UNIVERSITY OF KERALA

THIRUVANANTHAPURAM

MSc Degree in Botany (Semester System)

Revised Course structure and Syllabus

(2013 Admissions onwards)

January 2012

PG BOARD OF STUDIES IN BOTANY

UNIVERSITY OF KERALA

MSc Degree in Botany (Semester System)

Revised Course structure

semester	Paper Code	Title of the paper	Hours/ semester	Hours / week		ESA hours	Maximum Marks		
				L	P	3	CA	ESA	Total
I	BO 211	Phycology, Mycology & Plant Pathology	108	6	2	3	25	75	100
	BO212	Bryophyta, Pteridophyta & Gymnosperms	108	6	2	3	25	75	100
	BO213	Microbiology, histology, Microtechnique & histochemistry	108	6	3	3	25	75	100
	BO214	Practical I	126		7	4	25	75	100
	Total for Semester I		**450**	**18**	**7**	**13**	**100**	**300**	**400**
II	BO 221	Taxonomy, Economic Botany & Ethnobotany	108	6	2	3	25	75	100
	BO 222	Environmental Biology,Phytogeography, Conservation Biology & Evolution	108	6	2	3	25	75	100
	BO 223	Cell and Molecular Biology & Genetics	108	6	3	3	25	75	100
	BO224	Practical II	126		7	4	25	75	100
	Total for Semester II		**450**	**18**	**7**	**13**	**100**	**300**	**400**
III	BO 231	Plant Breeding, Horticulture & Reproductive Biology	108	6	1.5	3	25	75	100
	BO232	Biophysics , biochemistry & Plant physiology	108	6	3	3	25	75	100
	BO233	Research Methodology, Biostatistics Plant Biotechnology	108	6	2.5	3	25	75	100
	BO234	Practical III	126		7	4	25	75	100
	Total for Semester III		**450**	**18**	**7**	**13**	**100**	**300**	**400**
IV	BO241	Special Paper –I Bioinformatics	144	8	2	3	25	75	100
	BO242	special Paper –II Elective	144	8	5	3	25	75	100
	BO243	Practical IV	126		7	4	25	75	100
	BO201	Dissertation	36	2				100	100
	BO202	Submissions					25	75	100
	BO203	Comprehensive Viva Voce						100	100
	Total for Semester IV		**450**	**18**	**7**	**10**	**100**	**500**	**600**
		Grand Total					**400**	**1400**	**1800**
L-Lecture, P-practical, ESA-End Semester Assessment, CA-Continuous Assessment(internal)									

SCHEDULE OF WORK LOAD

Semester	Paper code	Subject	Total hours		T Hours/week	P Hours/week
			T	P		
I	BO 211	Phycology	54	27	3	1.5
		Mycology	36	9	2	0.5
		Plant pathology	18	0	1	0
	BO 212	Bryophyta	27	9	1.5	0.5
		Pteridophyta	45	18	2.5	1
		Gymnosperms	36	9	2	0.5
	BO 213	Microbiology	36	9	2	0.5
		Histology	27	9	1.5	0.5
		Microtechnique & histochemistry	45	36	2.5	2
II	BO 221	Taxonomy	72	27	4	1.5
		Economic botany	9	9	.5	.5
		Ethnobotany	9	0	.5	0
		Evolution	18	0	1	0
	BO 222	Environmental Biology	72	36	4	2
		Phytogeography	18	0	1	0
		Conservation Biology	18	0	1	0
	BO 223	Cell & Molecular Biology	54	36	3	2
		Genetics	54	18	3	1
III	BO 231	Plant Breeding	63	9	3.5	0.5
		Horticulture	18	9	1	0.5
		Reproductive biology	27	9	1.5	0.5
	BO 232	Biophysics	27	9	1.5	0.5
		Biochemistry	36	18	2	1
		Plant Physiology	45	27	2.5	1.5
	BO 233	Research Methodology	18	0	1	0
		Biostatistics	27	9	1.5	0.5
		Plant Biotechnology	63	36	3.5	2
IV	BO 241	Special Paper – I Bioinformatics	144	36	8	2
	BO242	Special paper – II Elective	144	90	8	5
		Dissertation	18	0	2	0

Elective Special Papers

BO 242a : Biotechnology

BO 242b : Environmental Biology

BO 242c : Plant Biochemistry and Enzymology

BO 242d : Cytogenetics

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.

Study Tour

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

2nd 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.

Submissions (4th Semester Practical Examination)

1. Detailed report on visit to research institutions and the type of research works undertaken by these centers
2. A Model research proposal seeking fund to carry out research on a specific problem
3. Power Point presentation of the dissertation carried out by the student before the examiner.

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
- Summery and conclusion
- References

Scheme for Practicals	**Duration**	**CA**	**ESA**	**Total Marks**
Practical I (BO 214) includes all the topics under papers BO 211, 212 & 213	4 hrs	25	75	100
Practical II (BO 224) includes all the topics under papers BO 221, 222 & 223	4 hrs	25	75	100
Practical III (BO 234) includes all the topics under papers BO 231, 232 & 233	4 hrs	25	75	100
Practical IV (BO 243) includes all the topics under papers BO 241 & 242	4 hrs	25	75	100

The practical examinations are conducted at the end of the semester II and Semester IV. Practical I and II examinations will be conducted at the end of the Semester II and Practical III and IV examinations will be conducted at the end of the Semester IV.Certified records of practical works done and submissions, if any, should be submitted at the time of each practical examinations.

SCHEME OF EXAMINATION AND MARK DISTRIBUTION

Semester	Paper code	Paper	Hours/ Semester	ESA hours	Maximum marks		
					CA	ESA	Total
I	BO211	Paper 1	108	3	25	75	100
	BO212	Paper 2	108	3	25	75	100
	BO213	Paper 3	108	3	25	75	100
	BO214	Practical I	126	4*	25	75*	100
	Total for Semester I		**450**	**13**	**100**	**300**	**400**
II	BO221	Paper 1	108	3	25	75	100
	BO222	Paper 2	108	3	25	75	100
	BO223	Paper 3	108	3	25	75	100
	BO224	Practical II	126	4	25	75	100
	Total for Semester II		**450**	**13**	**100**	**300**	**400**
III	BO231	Paper 1	108	3	25	75	100
	BO232	Paper 2	108	3	25	75	100
	BO233	Paper 3	108	3	25	75	100
	BO234	Practical III	126	4	25	75	100
	Total for Semester III		**450**	**13**	**100**	**300**	**400**
IV	BO242	Special Paper I	144	3	25	75	100
	BO243	Special Paper II	144	3	25	75	100
	BO244	Practical IV	126	3	25	75	100
	BO201	Dissertation	36			100	100
	BO202	Viva voce				100	100
		Submissions			25	75	100
	Total for Semester IV		**450**	**13**	**100**	**500**	**600**
Grand Total					**400**	**1400**	**1800**

Distribution of marks in each Semester Examination

Semester	Continuous Assessment		End Semester Assessment		Total marks
	Theory	Practical	Theory	Practical	
I	75	25	225	--	325
II	75	25	225	150(75+75)	475
III	75	25	225	--	325
IV	50	25	150	150(75+75)	375
	Dissertation				100
	Submissions				100
	Comprehensive Viva Voce				100
	Grand Total				**1800**

Distribution of Marks in Practical Examination

Practical Exam	Total Marks	Examination	Record/Submission
I	**75**	**55**	**Record – 10** **submission – 10**
II	**75**	**55**	**Record – 10** **Herbarium/Field note-10**
III	**75**	**65**	**Record – 10**
IV	**75**	**65**	**Record -10**

SEMESTER I

PAPER BO 211.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 . (4h)
2. Classification of Algae (Christensen1964,Round1973;Whittaker&Margulis1978, R.E.Lee). Characteristic features of major divisions (6h)
3. Thallus organization and its morphological variations; Ecological and evolutionary trends. (6h)
4. Cell structure - Prokaryotic, mesokaryotic and eukaryotic organizations (4h)
5. Structure, reproduction and life cycle of the following types:
   Hydrodictyon, Ulva, Pithophora, Draparnaldiopsis, Bulbochaete, Cephaleuros, Codium, Halimeda, Acetabularia, Nitella, Sphacelaria, Padina, Turbinaria, Porphyra, Amphiroa, Gracilaria, Ceramium, Spirulina, Scytonema (30h)
6. Economic Importance of Algae –Algae as biofertilisers, as food, their uses in industry, water blooms and their ecological role.(4h)

Practical 27 hrs (1.5 hrs/wk)

1. A record of the local algal flora – A study of their morphology and structure
2. Field trips to be conducted for students to get familiarized with the local flora

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. Kashyap,A.K.and Kumar,H.D. Recent advances in Phycology.Rastogy & company.

5 . Kumar,H.D.1985.Algal cell biology.East West Press,New Delhi.

6. Kumar ,H. D.1999.Introductory Phycology .East West Pvt. Ltd.,New Delhi.
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. Comp.. 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*)*; contributions of Indian Mycologists. (3h)
2. Structure, reproduction and phylogeny of: Phycomycetes,Ascomycetes,Basidiomycetes,and Deuteromycetes. (6h)
3. Thallus structure ,reproduction and life cycle of the following types: *Phytophthora, Albugo, Pilobolus, Penicillium, Aspergillus, Erysiphe, Uromyces, Polyporus, Lycoperdon, Geaster, Dictyophora, Nidularia, Schizophyllum Colletotrichum, Fusarium, Alternaria, Helminthosporium, Cercospora, Parmelia, Graphis* (23h)
4. Economic importance of fungi with special reference to secondary Metabolites; Fungi as biocontrol agent.(2h)
5. Classification, thallus structure ,reproduction, ecological significance and economic importance of Lichens .(2h)

Practical **9hrs(1/2hr/wk)**

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

References

1. Ainsworth,G.C.,Sparrow,K.E., Sussman.The Fungi. Academic Press, NewYork
2.. Alexopoulose,C.J.,Mims,C.W., 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 Publish.House, New Delhi.

7. Elizabeth Moore-Landeeker.1996.Fundamentals of Fungi.Prentice Hall, New Jersey.

8. Hale,M.E.1983.Biology of Lichens. Edward Arnold,London.

9. Hudson, H. J. Fungal Biology. Edward Arnold, London.

10..Moore, D..*et al* .1986.Developmental Biology of higher Fungi

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. (2hrs)
2. Defence mechanisms - Systemic Acquired Resistance and Induced Systemic Resistance, major signalling pathways of plant defense mechanism. (4 hrs)
3. Epidemiology and quarantine. (I 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.

i.	Paddy	-	Brown spot and false smut
ii.	Sweet potato	-	White rust
iii.	Rubber	-	Powdery mildew
iv.	Coffee	-	Rust
v.	Tea	-	Red rust
vi.	Sugarcane	-	Red rot
vii.	Vanilla	-	Bean rot
viii.	Mango	-	Leaf spot
ix.	Ladies finger	-	Yellow vein mosaic
x.	Pepper	-	Quick wilt (9 hrs)

Practical

A record of all diseases mentioned in the syllabus.

References

1. Agrios, G.N.1997.Plant pathology. Academic Press, New Delhi .
2. Bilgrami,K.S.&H.C.Dube.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 .Bharati bhavan, 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. ehrotra,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 BO 212. 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 (Shofield 1985); 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, Sphagnu, Funaria (12hrs)
4. Origin and evolution of Bryophytes, Brief account on Fossil Bryophytes (2 hrs)
5. Bryophytes as indicators of water and air pollution. (1hr)

Practical 9hrs (1/2 hr /wk)

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. Prem Puri.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 ,London.

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

1. General characters, classification (Bierhost1971) and life cycle of Pteridophytes; Contributions of Indian Pteridologists. (3hrs)
2. Comparative morphology,structure, ecology and phylogeny of the following groups: Psilopsida, Lycopsida, Sphenopsida, Pteropsida. (8hrs)
3. Structure ,reproduction and life cycle of the following types: *Isoetes,Ophioglossum,Angiopteris,Osmunda,Ceratopteris,Blechnum,Lygodium,Adiantum,Gleichenia,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* (4hrs)

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. McGraw 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.Essentias 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 (Sporne1965; David Bierhost1971); 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,Ephedra (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 Alok Moitra 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 Gym nosperm 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.

SEMESTER II

PAPER BO 221: TAXONOMY OF ANGIOSPERMS, ECONOMIC BOTANY, ETHNOBOTANY AND EVOLUTION

(Theory 108 H; Practical 36 H) **(Theory 6 H/wk; Practical: 2 H/wk)**

A. TAXONOMY OF ANGIOSPERMS

(Theory: 72H; Practical: 27 H) **(Theory 4 H/wk; Practical: 1 ½ H/wk)**

1. Principles of taxonomy as applied to the systematic and classification of plant kingdom - species concept, taxonomic structure. (**2h)**

2. Classification – brief study of Artificial (Linnaeus), Natural (Benthem and Hooker) and Phylogenetic (Bessey and Takhtajan) systems. **(4 h)**

3. Detailed study of modern system of classification – Angiosperm Phylogeny Group (APG) classification system. **(2 h)**

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 nomen nudum. **(3 h)**

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 Botanical Garden, Lucknow and Tropical Botanical Garden, Trivandrum. **(4 h)**

5. Construction of taxonomic keys (indented and bracketed) and the utilization. **(2 h)**

6. Role and organization of Botanical Survey of India. **(1 h)**

7. Modern concepts and trends in plant taxonomy. Elementary treatment of i. Cytotaxonomy, ii. Chemotaxonomy, iii. Numerical taxonomy (taximetrics), iv. Molecular taxonomy, v.Biosystematics. **(5 h)**

8. Critical study of the current ideas on the origin of angiosperms with special reference to their ancestral stock, time and place of origin. **(2 h)**

9. 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 h)

Ranunculaceae	Magnoliaceae	Capparidaceae	Bixaceae
Polygalaceae	Caryophyllaceae	Portulacaceae	Dipterocarpaceae
Malvaceae	Geraniaceae	Rhamnaceae	Vitaceae
Sapindaceae	Leguminosae	Rosaceae	Rhizophoraceae
Myrtaceae	Melastomaceae	Passifloraceae	Cucurbitaceae
Apiaceae	Rubiaceae	Asteraceae	lumbaginaceae
Sapotacee	Oleaceae	Asclepiadaceae	Boraginaceae
Solanaceae	Lentibulariaceae	Bignoniaceae	Verbenaceae
Lamiaceae	Amaranthaceae	Aristolochiaceae	Piperaceae
Lauraceae	Loranthaceae	Euphorbiaceae	Urticaceae
Causuarinaceae	Orchidaceae	Scitaminae	Amaryllidaceae
Liliaceae	Commelinaceae	Arecaceae	Araceae
Cyperaceae	Poaceae.		

B. ECONOMIC BOTANY

(Theory: 09H ; Practical: 09 H) (Theory ½ H/wk; Practical: ½ H/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) Plantation crops: Coconut, Cocoa, Coffee and Tea

e) Spices and condiments: Pepper, Ginger, Turmeric, Cardamom and Nutmeg

e) Tuber crops-: Potato, Sweet potato and Tapioca

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

g) Vegetables: Tomato, Brinjal, Cucumber, Ash gourds and Bitter gourd

h) Medicinal plants: Sarpagandha, Belladonna, Cinchona, Vinca, Glycirrhiza.

i) Narcotics: Cannabis, Opium

j) Timber yielding plants: Rose wood, Teak Wood

Practicals

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

Key references:

1. Arora PK and Nayar EK. Wild relatives of Crops plants in India, NBPGR Sci. Monograph No. 7
2. CSIR, The useful plants of India, Publication and Information Directorate, CSIR, New Delhi
3. Judd WS, Campbell CS, Kellog EA & Stevens PF (1999), PlantSystematics. Sinauer Associates, Inc., Massachusetts, USA
4. Kochar LS (1981) Economic Botany in the Tropics, Macmillan
5. Lawrence GHM (1964), Taxonomy of Vascular Plants, Mac Millon Co., New York
6. Rendle AB (1967), Classification of flowering plants, Cambridge University Press
7. Sharma OP (1990) Plant Taxonomy, Oxford Publishers, New Delhi
8. Singh G (1999), Plant systematics: Theory and Practice, Oxford IBH.

Supportive References:

9. Davis PH & Heywood (1963), Principles of Angiosperm Taxonomy, Oliver-Boyd
10. Gamble JS (1935), Flora of Presidency of Madras, London

11. Gibbs RD, Chemotaxonomy of flowering plants
12. Hill AF (1952), Economic Botany, Tata McGraw Hill
13. Hooker JD (1879), Flora of British India. Reeve &Co., London
14. Hutchinson J (1959), Families of flowering plants, Cambridge University Press
15. Lawrence GHM (1955), An Introduction to plant Taxonomy, Central Book Depot
16. Sen S (1992), Economic Botany, New Central Book Agency, Culcutta
17. Sivarajan VV (1991) An introduction to Principles of Taxonomy, London
18. Sivarajan VV (1999), Principles of plat Taxonomy, Oxford and IBH Publishing Co.
19. Stace C (1985), Plant Taxonomy and Biosystematics, London.
20. Takhtajan AL (1969) Flowering plants. Origin and Dispersal, Oliver and Boyed.

C. ETHNOBOTANY

(Theory: 09H) (Theory: ½ H / 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

Key references:

1. Jain SK (1987). A manual of ethnobotany, Indus Intl. Publishers, New Delhi
2. Jain SK (2001). Medicinal Plants, National Book Trust, India
3. Wood M (1997), The book of herbal wisdom: using plants as medicines, North Atlantic Books, California.

Supportive References:

4. Cunnigham A (2001) Applied ethnobotany: people, wild plant use and conservation, Earthscan, UK
5. Martin GJ (2004) Ethnobotany: a methods manual, Earthscan, UK
6. Jain SK and Mudgal V (1999) A hand book of ethnobotany. Indus Inst. Publishers, New Delhi.

D. EVOLUTION

(Theory: 18H; 1 H / Wk)

1. Origin and evolution of life (including aspects of pre-biotic and molecular evolution) (2hrs)
2. Concepts and theories of evolution. Classical and synthetic theories of evolution. (4hrs)

3. Forces and mechanism of evolution. (3hrs)

4. Speciation (3hrs)

5. Isolation mechanism. (2hrs)

6. Evolution above species level. (2hrs)

7. Molecular evolution. (2hrs)

Key references:

1. Strickberger MW (1996). Evolution, Jones and Bartlett Publishers, New York
2. Savage JM (1969), Evolution, Oxford &IBH, New Delhi.
3. Sproule A (1998) Charles Darwin: Scientist who have changed the world. Orient Longman, New Delhi.

Supportive References:

4. Blackle (1983) Evolutionary principles, Oxford & IBH, New Delhi
5. Briggs D &Walters SM (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. BO 213.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. (4 hrs)
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**,** Cyanobacter (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. (14hrs)

Practical **9hrs (1/2 hr /wk)**

1. Practicals involving preparation of media,principles of isolation , pure culturing aspects and maintainance 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.Biolog y of microorganisms Prentice Hall,London
4. Casida,L.E..1997Industrial 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. Gerald Karp 2008.Cell and Molecular biology-concepts and experiments. John Wiley &sons, New York.
7. Ivan Roitt,1997.Essential Immunology .Black Well Science Ltd ,London.
8. Kumar ,H.D. and Swati kumar.1999.Modern concepts of Microbiology,Vikas Publishing House, New Delhi.
9. Lodish Berk *et al.2008.* Molecular Cell Biology6th 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. Powar,C.B.and Daginawala,H.F.General Microbiology Vol.II.Himalaya Publishers,Bombay.
13. Rao,A.S.2001.Introduction to Microbiology. Prentice Hall of India, New Delhi.
14. Sharma,P.D.2005.Environmental microbiology.Narosa publishers, New Delhi.
15. Stainer.R.Y.*et al.*1990The microbial world. Prentice Hall of India,New Delhi.

B. HISTOLOGY 27hrs (1.5 hrs/wk)

1. Origin, structure and function of cambia and their derivatives (6hrs)
2. Seasonal variation in cambial activity, role of cambium in wound healing and grafting (2h)

3. Anomolous cambial activities in *Bignonia, Amaranthus, Mirabilis, Bougainvillea, Piper, Aristolochia, Thunbergia* (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, Alstonia scholaris* (6h)
5. Nodal anatomy, root –stem transition, transfer cells. (2hrs)
6. Floral anatomy. (1hrs)
7. Histochemical and ultra structural aspects of development, differentiation and morphogenesis. (3hrs)
8. Anatomy in relation to Taxonomy. (1hr)

Practical **9hrs (1/2hr/wk)**

1. Anomolous structures of types mentioned in the syllabus
2. Leaf anatomy:epidermal peels ,stomatal study ,T.S.of lamina.
3. Nodal anatomy and root-stem transition.
4. 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. Chemical fixation –reagents and fixatives, chemistry of fixation; Tissue dehydration – reagents, Infiltration and embedding ; Sectioning and mounting (10 hrs)
3. Tissue processing technique for light microscope,hand and serial sections, squashes, smears and maceration (7 hrs)
4. Microtomy-Rotary,sledge,Freezing ,Cryostat and Ultratomes (5hs)
5. Classification and chemistry of biological stains. General and specific vital stains and flurochromes. (5hrs)
6. Micrometry, camera lucida,photomicrography. (3hrs)
7. Tissue processing techniques for electron microscopy (2hrs)
8. Detection and localization of primary metabolites- Carbohydrates (PARS reaction),Proteins (Coomassie brilliant blue staining) Lipids(Sudan Black method) .Brief mention about other methods also. (5hrs)
9. Detection and localization of secondary metabolites- alkaloids, terpenoids, phenolics (3hrs)
10. Enzyme histochemistry- General design and applications. (3hrs)

Practical 36hrs (2hrs/wk)

1. Preparation of double stained free hand sections and identification of the tissues with reasons (Normal or Anomolous secondary thickening).
2. Preparation of serial sections from the given block and identification of the tissues with histological reasoning.
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 are expected to get a thorough understanding on reagents and buffers for tissue processing .
7. Students should submit 15 permanent slides (5 serial,5 hand sections, and 5 slides from squash, mear, whole mount ,sledge and histochemical localization)

References

1. Gahan,P.B.1984.Plant histocchemistry and Cytochemistry. Academic Press, London
2. Gary,P.1964.Hand book of Basic microtechnique. John Wiley & Sons, New York.
3. Harris, Electron Microscopy in Biology
4. Johansen, D.A.1940. Plant Microtechnique. Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.
5. Johanson,W.A.1982.Botanical Histochemistry .-Principles and Practice Freeman Co.
6. Johanson,W.A.1984.Plant Microtechnique.McGraw Hill, . New York.
7. John E .SASS.1964. Botanical microtechnique. Oxford & IBH Publishing Co.Calcutta.
8. Kierman,J.A.1999.Histological and Histochemical Methods.Butterworth Publ. London.
9. Pearse,A.G.E.1960. Histochemistry. Vol.I& Vol.II,J&A. Churchill, London.
10. Ruzin,Z.E.1999. Plant Microtechnique and Microscopy.Oxford Press,New York.

Practical I (BO214)

Submissions

Students should submit at least 10 specimens representing algae, fungi, bryophyte, pteridophytes and gymnosperm.

PAPER BO222

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

(Theory: 54 h ; Practical: 36 h) **(Theory 3 h/wk; Practical: 2 h/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 h)**
2. Physical environment; biotic environment; biotic and abiotic interactions. Concepts and dynamics of Ecosystems: Types – Freshwater, marine 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. **(8 h)**
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 h)**
4. Nature of communities; community structure and attributes; levels of species diversity and its measurement; edge effect and ecotone. **(4h)**
5. Ecosystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine. Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. **(7h)**
6. Species interactions - types of interactions, interspecific competition, herbivory, carnivory, symbiosis. **(4 h)**
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 h)**
8. Ecological concepts of species: Autecological level (genecology), Synecological level (Ecosystem level). Ecads (Ecophenes), Ecotypes, Ecospecies. **(4 h)**

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

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

11. 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 h)**

12. Practical

1. Analysis of vegetation - Quadrate /line transects to find frequency and interpret the vegetation in terms of Raunkiaer'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

Key references

1. Odum, F. E. 1971. Fundamentals of Ecology. W.B. Saunders and Company.
2. Sharma, P. D. Enviornmnetal Biology, Himalaya Publications
3. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner

Supportive References:

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 P.K. Goel, Introduction to air pollution, Techno-Science Publication.
7. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai.

B. FOREST BOTANY

(Theory: 9 h; 1/2 h/wk)

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

Key references

1. Agarwal AP, Forest in India, Oxford & IBH

2. Gregorve GR, Forest products, production, trade and consumption, quantity and value of raw materials requirements, Ford foundation, New Delhi

Supportive References:

4. Puri GS, Indian Forest Ecology, Vol I & II, Oxfaord & IBH

5. Champion GH & Seth KA, A revised survey of forest types of India.

C. PHYTOGEOGRAPHY

(Theory: 18 h; 1 h/wk)

1. Define – Phytogeography - static and dynamic phytogeography. **(2 h)**
2. Geological history and evolution of plant life. **(4 h)**
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 h)

4. Phytogeographic regions of the world (Vegetational belts). **(4 h)**
5. Soil, climate, flora, and vegetation of India. **(4 h)**

Key references

1. Ronald Good. 1964. The geography of flowering plants. Lengmans.

2. Bharucha F.R. 1984. Atext book of plant geography of India. Oxford University Press.

3. Puri G.S. 1983. Indian Forest Ecology, Vol I, II. Oxford, New Delhi.

Supportive References:

4. Schatz, G.E. 1996. *Malagasy / Indo-Australo-Malesian Phytogeographic Connections.* http://www.mobot.org/MOBOT/Madagasc/biomad1.html

5. The International Biogeography Society http://www.biogeography.org/

6. Tree of Life. URL: http://tolweb.org/tree/phylogeny.html

D. CONSERVATION BIOLOGY

(Theory: 27; 1.5 h/wk)

1. Concept, aim and principles of conservation. **(1 h)**
2. Convention on Biological Diversity - Objectives – Definition of biodiversity – Roles of IUC (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 h)**
3. Conservation biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves). **(3 h)**
4. Agriculture and conservation of resources. Novel agricultural technologies – Nitrification inhibitors, Wind mills for irrigation, Solar energy for drawing ground water, Biogas for cooking and slurry left to be used as fertilizers. **(3 h)**
5. Urbanization and Conservation – Planning for environmentally compatible human settlements and strategy for sustainable industrial development. **(2 h)**
6. Conservation and energy – Causes of energy crisis, Conventional and Non conventional energy sources. **(2 h)**
7. Plant as a source of renewable energy. Development of non-polluting energy systems - Solar energy, Wind energy, energy recovery from solid wastes. **(2 h)**
8. Conservation of Physical resources. (Mention all physical factors of environment). **(2 h)**
9. Afforestation- social forestry, agroforestry, International Biological programme (IBP), 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. **(6 h)**
10. Environmental awareness – role of Government and NGOs- Gaia hypothesis. **(2 h)**

Key references

1. Dasman R.F. 1976. Environmental conservation, John Wiley and Sons, New York.
2. Malcom L., Hunter J.R. and James Gibbs. 2007. Fundamentals of Conservation Biology, Blackwell Publishing.

3. Andrew S. Pullin.2002. Conservation Biology, Cambridge University Press.
4. Fred Van Dyke 2008. Conservation Biology, foundation, concept, applications, Springer.

Supportive References:

5. MacDonald and Katrina Service 2007. Key Topics in Conservation Biology, Blackwell Publishing
6. Fiedler, P.I. and Kareiva P.M. 1998. Conservation Biology for the coming decade, Chapman and Hall.

Practical

1. One day visit to ecologically significant location (National parks/ mangroves/estuaries)
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).

PAPER BO223: CELL AND MOLECULAR BIOLOGY, GENETICS

Theory 108 hrs; Practical 54 hrs (theory 6 hrs/week; Practical 3 hrs/week)

A. CELL AND MOLECULAR BIOLOGY (T- 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, 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. **6 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 the structure 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 – G_1, S, G_2 – Prophase, Metaphase 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. **4 hrs**
6. Cell differentiation - General characteristics, molecular mechanism of cell differentiation. **2 hrs**
7. Prokaryotic and eukaryotic DNA replication- DNA polymerases and proteins involved in DNA synthesis and their specific roles. Structure and properties of RNA polymerases in prokaryotes and eukaryotes. General and specific transcription factors, Mechanism of transcription and post transcriptional modifications of RNAs, RNA editing. **8 hrs**
8. Molecular nature of genes - An introduction to gene functions. Techniques of gene expression: northern and western blotting; Gel retardation; Primer extension; Reporter assay.
9. Molecular tools for studying genes and gene activity. **5 hrs**
   a. Molecular marker technologies
   b. Molecular cloning methods **4 hrs**
10. 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**
11. DNA sequencing, chemical synthesis of nucleotides **4 hrs**
12. Polymerase Chain Reaction and its application. **2 hrs**

Practical **36 hrs; 2 hrs/week**

1. Mitosis – Metaphase and Anaphase 6 hrs

2. Meiosis – All stages - *Rhoeo, Chlorophytum, Crotalaria, Datura* (at least two should be recorded) 6 hrs
3. Isolation and purification of genomic DNA. 8 hrs
4. Isolation of total RNA (Demonstration only) 8 hrs
5. Isolation and Partial purification of Proteins. 8 hrs

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 – Brief account. (2 h)

2. Sex determination, Dosage compensation, Barr body, Lyon's hypothesis. (2 h)

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 h)

4. Microbial Genetics – Genetic recombination in viruses – lysogenic and lytic cycles in bacteriophages. Benzer's experiment in the rII locus of T4 phage, retro viruses, reverse transcriptase, 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 h)

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

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 h)

II Molecular Genetics

1. DNA as the genetic material, DNA constancy, C - Value paradox, structure of B-DNA and Z – DNA. (2h)
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, Okasaki fragments. 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. (6h)
3. DNA damage and repair- Photoreactivation repair, excision repair, recombinational repair, SOS repair. Genetic diseases caused by defects of DNA repair system – Blooms syndrome, Xeroderma pigmentosum, Retinoblastoma. (2h)
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. (4h)
5. Genetic code – Genetic code word dictionary. Features of the genetic code and its exceptions. (2h)
6. Protein synthesis - Central dogma, Transcription, organization of transcriptional units. Prokaryotic and eukaryotic RNA polymerases and their function. RNA processing and translation. (2h)
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. (8h)

8. Gene synthesis – Khorana's artificial synthesis of the gene for alanine. Transfer RNA and tyrosine transfer RNA of yeast. (2h)
9. Blotting techniques- Southern, Northern and Western blotting. DNA finger printing and foot printing. (2h)

III. Population Genetics and Developmental Genetics

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

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. (2h)

Practicals

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

Key references

1. Goodenough, U. Genetics. Holt Saunders, New York.
2. Lewin , 2000. Genes VII. Oxford University Press, New York.
3. Lodish *et al*. 2000. Molecular and Cell Biology. W. H.Freeman and Co, New York.
4. Sinnot, E. W. ET AL., 1958. Principles of Genetics. McGraw Hill, New Delhi.
5. Strickberger, M. W. 1985. Genetics. Macmillian India, New Delhi.

SEMESTER III

Paper. BO 231. PLANT BREEDING, HORTICULTURE AND REPRODUCTIVE BIOLOGY

(Theory 108 hrs; Practical 27 hrs)

A. **PLANT BREEDING** **(63 hrs Theory)**

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 way cross, 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 Biodivesity Policy. (2 hrs)

Practicals (9hrs)

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. Study of pollen types using acetolysed and non-acetolysed pollens
5. Developmental stages of anther, ovule, embryo and endosperm.

B. HORTICULTURE (18 hrs Theory)

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

2.Tools and Implements. (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: (1hr) Vegetable/ medicinal/ floral. (2) Home gardens, public gardens, vertical gardens, roof gardens. Lawns and landscapes. (2 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.Plant growing problems. Control of disease and pests. (1 hr)

Practicals (9 hrs Practical)

1.Budding – 'T' Budding and Patch Budding

2.Layering – Any two methods.

3. Grafting – Any two methods.

4.Designing of gardens and Methods of Landscaping

C. REPRODUCTIVE BIOLOGY (27 hrs)

1. Asexual reproduction: Vegetative apomixes. Adventive embryony. Non recurrent apomixis, diplospory, apospory, parthenogenesis, androgenesis, automixis, semigamy, agamic complex. (4 hrs)
2. Sexual reproduction: Microsporogenesis - male gameteophyte - pollen fertility and sterility Types of male sterility: Gametic and zygotic sterility. Somatoplastic sterility. Cytoplasmic and genetic sterility. Pollen storage. Pollen viability and germination. (5 hrs)
3. Megasporogenesis-embryosacs-development and types. (3 hrs)
4. Pollination biology - primary and secondary attractants of pollination - ultra structural and histochemical details of style and stigma - significance of pollen-pistil interactions. (3 hrs)
5. Fertilization-barriers to fertilization- genetics of incompatibility - methods to overcome incompatibility: intra ovarian pollination and in vitro fertilization - embryo rescue. (4 hrs)
6. Embryo, endosperm and seed development. Polyembryony. Parthenocarpy. (4 hrs)
7. Androgenesis and gynogenesis. (2 hrs)
8. Recent advances in palynological studies - Pollen allergy - Economic importance of pollen - Pollen analysis of honey - role of apiaries in crop improvement. (2 hrs)

Practicals (9 hrs)

1. Pollen germination: *in vitro* and *in vivo* viability tests
2. Study of pollen types using acetolysed and non-acetolysed pollen
3. Developmental stages of anther, ovule, embryo and endosperm.

References

1. Bhojwani, S.S and Bhatnagar, S.P. 2000. The Embryology of Angiosperms, Vikas Publishing House Pvt. Ltd. New Delhi.
2. Johri, B.M. 1984. 1984. Embryology of Angiosperms. Springer Verlag. Berlin.
3. Maheswari, P. 1980. Recent Advances in the Embryology of Angiosperms.
4. Pandey, A.K. 1997. Introduction to Embryology of Amngiosperms. CBS Publishers and Distributors, New Delhi.
5. Pandey, S.N. and Chadha, A. 2000. Embryology. Vikas Publishing House Pvt. Ltd. New Delhi.

Paper. BO 232. BIOPHYSICS, BIOCHEMISTRY AND PLANT PHYSIOLOGY

(Theory 108 hrs; Practical 54 hrs)

A. BIOPHYSICS (27 hrs)

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. Bond length. 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. (3 hrs)

3.Principles and applications of light and electron microscopy, bright field, phase contrast, fluorescence, scanning and transmission electron microscopy. Cytophotometry, flow cytometry, confocal microscopy, FISH, GISH. (4 hrs)

4.Chromatography: Principle and applications of Gel filtration, Ion exchange and affinity chromatography, thin layer chromatography, gas chromatography, HPLC,HPTLC, LCMS, GCMS. (5 hrs)

5. Electrophoresis. Enzyme localization by electrophoresis. Zymogram and isozyme analysis. ELISA. Electro focusing. (3 hrs)

6.Centrifugation. Ultra centrifugation. (2 hrs)

7. Principles of biophysical methods used for analysis of biopolymers: X-ray diffraction; fluorescence, UV, visible, IR,NMR, ESR Spectroscopy, ORD/CD, hydrodynamic methods, plasma emission spectroscopy. Atomic absorption spectroscopy. (4 hrs)

8. Principles and applications of tracer techniques in biology. Radiation dosimetry. Radioactive isotopes. Autoradiography. Cerenkov radiation. Liquid scintillation. (3 hrs)

Practicals (9 hrs)

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

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1. Casey, E.J. Biophysics: Concepts and Mechanics**.**

2. Daniel, M. 1999. Basic Biophysics for Biologists. Agro Botanica, Bikaner.

3. David Freifelder. Physical Biochemistry - Application to Biochemistry and Molecular biology.

4. F.M.Slayter. 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. Biophysical Chemistry –Principles and techniques. Himalaya Publishing House.

B. BIOCHEMISTRY (36 hrs)

1. Structure, function and metabolism of carbohydrates – Synthesis of starch, cellulose and sucrose. Interconversion of hexoses and pentoses. (10 hrs)
2. Structure, function and metabolism of lipids: Biosynthesis of fatty acids. Biosynthesis of Triacyl glycerol, diacyl glycerol, monoacyl glycerol. Gluconeogenesis. Phospholipids. Lipid oxidation. (10 hrs)
3. Proteins and amino acids: Classification based on structure, function and localization sites. Primary, secondary tertiary and quarternary structure. Biosynthesis. Ramachandran plot. Purification of proteins. (6 hrs)
4. Enzymes: Major groups. Distribution of plant enzymes. Soluble and membrane bound enzymes. Isozymes. Abzymes. (5 hrs)
5. Biosynthesis of purines and pyrimidines. Metabolism of nucleotides. (5 hrs)

Practicals (9 hrs)

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, assay and determination of specific activity of plant enzymes of germination, growth and fruit ripening, viz amylase, lipase, protease peroxidase, polyphenol oxidase.
6. Isolation and quantification of plant lipids by dry and wet methods.

References

1. Campbell, M.K. 1999. Biochemistry. Saunders College Publishing, New York.
2. Conn, E.E. and Stumpf P.K. et al., 1999. Biochemistry. John Wiley and Sons. New Delhi.
3. David T. Dennis and David H. Trurpin (Eds.) 1993. Plant Physiology. Biochemistry and Molecular Biology. Longmann Scientific and Technical, Singapore.
4. Fisher J. et. al., 1999. Instant notes in Chemistry for Biologists. Viva Books Pvt. Ltd. New Delhi.
5. Goodwin and mercer 1996. Introduction to plant Biochemistry. CBS Publishers and Distributors, New Delhi.
6. Hames, B.D. et al., 1999. Instant notes in Biochemistry. Viva books Pvt. Ltd. New Delhi.
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8. Jain, J.L. 2000. Fundamentals of Biochemistry. S. Chand & Co. New Delhi.
9. Plummer, D.T. 1996. An Introduction to practical Biochemistry. McGraw Hill
10. Satyanarayana, U. 1999. Biochemistry. Books and Allied (P) Ltd. Calcutta.
11. Wilson and Goulding. 1992. Biologists Guide to Principles and Techniques of Practical Biochemistry.

C. PLANT PHYSIOLOGY (45 hrs)

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. CO_2 fixation: C_3, C_4 and CAM pathways. Energetics of CO_2 fixation. (10 hrs)
2. Photorespiration and glycolate metabolism. Mechanism of photorespiration in C_3 and C_4 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 seedling and 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

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.

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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. Daphne. J. Osborne, Micheal. B. Jackson. 1989. Cell separation in plants physiology, Biochemistry and Molecular Biology. Springer – Verlag. Berlin.
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5. Devlin and Witham, 1997. Plant Physiology. CBS Publishers and Distributors, New Delhi.
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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. Lincoln Taiz and Eduardo Zeiger, 1991. Plant Physiology. The Benjamin/ Cummings publishing Company, Inc.
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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.

Paper BO 233. RESEARCH METHODOLOGY, BIOSTATISTICS AND PLANT BIOTECHNOLOGY

Theory 108 hrs; Practical 45 hrs)

A. Research Methodology (18 hrs)

1. Introduction to Research methodology. (2 hrs)
2. Research design: objectives , defining a problem, derivation of hypothesis ,review of literature, experimental design, data analysis, writing the thesis (2 hrs)
3. Experimental design : methodology – analytical, biochemical, molecular (2 hrs)
4. Data analysis- use of statistical tools, interpretation of results (4hrs)
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, preparing the reference section (4 hrs)

B. Biostatistics (27 hrs)

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)

a. Work out the problems on mean, median, mode
b. Calculation of central tendency and dispersion of data from plant science
c. Find out ANOVA, f- value, LSD of data from plant science
d. Find out broad sense heritability of data from plant science
e. Preparation of graphs using EXCEL or similar packages

C. PLANT BIOTECHNOLOGY (63 hrs Theory; 36 hrs Practical)

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 inter national 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, liposme mediated 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)

Practicals

1. Preparation of culture medium (MS, N&N, SH, B_5), 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.
4. 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.
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9. Jefrey. M.. Backer el al., 1996. Biotechnology- A Laboratory Course. Academic Press, New York.

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19 Wulf Crueger and Anneliese Crueger. 2000. Biotechnology - A Text book of Industrial Microbiology.

SEMESTER IV
SPECIAL PAPER – I BO 241: BIOINFORMATICS
(THEORY 144 HRS; PRACTICAL 36 HRS)

1. Introduction to Bioinformatics: Definition and History of Bioinformatics - Internet Computational Biology and Bioinformatics. **(12 hrs)**
2. Biological databases- Types of data and databases, Nucleotide sequence database (EMBL, GENBANK, DDBJ)- Protein sequence database (PIR, SWISS-PROT, TrEMBEL), Secendary Databases (PROSITE, PRINTS, BLOCKS), Protein Structure Database (PDB) **(12 hrs)**
3. Information retrieval from databases – search concepts, Tools for searching, homology searching, finding Domain and Functional site homologies **(12 hrs)**
4. Structural Bioinformatics – Molecular Structure viewing tool –Rasmol, Protein Structure Prediction – Secondary Structure prediction (Chou Fasman method and other Bioinformatics tools for secondary structure prediction) and Tertiary structure prediction (Comparative modeling, Abinitio prediction, Homology modeling) **(12 hrs)**
5. Genomics - Types (Structural and Functional), Genome Annotation, Gene Finding , Comparative genomics, Single nucleotide Polymorphisn Gen-SNIP. **(12 hrs)**
6. Proteomics – Protein expression analysis, Mass spectrometry in protein identification, Protein Sorting, Metabolomics, KEGG, Systems Biology-an introduction **(12 hrs)**
7. Sequence Analysis – Global Alignment, pairwise analysis, Scoring Matrices (an introduction), Multiple Sequence Analysis **(12 hrs)**
8. Molecular Phylogeny – Gene and Species tree. Molecular evolution and Kimuras theory, Phylogenetic Trees, Terminology in Phylogenetic tree. Cladogram and Phylogram, Significance of Molecular Phylogeny **(12 hrs)**
9. Computer Aided Drug Design and Molecular Docking, Breif study about Docking tools, AutoDock, molegro virtual docker, GOLD **(12 hrs)**
10. Tools (Softwares) used in Bioinformatics - BLAST (including ALGORITHM of BLAST), Sequin, ClustalX, Clustal W, RasMol, Treeview, Phylip, GRAIL, GENSCAN, PROCRUSTES **(12 hrs)**
11. Use of Linux and Bio-PERL in Bioinformatics **(12 hrs)**
12. Applications of Bioinformatics – Transcriptomics, Metabolomics, Pharmocogenomics, combinational synthesis (Brief Accounts) **(8 hrs)**

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Patterson, B.K., Techniques in Quantification and Localization of Gene Expression.

Mount, D.W. (2001).” Bioinformatics – Sequence and GenomeAnalysis”, 1st Edition, Cold Spring Harbor Laboratory Press, New York, USA..

Evens, W.J. and Grant, G.R., Statistical Methods in Bioinformatics: An Introduction.

Liu, B.H., Statistical Genomics: Linkage Mapping and QTL Analysis

Pierre Baldi and SorenBrunak, Bioinformatics: The Machine Learning Approach.

Practicals

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)

PAPER BO 242a: SPECIAL PAPER –II ELECTIVE

BIOTECHNOLOGY

(Theory 144 hrs; 90 hrs)

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 : 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 III : Genetic Engineering (40hrs)

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 IV : 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 V : Transgenic organisms (20 hrs)

1. Microbes – production of pharmaceuticals (somatostatin, humulin, interferons) Genetically modified microbes – biodegradation, biopesticides, bioremediation, mineral leaching and biofertilizers
2. Plants – insect resistance (Bt), virus resistance-coat protein, satellites, herbicide resistence. Increasing shelf life of foods – flavr savr 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

f. Preparation of stock solutions for tissue culture

g. Preparation of solid and liquid media for test tube cultures and petri plate culture
h. Induction of callus culture and suspension culture
i. Encapsulation of embryos using sodium alginate
j. Isolation and quantification of genomic DNA
k. PAGE and AGE – demonstration
l. Restriction digestion and ligation using kits – demonstration

References

1. Lewin B. (2003): Genes – VIII, Oxford University Press, New York.
2. Primrose, S.B. (1989): Animal Biotechnology Blackwell Scientific Publication, London.
3. Old R.W. and Primrose, S.B. (1989): Principles of Gene Manipulation, Blackwel scientific Publication, London.
4. Watson, J.D. *et al*. (1987): Cell and Molecular Biology, John Wiley Publications, NY
5. Freifelder, D. (1993): Molecular Biology, Jones and Bartlett, Publishers, London.

BO 242b : Special paper II : Elective

Environmental Biology

Theory 144 hrs; Practical 90 hrs

Unit I : Ecological concepts **(20 hrs)**

1. Scope and historical perspective – interdisciplinary approach. **(5 hrs)**
2. Systems concept in ecology: organism as an ecological system, levels of organization of living world, relation between organism and environment, homeostasis and ecological balance **(5 hrs)**
3. Concept of model and ecosystem modeling **(5 hrs)**
4. Concept of Biosphere **(5 hrs)**

Unit II : organism and environmental complex **(24 hrs)**

1. Ecological processes: basic laws of energy flow, flow of energy, law of ten percent, Odum's Box pipe model of energy flow. **(8 hrs)**
2. Biogeochemical cycling: Major sedimentary and gaseous types, turnover rate and turn over time, residence time, nutrient budgeting and nutrient sink. **(8 hrs)**
3. Environmental factors: climatic, edaphic, topographic and biotic factors **(8 hrs)**

Unit III: population and community Ecology **(28 hrs)**

1. Concept of population and population attributes – biotic potential, Natality, Mortality, survivorship curves, Life tables, Age structure **(8 hrs)**
2. Population Dynamics: population growth, growth forms, fluctuations, J-shaped and S-shaped growth curves, concept of carrying capacity and environmental resistance, r and k selection **(8 hrs)**
3. Community structure: species diversity, species composition, stratification and quantitative characters. **(6 hrs)**
4. Community energetic **(6hrs)**

Unit IV : Ecosystem Ecology **(24 hrs)**

1. Concept of ecosystem, types – Major terrestrial and aquatic ecosystems **(6 hrs)**
2. Structural attributes of ecosystem – components of ecosystem **(6 hrs)**

3. Functional attributes – Concept of productivity, trophic levels, trophic relations, food chain and food web, ecological pyramids **(6 hrs)**
4. Ecosystem development and evolution **(6hrs)**

Unit V : Environmental Ecology **(28 hrs)**

1. Pollution – major types of pollution, biological effects, environmental impacts at the local and global levels – BOD, eutrophication, bioaccumulation, biomagnifications, ecological imbalance. **(4 hrs)**
2. Land degradation – causes, effects of land degradation, remedial measures. **(4 hrs)**
3. Waste management – waste minimization, recycling of industrial wastes, solid waste management. Waste disposal mechanisms. **(4 hrs)**
4. Environmental biotechnology – bioremediation, technology for biological waste disposal, biogas plants. **(4 hrs)**
5. Environmental issues – global warming, ozone layer depletion, deforestation and desertification, destruction of natural ecosystems. **(4 hrs)**
6. Environmental protection – environmental laws, conservation efforts, UNEP, IPCC, Kyoto protocol, Earth summits. **(4 hrs)**
7. Prospects of remote sensing in environmental studies. **(4 hrs)**

Unit VI : General study on the following areas of applied ecology **(20 hrs)**

1. Physiological ecology – micro climate, gas exchange interactions, stress ecology of salinity, osmotic pressure and temperature. **(6 hrs)**
2. Industrial ecology - remediation of toxic and inhibitory pollutants, microbial conversion of ligno cellulosic wastes, reclamation of polluted water bodies, polymer recycling, concept of clean technologies for crop and food production, ecological engineering, Green design. **(8 hrs)**
3. Molecular ecology – brief account **(6 hrs)**

Practical **(90 hrs)**

1. To find out the primary production in the given sample by using light and dark bottles.
2. Estimation of phosphate and nitrite in the water samples.
3. Estimation of hardness and salinity in the water samples.
4. Quantification of the planktons, present in the given two water samples.
5. Analysis of major elements (Na, K, Ca and Fe) of water samples.

6. Analysis of chlorophyll pigments in water.
7. Elemental analysis of plant samples.
8. Quadrat study of a given area to find out the Importance Value Index (IVI) of the community.

References

1. Aradhana PS (ed) 1998, Envirnmental Management, Rajat Publications, Delhi.
2. Ambasht RS and Ambasht NK, 1996. A text book of Plant Ecology. Students' friends and Co, Varanasi.
3. Dash MC, 1996. Fundementals of Ecology.TMH Publishing Company, New Delhi.
4. Kumar HD, 2000. Modern concepts of Ecology. Vikas Publishing House, New Delhi.
5. Kumar HD, 1997. General Ecology. Vikas Publishing House, New Delhi.
6. Odum EP, 1971. Fundementals of Ecology. WB Saunders and Co.

BO 242c : Special Paper II

PLANT BIOCHEMISTRY AND ENZYMOLGY

(Theory 144 hrs;Practical 90 hrs)

Plant Biochemisrty

1. Biochemical organization of the cell. (8 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. Enzyme mediated regulation of metabolism. (8 hrs)
6. Secondary metabolism – main pathways and their inter relationships. (8 hrs)
7. Protein structure, purification and characterization. (8 hrs)
8. Biomolecular interactions – general account (8 hrs)

Enzymology

1. Plant enzymes – general properties, classifications and Nomenclature. (6 hrs)
2. Structural and functional organization of enzymes – primary, secondary and tertiary structure, molecular characterization of functional organization. (10 hrs)
3. Sub cellular localization of enzymes by LM and TEM. Histochemistry of enzyme reaction. (8 hrs)
4. Enzyme purification and characterization – desalting methods, isolation and assay of plant enzymes and enzyme kinetics. (10 hrs)
5. Michaelis Menton 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. (10 hrs)
7. Native PAGE in enzyme localization, principles and methodology, zymogram. (8 hrs)
8. Iso Electric Focusing (IEF). (6 hrs)
9. Immobilization of enzymes, enzyme engineering – techniques and applications. (8 hrs)
10. Biotechnological applications of enzymes. (8 hrs)

Practicals

1. Isolation, partial purification and estimation of specific activity of plant enzymes – poly phenol oxidase, malate dehydrogenase.
2. Isoenzyme analysis and preparation of Zymogram.
3. Separation of enzyme proteins by Native PAGE.

References

1. Adams RLP, Knowler JT, Leader DP, 1986. The biochemistry of Nucleic acids. 10th ed, Chapman and hall.
2. Burdan RH, Knippen berg PH (Edt), 1989. Techniques in Biochemistry and Molecular Biology, 2nd edn, Elsevier.
3. Fersht A, 1985. Enzyme structure and mechanism, 2nd edn, Freeman.
4. Gurr MI, Harwood JL, 1991. Lipid Biochemistry: An introduction. 4th edn. Chapman and Hall.
5. Vance DE, Vance JE (Edt): 1991. Biochemistry of Lipips, Lipoproteins and membranes, Elsevier.
6. Voet DJ, Voet JG, 2008. Principle of Biochemistry, 3rd edn. John Wiley Sons Inc.
7. David Freifelder. Physical Biochemistry - Application to Biochemistry and Molecular biology.
8. Campbell, M.K. 1999. Biochemistry. Saunders College Publishing, New York.
9. Conn, E.E. and Stumpf P.K. et al., 1999. Biochemistry. John Wiley and Sons. New Delhi.
10. David T. Dennis and David H. Trurpin (Eds.) 1993. Plant Physiology. Biochemistry and Molecular Biology. Longmann Scientific and Technical, Singapore.
11. Fisher J. et. al., 1999. Instant notes in Chemistry for Biologists. Viva Books Pvt. Ltd. New Delhi.
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.

BO 242d : Special Paper II

Cytogenetics

(Theory 144 hrs ;Practical 90 hrs)

1. Basic trends in cytogenetics – genetic continuity and variation. (10 hrs)
2. Haploidy – types of haploids, euhaploids, monohaploids, polyhaploids, Aneuhaploids; meiosis in haploids, induction of haploids.
    a. Morphology, anatomy and physiology of haploids.
    b. Genetic control of haploidy, genome analysis, inheritance in haploids- dosage effect.
    c. Significance of haploids in crop improvement. (12 hrs)
3. Polyploids – types of polyploids, numerical variation in chromosomes.
    a. Autopolyploids, allopolyploids, segmental allopolyploids, autoallopolyploids.
    b. Origin of polyploids, meiosis in polyploids, cytological and genetic effects of polyploids.
    c. Role of polyploids in plant diversity and evolution
    d. Induction of polyploidy – methods of induction, morphological and cytological analysis of induced polyploids, significance of induced polyploidy in plant improvement. (12 hrs)
4. Aneuploids – trisomics, double trisomics, tetrasomics, double tetrasomics. Types of trisomics – primary, secondary, tertiary, compensating fragment and telocentric trisomics. Role of aneuploidy in producing variation and its significance in evolution. (10 hrs)
5. Genetics of polyploids and aneuploids – theories of tetrasomic inheritance, Muller's hypothesis, Haldane's hypothesis, double reduction, techniques of nullisomic and monosomic analysis in polyploids, trisomic analysis in diploids. (12 hrs)
6. Structural variations in chromosomes – origin and meiotic characters. (10 hrs)
7. Cytogenetic effects – effect on crossing over, position effect, translocation complex, Renner complex, Renner effect, Breakage, Fusion Bridge cycle. (12 hrs)
8. Cytogenetics of hybrids. (8 hrs)
9. Sexual dimorphism – Genetic theory, cytological basis (8 hrs)

10. Sex chromosomes – undifferentiated structural heteromorphic multiple, protenor (XO), Neosex chromosomes, meiotic behavior of sex chromosomes in *Melandrium album* and *Rumex hastatus*. Evolution of sex chromosomes. Chromosomal mechanism of sex determination in Melandrium and Drosophila and the role of X and Y chromosomes and autosomes in them. (12 hrs)
11. Special types of chromosomes. (8 hrs)
12. B- chromosomes – origin, distribution, terminology, occurrence in different biological groups, morphology, classification, preferential distribution, post meiotic preferential distribution, differential fertilization, elimination, significance and adaptive value of B-chromosomes. (12 hrs)
13. Karyotype analysis and karyotype evolution. (8 hrs)
14. Chromosome banding – techniques and their applications. (10 hrs)
15. Human cytogenetics. (8hrs)

Practical

1. Somatic and meiotic chromosome study in selected polyploid and aneuploid. Eg. *Musa, Crinum.*
2. Allopolyploid - polyploidy series in *Chlorophytum*
3. Induction of polyploidy using Colchicine in selected plants.
4. Cytological and morphological analysis of the colchiploids.
5. Meiotic study of *Rhoeo discolor*
6. Chromosome banding – G – banding

References

1. Ambrose EJ and Easty DM 1980. Cell Biology – 3rd edition, Vikas Publ. New Delhi
2. Bernard John, 1990. Developmental and Cell Biology series, Cambridge. University Press.
3. Heinz herrmann, 1989. Cell Biology. An enquiry into the nature of the living state. Harper and Row Publishers, New York.
4. Sharma DK and Sharma A (Eds) 1985. Advances in chromosomes and Cell genetics. Oxford and IBH Publ. Co, New Delhi.
5. Stebbins GL, 1950. Variation and evolution in higher plants. Columbia Uni. NY.
6. Stebbins GL 1971. Chromosomal Evolution in higher plants. Addison, London.