A (1999) Genomes. John Wiley & Sons. New York.
4. Chawla H.S(2000) Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
5. Dixon R.A. and Gonzales R. A. (Eds.) (1994) Plant Cell Culture - A Practical Approach. Oxford University Press, New York.
6. Gamborg O.L and Phillips G.C(1998) Plant Cell, Tissue Organ Culture. Narosa Publishing House, New Delhi.
7. Griffiths el al. (1999) Modern Genetic Analysis. W.H. Freeman & Co. New York.
8. Gupta P.K(1999) Elements of Biotechnology. Rastogi Publications, Meerut.

SEMESTER IV

PAPER 15PBO41: SPECIAL PAPER –I
PLANT PHYSIOLOGY, BIOCHEMISTRYAND ENZYMOLGY
(Theory 144 hrs;Practical 90 hrs)

A. PLANT PHYSIOLOGY 45 hrs (2.5 hrs/wk)

1. Photosynthesis: Efficiency and turn over. Light harvesting complexes.Photosystem I and II - Structure and function.Mechanism of electron transport. Water oxidizing clock.RubisCo – Structure and function. Photo inhibition. Phytochromes. CO2 fixation: C3, C4 and CAM pathways. Energetics of CO2 fixation. (10 hrs)
2. Photorespiration and glycolate metabolism. Mechanism of photorespiration in C3 and C4 plants.Factors regulating photorespiration. (6 hrs)
3. Transport of metabolites – Xylem and Phloem sap translocation – current trends. (5 hrs)
4. Photoregulation and growth responses. Growth regulators and their mode of action. Plant morphogenesis. Physiology of flowering, fruit ripening senescence and abscission, Vernalisation. (6 hrs)
5. Seed metabolism, Hydration Phase of germination, Inter relationship between growing seedlingand the storage tissues, glyoxylate cycle in fatty seeds during germination. (5 hrs)
6. Physiological response of plants to stresses like drought, heat and cold. Salt tolerance in plants. (5 hrs)
7. Role of phytoalexins. Defence mechanism. Phenyl propanoid pathway in plants. (2 hrs)
8. Tree Physiology – Leaf canopies, Radiation environment, Effect of irradiance in plants; Tree and water relations. (4 hrs)
9. Allelopathy – Plant derived compounds. (2 hrs)

Practicals 36 hrs (2 hrs/wk)
1. Extraction and estimation of total proteins by TCA precipitation and Lowrys method.
2. Isolation of chloroplast from fresh leaves and estimation of chlorophyll proteins.
3. Chlorophyll survey of five plants. Quantification, absorption spectra of chlorophyll and carotenoids using different solvents.
4. Hill activity by DCPIP/ ferricyanide reduction.
5. Extraction and estimation of total phenols.
6. Physiological identification of CAM in plant species.

References

1. Brett C.T and Waldron K.K(1996) Physiology and Biochemistry of Plant Cell Walls, Chapman and Hall London.
2. Conn E.E and Stumpf P.K et al(1999) Biochemistry. John Wiley and Sons. New Delhi.
3. Osborne D.J, Jackson M.B(1989) Cell separation in plant physiology, Biochemistry and Molecular Biology.Springer – Verlag. Berlin.
4. Dennis D.T and Trurpin D.H (Eds.) (1993) Plant Physiology, Biochemistry and Molecular Biology. Longmann Scientific and Technical, Singapore.
5. Devlin and Witham (1997) Plant Physiology. CBS Publishers and Distributors, New Delhi.
6. Fitter A.H and Hay R.K.M(1987) Environmental physiology of plants. Academic Press.
7. Hall D.O and Rao K.K (1999) Photosynthesis. Cambridge University Press.
8. Hatch M.D. et. al.(1971) Photosynthesis and Photorespiration.
9. Hess D. (1975) Plant physiology. Narosa Publishing House, New Delhi
10. Jain J.L(2000) Fundamentals of Biochemistry. S. Chand & Co. New Delhi.
11. Taiz L and Zeiger E(1991) Plant Physiology. The Benjamin/ Cummings publishing Company, Inc.
12. Noggle and Fritz(1999) Introductory Plant physiology. Prentice hall, London.
13. Salisbury F.B. and Ross. C. (2000) Plant physiology. John Wiley & Sons, New Delhi.
14. Strafford G.A. (1979) Essentials of Plant Physiology. Heinemann Publishing Co. New York.
15. Wilkins M.B (Ed) (1984) Advanced Plant Physiology, Pitman Publishing Co. New York.
16. William G. Hopkins(2002) Introduction to Plant Physiology. John Wiley & Sons.Inc. New York.
17. Taiz and Zeiger (2003) Plant Physiology. Panima Publishers, New Delhi.

B. PLANT BIOCHEMISTRY54 hrs (3 hrs/wk)

1. Biochemical organization of the cell. (7 hrs)
2. Metabolism and biochemical energetics. (8 hrs)
3. Intermediary metabolism. Major pathways and evolutionary significance. (8 hrs)
4. Primary metabolic pathways and their inter relationships. (8 hrs)
5. Secondary metabolism – main pathways and their inter relationships. (8 hrs)

6. Protein structure, purification and characterization. (8 hrs)
7. Biomolecular interactions – general account (7 hrs)

Practicals 18 hrs (1 hr/wk)

1. Preparation of buffers
2. Preparation of standard solutions of BSA, Glucose, Catechol
3. Extraction and estimation of soluble proteins by Bradford method
4. Estimation of reducing sugars
5. Isolation and quantification of plant lipids by dry and wet methods

C. ENZYMOLOGY 45 hrs (2.5 hrs/wk)

1. Plant enzymes – general properties, classifications and Nomenclature. (3 hrs)
2. Structural and functional organization of enzymes – primary, secondary and tertiary structure, molecular characterization of functional organization. (6 hrs)
3. Sub cellular localization of enzymes by LM and TEM. Histochemistry of enzyme reaction. (4 hrs)
4. Enzyme purification and characterization – desalting methods, isolation and assay of plant enzymes and enzyme kinetics. (6 hrs)
5. MichaelisMenton equations and its significance, Lineweaver plots, enzyme inhibitions, activation. (6 hrs)
6. Allosteric enzymes, metabolic regulation – sigmoid, kinetic, steady state metabolic pathways by control of enzymatic pathways. (6 hrs)
7. Native PAGE in enzyme localization, principles and methodology, zymogram. (4 hrs)
8. Iso Electric Focusing (IEF). (2 hrs)
9. Immobilization of enzymes, enzyme engineering – techniques and applications. (5 hrs)
10. Biotechnological applications of enzymes. (2 hrs)

Practicals18 hrs (1 hr/wk)

1. Isolation, assay and determination of specific activity of plant enzymes of germination, growth and fruit ripening, viz. amylase, lipase, protease, peroxidase, polyphenol oxidase
2. Isoenzyme analysis and preparation of Zymogram.
3. Separation of enzyme proteins by Native PAGE.

References

1. Adams R.L.P, Knowler J.T, Leader D.P(1986)The biochemistry of Nucleic acids. 10th ed, Chapman and hall.

2. Burdan R.H, Knippenberg P.H (Ed)(1989). Techniques in Biochemistry and Molecular Biology, 2nd edn, Elsevier.
3. Fersht A(1985). Enzyme structure and mechanism, 2nd Edn. Freeman.
4. Gurr M.I, Harwood J.L(1991). Lipid Biochemistry: An introduction. 4th Edn. Chapman and Hall.
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6. Voet D.J, Voet J.G (2008) Principle of Biochemistry, 3rd Edn. John Wiley Sons Inc.
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12. Goodwin and Mercer (1996) Introduction to plant Biochemistry. CBS Publishers and Distributors, New Delhi.
13. Hames B.D. et al.(1999). Instant notes in Biochemistry. Viva books Pvt. Ltd. New Delhi.

PAPER 15PBO42: SPECIAL PAPER –II
ELECTIVE BIOTECHNOLOGY
(Theory 144 hrs(8 hrs/wk); Practicals 54 hrs (3 hrs/wk))

Unit I: Basics of Biotechnology (20 hrs)

1. Genesis, projection of biotechnology as an interdisciplinary pursuit, prospects and bottlenecks.
2. Vectors, plasmids, bacteriophage and other viral vectors, cosmids, Ti plasmid, yeast artificial chromosome.
3. Enzymes used in genetic engineering, restriction enzymes- their types and target Sites.
4. Impacts of biotechnology on agri-biodiversity, medicine, industry and Environment.

Unit II: Plant Tissue Culture techniques (24 hrs)

1. Techniques and applications – callus culture and regeneration of plants, micropropagation for large scale production of crop plants, medicinal plants and ornamentals.
2. Suspension culture and development – methodology, kinetics of growth and production formation, elicitation methods, hairy root culture
3. Protoplast culture – isolation , fusion, generation of hybrids, cybrids,preferential elimination of chromosomes, role in cytoplasmic male sterility and genetic transformation.
4. Exploitation of somaclonal and gametoclonal variations for plant improvement

Unit III: Microbial Genetics and technology (20 hrs)

1. Replication, regulation of bacterial gene expression
2. Mutations, genetic transfer, manipulation of gene expression in prokaryotes
3. Microbial production of amino acids, antibiotics, microbial enzymes, organic Acids.
4. Methods for laboratory fermentations, isolation of fermentation products, Elementary principles of microbial reaction engineering
5. Microbial culture selection, fermented foods,probiotics.

Unit IV: Genetic Engineering (40 hrs)

1. Generation of Foreign DNA molecules, cutting and joining of DNA molecules – linkers, adapters, homopolymers.
2. Gene isolation, gene cloning, cDNA and genomic DNA library, expression of cloned genes.

3. Transposons and gene targeting
4. DNA labeling, DNA sequencing – Polymerase Chain Reactions (PCR), DNA finger printing.
5. Southern, Western and Northern blotting,Dot blots, in situ hybridization
6. Molecular marker techniques – RFLP, RAPD, AFLP, SCAR, STR, SSR
7. Site directed mutagenesis
8. Gene transfer technologies – Agrobacterium and CaMV mediated gene transfer direct gene transfer using PEG, Micro injection, electroporation, biolistic method, liposome mediated DNA delivery, gene therapy.
9. Transgenic organisms, Social and ethical issues, IPR, Patents and Biopiracy

Unit V: Transgenic organisms (20 hrs)

1. Microbes – production of pharmaceuticals (somatostatin, humulin, interferons). Genetically modified microbes – biodegradation, biopesticides, bioremediation, mineral leaching andbiofertilizers.
2. Plants – insect resistance (Bt), virus resistance-coat protein, satellites, herbicide resistance. Increasing shelf life of foods – flavrsavr tomatoes, control of seed germination , genetically modified foods.
3. Animals – production of vaccine and pharmaceuticals, hybridomas, monoclonal antibodies.

Unit VI: Process Biotechnology (20 hrs)

1. Bioprocess technology for the production of cell biomass and primary/secondary metabolites.
2. Microbial production, purification and bioprocess applications of industrial enzymes and organic compounds.
3. Bioreactor designs for exploitation of microbial products, scaling up and downstream processing.
4. Chromatic and membrane based bioseparation methods, immobilization of enzymes and cells and their application for bioconversion processes.

Practicals 54 hrs (3.0 hrs/wk)

1. Preparation of stock solutions for tissue culture
2. Preparation of solid and liquid media for test tube cultures and petri plate Culture.
3. Induction of callus culture and suspension culture
4. Encapsulation of embryos using sodium alginate
5. Isolation and quantification of genomic DNA
6. PAGE and AGE – demonstration
7. Restriction digestion and ligation using kits – demonstration

References

1. Karp G. (2013) Cell and Molecular Biology: Concepts and experiments. Willey & Sons.
2. Lewin B. (2003) Genes – VIII. Oxford University Press, New York.
3. Prakash E.J.J (2009) Outlines of Biotechnology. Emkay Publications.
4. Primrose S.B. (1989) Animal Biotechnology. Blackwell Scientific Publication, London.
5. Old R.W. and Primrose S.B. (1989) Principles of Gene Manipulation. Blackwell scientific Publication, London.
6. Watson J.D. *et al.* (1987) Cell and Molecular Biology. John Wiley Publications, NY.
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