UNIVERSITY OF KERALA

THIRUVANANTHAPURAM

M.Sc. Degree in Botany (Semester System)

Revised Course Structure & Syllabus

(w.e.f.2019 Admissions)

October 2018

PG BOARD OF STUDIES IN BOTANY

UNIVERSITY OF KERALA

M.Sc. 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, Microbiology &Plant Pathology	108	6	2	3	25	75	100
	BO212	Bryophyta, Pteridophyta & Gymnosperms	108	6	2	3	25	75	100
	BO213	Histology, Reproductive Biology, Microtechnique & Histochemistry	108	6	3	3	25	75	100
	BO214	Practical I	126		7	4	25♦	75♦	Δ
	Total for Semester I		**450**	**18**	**7**	**13**	**75**	**225**	**300**
II	BO 221	Taxonomy of Angiosperms, Economic Botany & Ethnobotany	108	6	2.5	3	25	75	100
	BO 222	Environmental Biology, Forest Botany, Phytogeography& Conservation Biology	108	6	2	3	25	75	100
	BO 223	Cell Biology, Genetics & Evolution	108	6	2.5	3	25	75	100
		Practical I							100♦
	BO 224	Practical II	126		7	4	25	75	100
	BO 225	Submission I* (I A+1B)						25+25	50
	Total for Semester II		**450**	**18**	**7**	**13**	**100**	**350**	**550**
III	BO 231	Plant Breeding, Horticulture & Biostatistics	108	6	1.5	3	25	75	100
	BO 232	Biochemistry, Plant Physiology & Research Methodology	108	6	3	3	25	75	100
	BO 233	Molecular Biology, Immunology & Plant Biotechnology	108	6	2.5	3	25	75	100
	BO 234	Practical III	126		7	4	25♦♦	75♦♦	Δ Δ
	Total for Semester III		**450**	**18**	**7**	**13**	**75**	**225**	**300**
IV	BO 241	Special Paper –I Bioinformatics & Biophysics	144	8	2	3	25	75	100
	BO 242	Special Paper –II Elective	144	8	5	3	25	75	100
		Practical III							100♦♦
	BO 243	Practical IV	126		7	4	25	75	100
	BO 244	Dissertation	36	2				100	100
	BO 245	Submissions II**						50	50
	BO 246	Comprehensive Viva Voce					25 .	75	100
	Total for Semester IV		**450**	**18**	**7**	**10**	**100**	**450**	**650**
		Grand Total					**400**	**1400**	**1800**
L-Lecture, P-practical, ESA-End Semester Assessment, CA-Continuous Assessment (Internal)									

Δ The S1 practical examination marks (25♦+75♦=100♦) will be awarded only during II semester practical Examinations.

Δ ΔThe S3 practical examination mark (25♦♦+75♦♦=100♦♦) will be awarded only during IV semester practical Examinations.

* Evaluation of the Submission 1(A) will be along with Practical I.Evaluation of the Submission 1(B) will be along with Practical II.

** The evaluation of the Submission II will be along with the Viva Voce at the end of 4th Semester.

SCHEDULE OF WORK LOAD

Semester	Paper code	Subject	Total hours		T Hours/week	P Hours/week
			T	P		
I	BO 211	Phycology	36	18	2	1
		Mycology	27	9	1.5	0.5
		Plant Pathology	18	0	1	0
		Microbiology	27	9	1.5	0.5
	BO 212	Bryophyta	27	9	1.5	0.5
		Pteridophyta	45	18	2.5	1
		Gymnosperms	36	9	2	0.5
	BO 213	Reproductive Biology	27	9	1.5	0.5
		Histology	36	9	2	0.5
		Microtechnique & Histochemistry	45	36	2.5	2
II	BO 221	Taxonomy of Angiosperms	90	36	5	2
		Economic botany	9	9	0.5	0.5
		Ethnobotany	9	0	0.5	0
	BO 222	Environmental Biology	54	36	3	2
		Forest Botany	9	0	0.5	0
		Phytogeography	18	0	1	0
		Conservation Biology	27	0	1.5	0
	BO 223	Cell Biology	36	18	2	1
		Genetics	54	27	3	1.5
		Evolution	18	0	1	0
III	BO 231	Plant Breeding	54	9	3	0.5
		Horticulture	18	9	1	0.5
		Biostatistics	36	9	2	0.5
	BO 232	Biochemistry	36	27	2	1.5
		Plant Physiology	54	27	3	1.5
		Research Methodology	18	0	1	0
	BO 233	Molecular Biology	36	9	2	0.5
		Immunology	18	0	1	0
		Plant Biotechnology	54	36	3	2
IV	BO 241	Special Paper – I Bioinformatics & Biophysics	90	18	5	1
			54	18	3	1
	BO 242	Special paper – II Elective	144	90	8	5
	BO 244	Dissertation	36	-	2	-

Elective II 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.

SUMBISSIONS

Submission I (Evaluation along with **2nd Semester Practical Examination)**

Submission 1 (A)

1. Algae/Fungi/Pathology – Five species representing at least one member from each group 5x 2= 10 marks
2. Bryophytes/ Pteridophytes/ Gymnosperms- Three species from each group 5x3=15 marks

Total = 25 marks

Submissions can be either as herbarium or as preserved specimens.
Evaluation of the Submission 1(A) will be along with Practical I.

Submission I (B)

1. Herbarium of invasive species/Exotic species (5 numbers each) 10x1= 10 marks
2. Economic products/Ethnobotany (5 numbers- representation from both) 5x2= 10 marks
3. Tour Report 5 marks

Total =25 marks

Evaluation of the Submission 1(B) will be along with Practical II.

Submission II (Evaluation along with **4th Semester Practical Examination)**

1. Detailed report on visit to any four National / Regional research institutions and the type of research works undertaken by thesecenters 10 marks
2. A model research proposal seeking fund to carry out research on a specificproblem 20 marks
3. Power Point presentation of the dissertation carried out by the student before theexaminer20 marks

Total = 50 marks

The evaluation of the Submission II will be along with the Viva Voce at the end of 4th Semester.

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 thestudy
- Materials andmethods
- Results anddiscussion
- Summary andconclusion
- 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 practicalexaminations.

Criteria for Continuous Assessment (CA)

Theory

Criteria	Marks
Attendance	>90- 5 marks
	>85%- 4 marks
	>80% - 3 marks
	>75% - 2 marks
	75% - 1 marks
Test Papers (2)	5x2= 10 marks
Seminar	5 marks
Assignment	5 marks
Total	**25 marks**

Practical

Criteria	Marks
Attendance	5 marks
Good Lab Practice	10 marks
Model Practical	10 marks
Total	**25 marks**

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 Score will be included in SemesterII	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
	Submission I					50	**50**
	Total for Semester II		**450**	**13**	**100**	**300**	**450**
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 Score will be included in SemesterIV	126	4	25	75	100
	Total for Semester III		**450**	**13**	**100**	**300**	**400**
IV	BO241	Special Paper I	144	3	25	75	100
	BO242	Special Paper II	144	3	25	75	100
	BO243	Practical IV	126	4	25	75	100
	BO244	Dissertation	36			100	100
	BO245	**Submission II**				50	**50**
	BO246	Viva voce				100	100
	Total for Semester IV		**450**	**10**	**100**	**500**	**550**
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	-	225	--	300
II	75	50(25+25)	225	150(75+75)	500
III	75	-	225	--	300
IV	50	50(25+25)	150	150(75+75)	400
	Dissertation				100
	Submissions				100
	Comprehensive Viva Voce				100
	Grand Total				**1800**

Distribution of Marks in Practical Examination

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

SEMESTER I

PAPER BO 211.PHYCOLOGY, MYCOLOGY,MICROBIOLOGY & PLANTPATHOLOGY

144 hrs (Theory: 108 hrs; Practical: 36 hrs)

Objectives:

- To familiarize the students the habitats ,classification, structure and life cycle of Algae, Fungi and lichen and the evolutionary trends in Algae and Fungi
- To get a basic idea about the ecological significance of Algae, Fungi and Lichen.
- To introduce the students about the aspects of Microbiology like classification, structure ,metabolism ,Bacterial culture and microbial diseases.
- To understand the role ofmicrobes in Agricutural, Environmental and industrial applications
- To get the knowledge on various plant diseases caused by different types of pathogens and defence mechanism

Learning Outcomes:

The student will be able to

- Identify, collect and preserve different types of algae, fungi and lichens
- Develop a basic understanding about the structure and life cycle of algae, fungi and lichens
- Apply the knowledge on ecological and environmental significance of microbes for the benefit of the society
- Identify and suggest measures for the prevention and control of diseases in crop plants

A. PHYCOLOGY **36 hrs (2 hrs/wk)**

1. Principles and modern trends in taxonomy of algae ; Contributions of Indian Algologists (2 hrs)
2. Classification of Algae (Fritsch F. E. 1935; Lee R. E. 2018). Characteristic features of major Divisions (4 hrs)
3. Thallus organization and its morphological variations; Evolutionary trends. (2 hrs)
4. Ecological role of algae. Fossil algae - Brief account only. (2 hrs)
5. Cell structure - Prokaryotic, mesokaryotic and eukaryotic organizations. (2 hrs)

6. Structure, reproduction and life cycle of the following types: (20hrs)
   Hydrodictyon, Ulva, Pithophora, Draparnaldiopsis, Cephaleuros, Halimeda, Acetabularia, Nitella, Padina, Turbinaria, Amphiroa, Gracilaria, Ceramium, Spirulina, Scytonema
7. Economic Importance of Algae – Algae as biofuel. Algae as biofertilisers, as food, their uses in industry, water blooms and their ecological role. (4 hrs)

Practical

18 hrs (1hr/wk)

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

References

1. Lee, R. E. 2018. Phycology 5th Edition. Cambridge University Press, New Delhi.
2. Barsanti, L. & Gualtieri, P. 2014. Algae: Anatomy, Biochemistry, and Biotechnology, 2nd Edition. CRC Press.
3. Sharma, O. P. 2011. Text book of Algae. Tata McGraw Hill Publ. Comp. Ltd. New Delhi.
4. Bilgarmi, K. S & Saha, L. C. 2010. A Textbook of Algae. CBS Publishers, New Delhi.
5. Kumar, H. D. 1999. Introductory Phycology. East West Pvt. Ltd., New Delhi.
6. Vashishta, B. R. 1999. Algae. S. Chand & Company, New Delhi.
7. Bold, H. C. & Wynne, M. J. 1995. Introduction to Algae. Prentice Hall of India, New Delhi.
8. Kashyap, A. K. & Kumar, H. D. 1994. Recent advances in Phycology. Rastogy & Company.
9. Prescott, G. W. 1984. The Algae: A review. Lubrecht & Cramer Ltd.
10. Round, F. E. 1984.The Ecology of Algae. Cambridge University, Press, London.
11. Smith, G. M. 1976. Cryptogamic Botany Vol.1.Tata Mc Graw Hill Publ. Comp. Ltd. New Delhi.
12. Gangulee, H. C. & Kar, A. K. 1973. College Botany, Vol. I. New Central Book Agency Pvt. Ltd.
13. Fritsch F. E. 1935, 48. Structure and reproduction of algae. Cambridge University Press.

B. MYCOLOGY **27 hrs (1.5 hrs/wk)**

1. Principles and modern trends of classification of Fungi-

   - (Alexopoulos *et al.*1996*;* Kirk *et al.* 2001, 2008); Contributions of Indian Mycologists. (2 hrs)
2. Structure, reproduction and phylogeny of: Phycomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes (6 hrs)
3. Thallus structure, reproduction and life cycle of the following types:
   Phytophthora, Pilobolus, Aspergillus, Uromyces, Polyporus, Lycoperdon, Geaster, Ganoderma, Nidularia, Schizophyllum Colletotrichum, Fusarium and *Helminthosporium.*

   (14 hrs)

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

5. Classification, thallus structure, reproduction, ecological significance and Economic importance of Lichens. Thallus structure, reproduction and life cycle of the following types: *Parmelia, Graphis.* (3 hrs)

Practical **9hrs (½hr/wk)**

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

2. Staining of fungal filaments by Cotton Blue, Methylene Blue.

References

1. Sharma , O. P. 2017. Fungi and Allied Microbes. McGraw Hill Education

2. Dube, H. C. 2013. An Introduction to Fungi. 4th Edition. Scientific Publishers, India.

3. Kirk, P., Cannon P.F., Minter D.W. & Stalpers J. A. 2008. Ainsworth & Bisby's Dictionary of Fungi. 10th Edition. CAB International, Oxon UK.

4. Alexopoulose, C. J., Mims, C.W. & Blackwell, M. 2007. Introductory Mycology. 4th Edn. John Wiley & Sons, New York.

5. Sharma, O. P. 2007. Text book of Fungi. Tata McGraw Hill, Publishing Co. Ltd. New Delhi.

6. Sumbali, G. 2005.The Fungi. Narosa Publishing House, New Delhi.

7. Sharma, P. D. 2004.The Fungi for University students. Rastogi Publications, Meerut.

8. Kirk, P. M., Cannon, P. F., David, J. C. & Stalpers, J. A. 2001. Ainsworth & Bisby's Dictionary of the Fungi, 9th Edition. CABI Publishing.

9. Chopra, G.L.1998. A text book of Fungi. S. Nagin & Co. Meerut.

10. Srivastava, J. P. 1998. Introduction to Fungi. Central Book Depot, Allahabad.

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

12. Mehrothra, R.S. & Aneja, K. R. 1990. An Introduction to Mycology. Wiley Eastern Ltd. New Delhi.

13. Hudson, H. J. 1986. Fungal Biology. Edward Arnold, London.

14. Moore, D., Casselton L.A. Wood D.A. & J. C. Frankland1986. Developmental Biology of higher fungi. Cambridge University Press

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

16. Bessy, E. A. 1979. Morphology and Taxonomy of Fungi. Vikas Publishing House, New Delhi.

17. Ainsworth, G.C., Sparrow, K.E. & Sussman, A.S. 1973. The Fungi. Academic Press, New York.

18. Burnett, J. H. 1968. Fundamentals of Mycology. Edward Arnold Ltd. London.

C. MICROBIOLOGY **27 hrs (1.5 hrs/wk)**

1. Brief history of microbiology. Experiments of Pasteur and Tyndall, Koch's postulates. Methods of sterilization. (3 hrs)
2. Bacteria - Classification based on Bergey's Manual. Significance of 16 S RNA in Bacterial identification. (2 hrs)
3. Major groups of microorganisms and their characteristics -prions, viroids, viruses, bacteria, archaebacteria, mollicutes, actinomycetes, cyanobacteria, viable but nonculturable (VBNC) bacteria
   Morphology, and ultrastructure of typical bacterium. (6 hrs)
4. Growth and nutrition of microorganisms. Growth characteristics. Continuous culture devices - Chemostat. (3 hrs)
5. Extremophiles – Acidophilic, Alkalophilic, Thermophilic and halophilic bacteria. Stress response in bacteria. (2 hrs)
6. Microbial diseases. Human diseases: Bacteria (Rickettsia), Virus (AIDS). Animal diseases: Anthrax (Bacteria). (3hrs)
7. Microbes in Agriculture: Rhizosphere, Nitrogen fixation, Mycorrhiza**,** Cyanobacteria (2 hrs)
8. Industrial Microbiology: Microbial fermentation-Major industrial products from microbes: Beverages, Antibiotics, Secondary metabolites, Recombinant products (3 hrs)
9. Applied Environmental Microbiology: Water Purification and Sanitary Analysis. Waste water Treatment (primary secondary and tertiary), Bioremediation and Metal Bioleaching (3 hrs)

Practical **9 hrs (½ hr/ wk)**

1. Practical involving preparation of media, principles of isolation, pure culturing aspects and

maintenance of culture.

2. Differential staining -Gram staining of pure cultures of *Bacillus/Lactobacillus/Rhizobium/Escherichia coli.*
3. Demonstration of bacterial motility by hanging drop method.
4. Isolation of *Rhizobium* from root nodule of legumes.
5. Test for coliforms in contaminated water.
6. Isolation of pure bacterial culture by streak plate method.

References

1. Tortora, G.J., Funke, B.R. & Case, C.L. 2019. Microbiology an Introduction. 13th Edition. Pearson Education, Inc.
2. Talaro, K. P. & Chess, B. 2018. Foundations in microbiology. 10th Edition. Pearson Education, Inc.
3. Cowan, M.K. & Smith H. 2018. Microbiology: A Systems Approach. 5th Edition. Mc Graw Hill Edn.
4. Pommerville, J. C. 2017. Alcamo's Fundamentals of Microbiology, 11th Edition. Jones & Bartlett Learning.
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6. Madigan M. T., Bender K.S., Buckley D.H., Sattley W.M., & Stahl D.A. 2017 Brock Biology of Microorganisms. Pearson Education, Inc.
7. Bauman, R. W. 2015. Microbiology: with diseases by body system 4th Edn. Pearson Education, Inc.
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9. Dubey, R. C. & Maheswari, D.K. 2010. A Text book of Microbiology, S. Chand & Company, New Delhi.
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11. Atlas, M. & Bartha, R. 2000. Microbial Ecology, Longmann, New York.
12. Black, J. G. 1999. Microbiology – Principles and Explorations, Prentice Hall, London.
13. Casida, L. E. 1997. Industrial microbiology. New Age Publishers, New Delhi.
14. Pelczar, M. J., Chan, E. C. S. & Kreig, N. R. 1993. Microbiology-concepts

and applications. McGraw Hill, Inc. New York.

15. Stainer, R.Y. *Stanier R.Y., Ingraham J.L., Wheelis M.L. and Painter P.R.*. 1990. The microbial world. Prentice Hall of India, New Delhi.

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

1. History of Plant pathology, General principles and concepts of host-parasite interaction. (2 hrs)
2. Defence 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. (9 hrs)

I	Paddy	-	Brown spot and Sheath Blight
ii.	Ginger		Soft rot
iii.	Rubber	-	Powdery mildew
Iv	Cardamom		Mosaic disease
v.	Tea	-	Red rust
Vi	Sugarcane	-	Red rot
Vii	Ladies finger	-	Yellow vein mosaic
Viii	Pepper	-	Quick wilt
Ix	Bacterial wilt	-	Tomato

Practical

A record of all diseases mentioned in the syllabus.

References

1 Singh R.S. 2017. Introduction to Principles of Plant Pathology. 5th Edition. Medtech Publisher.

2 Mehrotra R.S. 2017. Plant Pathology. 3rd Edition. McGraw Hill Education

3 Dube H.C.2014.Modern Plant Pathology.3rd Edition, Agribios, New Delhi.

4 Sharma,P.D, 2013.Plant Pathology.Rastogi Publishers NewDelhi.

5. Agrios, G.N. 2005. Plant Pathology 5th Edition. Academic Press, New Delhi.

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18. Pathak, V. N., Khatri, N. K. & Pathak, M. 1996. Fundamentals of Plant pathology. Agrobotanical publishers, India, Bikaner.

PAPER BO 212. BRYOPHYTA, PTERIDOPHYTA AND GYMNOSPERMS

144 hrs (Theory: 108 hrs; Practical: 36 hrs)

Objectives

- To impart basic knowledge about geographical distribution , classification ,structure ,life history and phylogeny of Bryophytes, Pteridophytes and gymnosperms.
- To give an idea about their ecological role and economically important products obtained from them and their uses.
- To familiarize the fossil members of these groups.

Learning Outcomes:

The student will be able to

●Collect and identify various types of Bryophytes, Pteridophytres and Gymnosperms

● Get the skill in identification of ecological niche and in conservation management of these plant groups

● Correlate evolution of these plant groups with respect to their changes in the environment,based on their structure and function

A. BRYOPHYTA **27 hrs (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: (12 hrs)

Lunularia, Targionia, Cyathodium, Reboulia, Pallavicinia, Porella, Anthoceros, Sphagnum, Polytrichum.

4. Origin and evolution of Bryophytes, Brief account on Fossil Bryophytes (2 hrs)
5. Economic importance of Bryophytes, Bryophytes as indicators of water and air pollution. (1hr)

Practical **9 hrs (½ hr /wk)**

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

References

1. Botanical Survey of India. 2016. Liverworts and Hornworts of India – An annotated check list.
2. Vanderpoorten A. & Goffinet B. 2009. Introduction to Bryophytes. Cambridge Publishers.
3. Shaw, J. & Goffinet, B. 2000. Bryophyte Biology, Cambridge University Press.
4. Rashid, A. 1998. An introduction to bryophyte. Vikas Publishing House, New Delhi.
5. Chopra, R.N. 1998. Topics in Bryology. Allied Printers, New Delhi.
6. Chopra, R.N. & Kumara, P. K. 1988. Biology of Bryophytes. Wiley East, New Delhi.
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10. Cavers, F. 1976. The interrelationship of Bryophyta. S. R.Technic House, Asok Rajpath, Patna.
11. Watson, E.V. 1968.The structure and life of Bryophytes. Cambridge University, London.

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

1. General characters, classification (Bierhost, 1971) 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. (8 hrs)
3. Structure, reproduction and life cycle of the following types: (24 hrs)
   Isoetes, Ophioglossum, Angiopteris, Osmunda, Ceratopteris, Blechnum, Lygodium, Adiantum, Trichomannes, Acrostichum, Salvinia, Azolla.
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: (4 hrs)
   Rhynia, Lepidocarpon, Sphenophyllum, Zygopteris

Practical **18hrs (1hr/wk)**

1. Structural details of the vegetative and reproductive parts of the types mentioned in the syllabus.
2. Identification of fossil types mentioned above.

References

1. Sharma, O. P. 2017. Text book of Pteridophyta. McGraw Hill Education.
2. Sundara Rajan, S. 1999. Introduction to Pteridophyta. New Age Publications, New Delhi.
3. Rashid, A.1999. Pteridophyta. Vikas Publishing House, New Delhi.
4. Sporne, K. R. 1986. Morphology of Pteridophytes. Hutchinson University Library, London.
5. Stewart, W. N. 1983. Paleobotany and Evolution of Plants. Cambridge University Press, London.
6. Eames, E. J. 1983. Morphology of Vascular Plants. Standard University Press.
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8. Smith, G. M. 1976. Cryptogamic Botany Vol. II. Tata McGraw Hill, Publishing Co. Ltd. New Delhi.
9. Shukla, A. C. & Misra, S. P. 1975. Essentials of Paleobotany. Vikas Publishing House, New Delhi.
10. Bierhost, D.W. 1971. Morphology of vascular plants. Macmillan, London.
11. Scott, D. H.1962. Studies in Fossil Botany. Hafner Publishing Co. New York.
12. Arnold, C. A. 1947.An Introduction to Paleobotany. McGraw Hill, NewYork.

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

1. General characters, affinities, distribution and classification (Sporne, 1965; Christenhurz *et al.* 2011; Christenhurz & Bing, 2016); 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. (18 hrs)
3. Structure, reproduction and life cycle of the following types:
   Zamia, Araucaria, Cupressus, Podocarpus, Ephedra (12 hrs)

Practical **9 hrs (½ 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. James W.B. 2015The Gymnosperms Handbook: A practical guide to extant families and genera of the world. Plant Gateway Ltd.
2. Christenhurz M. J. M. Reveal, J. L. Farjon, A. Gardner, M. F &. Mill, R. R. M. and Chase M. W. (2011) A new classification and linear sequence of extant gymnosperms. Phytotaxa 19: 55-70. Magnolia Press
3. Vashishta, P.C. 2010. Gymnosperms, S. Chand & Company, New Delhi.
4. Chamberlain, C. J. 2000. Gymnosperms. CBS Publishers, New Delhi.
5. Biswas, C. & Johri, B. M. 1999. The Gymnosperms. Narosa Publishing House, New Delhi.
6. Bhatnagar, S. P. & Moitra, A. 1997. Gymnosperms. New Age Publications, New Delhi.
7. Sharma, O. P. 1997. Gymnosperms, Pragati Prakasan, Meerut.
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9. Ramanujan, C. G. K. 1976. Indian Gymnosperms in time and space. Today and Tomorrows printers and publishers, New Delhi.
10. Chamberlain, C. J. 1955. Gymnosperms-structure and evolution. Dover Publications, Inc. New York.
11. Coulter, J. M. & Chamberlain, C. J. 1964. Morphology of Gymnosperm. Central Book Depot, Allahabad.

PAPER. BO 213. HISTOLOGY, REPRODUCTIVE BIOLOGY, MICROTECHNIQUE ANDHISTOCHEMISTRY

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

Objectives:

- To understand the anatomical featuresof plant parts and to identify the anomalous growth
- To acquire knowledge on plant reproduction and development
- To correlate the anatomical and palynological features to taxonomy
- To familiarize the techniques for the preservation and processing of tissues
- To get practical experience in microtechnique and histochemistry

Learning Outcomes:

The student will be able to

- develop skill in using various laboratory techniques for the microscopic analysis of plant tissues
- get an indepth knowledge on differentiation and development of plant tissue systems
- develop an understanding on the types of reproduction and the various processes involved in it
- to apply the anatomical and palynological data in basic research

A. HISTOLOGY — 36 hrs (2 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 (3 hrs)
3. Anomolous cambial activities in *Bignonia, Amaranthus, Mirabilis, Bougainvillea, Piper, Aristolochia.* (8 hrs)

   Structure of wood TS, TLS and RLS - Soft wood, Hard wood, Sap wood, Heart wood. 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.* (7 hrs)
4. Nodal anatomy, root –stem transition, transfer cells. (4 hrs)
5. Floral anatomy. (2 hrs)

6. Organization of shoot and root apex, shoot and root development, leaf development and phyllotaxy. (4 hrs)
7. Anatomy in relation to taxonomy (2 hrs)

Practical **9 hrs (½ hr/wk)**

1. Anomalous structures of the 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. Cutler D.F., Ted Botha T. and Stevenson D.W. 2016. Plant Anatomy: An Applied Approach.
   John Wiley & Sons.
2. Clive K.2016. Plant Anatomy, Morphology and Physiology.Syrawood Publishing House
3. Esau, K. 2006. The Anatomy of Seed Plants. 2nd Edition. John Wiley & Sons, New York.
4. Fahn, A. 1989. Plant Anatomy, Pergamon Press, Oxford, New York.
5. Eames, A. J. & Mac Daniels, L. H. 1979. An Introduction to Plant Anatomy. McGraw Hill New York.
6. Cutler, E. G. 1978. Plant Anatomy (Vol. I, II.) Edward Arnold, London.
7. Chandurkar, P. J. 1966. Plant Anatomy. Oxford & IBH Publication Co. New Delhi.
8. Foster, A. S.1960. Practical Plant Anatomy. Van Nostrand & East West, New Delhi.
9. Metcalfe, C.R. & Chalk, L. 1950. Anatomy of the Dicotyledons and Monocots (Vol. I, II), Oxford University Press, London.

B. REPRODUCTIVE BIOLOGY **27 hrs (1.5 hrs/wk)**

1. Asexual reproduction: Vegetative apomixis. 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. Pollen storage. Pollen viability and germination. `(3 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- intra ovarian pollination and *in vitro* fertilization - embryo rescue. (4 hrs)
6. Embryo, endosperm and seed development. Polyembryony, Parthenocarpy. (4 hrs)
   Androgenesis and gynogenesis. (2 hrs)
7. Application of Palynology in taxonomy (2 hrs)
8. Economic importance of pollen, Pollen allergy -
   Pollen analysis of honey - role of apiaries in crop improvement. (2 hrs)

Practical **9 hrs (½hr/wk)**

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. Johri B. M. , SrivastavaP. S. 2015 Reproductive Biology of Plants Springer-Verlag Berlin and Heidelberg GmbH & Co.
2. Ramawat K.G. Mérillon J.M. and Shivanna K. R. 2014. Reproductive Biology of Plants. CRC Press.
3. Johri B. M. 2011. Embryology of Angiosperms. Springer.
4. Bhojwani, S.S & Bhatnagar, S.P. 2000. The Embryology of Angiosperms, Vikas Publishing House Pvt. Ltd. New Delhi.
5. Pandey, S.N. & Chadha, A. 2000. Embryology. Vikas Publishing House Pvt. Ltd. New Delhi.
6. Pandey, A.K. 1997. Introduction to Embryology of Angiosperms. CBS Publishers and Distributors, New Delhi.
7. Johri, B.M. 1984. Embryology of Angiosperms. Springer Verlag. Berlin.
8. Maheswari, P. 1980. Recent Advances in the Embryology of Angiosperms.

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

1. Scope of histochemistry and cytochemistry in Biology. (1hr)
2. Chemical fixation –reagents and fixatives, chemistry of fixation; Tissue dehydration – reagents, Infiltration and embedding; Sectioning and mounting (9 hrs)
3. Tissue processing technique for light microscope, hand and serial sections, squashes, smears and maceration (9 hrs)
4. Microtomy-Rotary, Sledge, Freezing, Cryostat and Ultratomes (5 hrs)
5. Classification and chemistry of biological stains. General and specific vital stains and flurochromes. (5 hrs)
6. Micrometry, camera lucida, photomicrography. (3 hrs)
7. Tissue processing techniques for electron microscopy. (2 hrs)
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. (5 hrs)
9. Detection and localization of secondary metabolites- alkaloids, terpenoids, phenolics. (3 hrs)
10. Enzyme histochemistry- General design and applications. (3 hrs)

Practical 36 hrs (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 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 10 permanent slides (2 serial, 4 hand sections, and 1 whole mount/sledge, 1squash, 1smear, 1 histochemical localization)

References

1. Yeung E.C.T., Stasolla C., Sumner M. J. & Huang B. Q. 2015. Plant Microtechniques and Protocols. Springer Nature
2. Prasad M. K. &Prasad M. K. 2000. Emkay Publications
3. Kierman, J.A.1999. Histological and Histochemical Methods. Butterworth Publ. London.
4. Ruzin, Z. E. 1999. Plant Microtechnique and Microscopy. Oxford Press, New York.
5. Harris, J. R. 1991. Electron Microscopy in Biology. Oxford University Press, New York.
6. Gahan, P.B. 1984. Plant Histochemistry and Cytochemistry. Academic Press, London.
7. Johanson, W. A.1984. Plant Microtechnique. McGraw Hill, New York.
8. Johanson, W. A. 1982. Botanical Histochemistry-Principles and Practice. Freeman Co.
9. John E. Sass. 1964. Botanical Microtechnique. Oxford & IBH Publishing Co. Calcutta.
10. Gary, P. 1964. Hand book of Basic Microtechnique. John Wiley & Sons, New York.
11. Pearse, A. G. E. 1960. Histochemistry. Vol. I & Vol. II, J&A. Churchill, London.
12. Johansen, D. A. 1940. Plant Microtechnique. Tata McGraw Hill Publishing Co. Ltd. New Delhi.

SEMESTER II

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

153 hrs (Theory 108 hrs; Practical 45 hrs)

Objectives:

●To understand the concepts and principles related to Plant taxonomy, Ethnobotany and Economic botany
●To acquire the skill in plant identification and herbaria preparation
●To create an attitude in conserving plants for sustainable development
● To understand the utility of different types of crops and their useful parts

Learning Outcomes:

The student will be able to

●identify, classify and prepare herbaria of flowering plants
● develop an attitude to document and conserve the local/ traditional plant wealth
● understand the significance of ethnic societies and their traditional knowledge for sustainable development
● suggest methods to explore the traditional knowledge from the ethnic societies

A. TAXONOMY OF ANGIOSPERMS — 90 hrs (5 hrs/wk)

1. Scope and importance of taxonomy. (1 hr)

2. Taxonomic structure - Taxonomic hierarchy, Taxonomic categories – supra specific and infra specific categories; Concept of species, genus and family. (4 hrs)

3. Systems of classification: Brief study of Artificial (Linnaeus), Natural (Bentham and Hooker) and Phylogenetic (Bessey and Takhtajan) systems. Study of basic principles and recent Angiosperm Phylogeny Group (APG) system of classification. (6hrs)

4. Plant nomenclature: Brief history on the origin and development of nomenclature; Contents and major provisions of latest International Code of Nomenclature for algae, fungi, and plants (ICN) - Author citation, Typification and different kinds of types, Effective and valid publication of names, Principle of priority and its limitations, Conservation of names, Names of hybrids. Definition of nomenclature terms- autonym, homonym, basionym, tautonym and nomen nudum. A very brief account on International Code of Nomenclature of Cultivated Plants (ICNCP). (6 hrs)

5. History and development of taxonomy in India. Contributions of pioneers of Indian taxonomy - William Roxburgh, J. D. Hooker and J. S. Gamble. (1 hr)

6. Taxonomical literature: General indices, floras, revisions, manuals, icons, monographs, reviews and journals (1hr)

7. Construction of taxonomic keys (indented and bracketed) and its utilization. (2 hrs)

8. Herbarium: Definition, techniques involved in the preparation of herbarium, utility of herbarium and their maintenance. General account of national and regional herbaria - Central National Herbaria, Calcutta (CAL) and Madras Herbarium (MH), Botanical Survey of India (BSI). (3 hrs)

9. Botanical garden and its importance 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. (2 hrs)

10. Role, organization and achievements of Botanical Survey of India. (1 hr)

11. Biosystematics – Turesson's concept and categories (2 hrs)

12. Trends in plant taxonomy – i. Cytotaxonomy ii. Chemotaxonomy iii. Numerical taxonomy iv. Molecular taxonomy v. Phylogenetic systematics - basic principles. (5 hrs)

13. Study of the current ideas on the origin of angiosperms - Bennettilean, Pteridospermean and Caytonialean ancestry. (1 hr)

14. 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. **(55 hrs)**

Ranunculaceae	Magnoliaceae	Capparidaceae	Polygalaceae
Caryophyllaceae	Portulacaceae	Dipterocarpaceae	Malvaceae
Rhamnaceae	Vitaceae	Sapindaceae	Leguminosae
Combretaceae	Rhizophoraceae	Myrtaceae	Melastomataceae
Passifloraceae	Cucurbitaceae	Apiaceae	Rubiaceae
Asteraceae	Sapotaceae	Oleaceae	Asclepiadaceae
Boraginaceae	Solanaceae	Scrophulariaceae	Acanthaceae
Verbenaceae	Lamiaceae	Amaranthaceae	Aristolochiaceae
Piperaceae	Lauraceae	Loranthaceae	Euphorbiaceae
Urticaceae	Orchidaceae	Scitaminae	Amaryllidaceae
Liliaceae	Arecaceae	Araceae	Cyperaceae
Poaceae.			

Practical **36 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 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 evaluation).
6. Preparation of dichotomous key (minimum 5 keys).
7. A minimum of 10 abbreviations of authors' names to be presented in the record.
8. Expansion of 10 floral formulas.
9. Exercises in nomenclatural citations and solving nomenclatural problems (At least 10).
10. A minimum of 50 herbarium specimens giving representation of minimum of 40 families to be submitted for valuation.

B. ECONOMIC BOTANY **9 hrs (½ hr/wk)**

1. Detailed study of the occurrence, morphology of the useful part and uses of the following crop plants with their botanical details.

a) Cereals and Millets: Rice, Maize and Ragi.

b) Pulses: Soybean, Horse gram.

c) Sugar yielding plants: Sugarcane.

d) Plantation crops: Coconut, Cocoa, Coffee, Tea and Rubber.

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

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

f) Fruits: Mango, Banana, Citrus, Guava, Cashew nut and Jack fruit.

g) Vegetables: Brinjal, Cucumber, little gourd, Bitter gourd, Winged bean and Sword bean.

h) Medicinal plants: Sarpagandha, *Vinca*, *Glycirrhiza*, *Adhatoda* and *Andrographis*.

i) Narcotics: Cannabis, Opium.

j) Timber yielding plants: Rose wood, Teak Wood.

Practical **9 hrs (½ hr/wk)**

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

References

1. Judd, W.S., Campbell, C. S., Kellog, E. A. & Stevens P. F. 2015. Plant Systematics. 4th Edn. Sinauer Associates, Inc., Massachusetts, USA.
2. Essig, F.E. 2015. Plant Life. A Brief History. Oxford University Press.
3. Takhtajan A. 2009. Flowering Plants. Springer.
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7. Sivarajan, V. V. 1991. An introduction to Principles of Taxonomy, London.
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12. Kochar, L. S. 1981. Economic Botany in the Tropics, Macmillan Co. New York.
13. Gibbs, R. D. 1975. Chemotaxonomy of Flowering Plants. In The quarterly review of Biology, 50: 3
14. Takhtajan, A. L. 1969. Flowering plants. Origin and Dispersal. Oliver and Boyed.
15. Rendle, A. B. 1967. Classification of Flowering Plants, Cambridge University Press.
16. Lawrence, G. H. M. 1964. Taxonomy of Vascular Plants, Macmillan Co. New York.
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18. Hutchinson, J. 1959. Families of Flowering Plants, Cambridge University Press.
19. Lawrence, G. H. M. 1955. An Introduction to Plant Taxonomy, Central Book Depot.
20. Hill, A. F. 1952. Economic Botany, Tata McGraw Hill.
21. Gamble, J. S. 1935. Flora of Presidency of Madras, London.
22. Hooker, J. D. 1879. Flora of British India. Reeve &Co., London.

C. ETHNOBOTANY

9 hrs(½ hr/wk)

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

6. Status of ethnobotanical studies in Kerala.

7. Contributions of S. K. Jain and E. K. Janaki Ammal.

8. Relevance of IPR in Ethnobotany.

References

1. Martin, G. J. 2004. Ethnobotany: A Methods Manual, Earthscan, UK.
2. Jain, S. K. 2001. Medicinal Plants, National Book Trust, India.
3. Cunnigham, A. 2001. Applied Ethnobotany: People, wild plant use and conservation, Earthscan, UK.
4. Jain, S. K. & Mudgal, V. 1999. A Hand book of Ethnobotany. Bishen Singh Mahendrapal Singh, Dehradun.
5. Wood, M. 1997. The Book of Herbal Wisdom: using plants as medicines, North Atlantic Books, California.
6. Jain, S. K. 1987. A Manual of Ethnobotany, Indus Intl. Publishers, New Delhi.

PAPER BO222

ENVIRONMENTAL BIOLOGY, FOREST BOTANY, PHYTOGEOGRAPHY ANDCONSERVATION BIOLOGY

144hrs (Theory 108 hrs; Practical 36 hrs)

Objectives:

- To learn the concepts on ecosystem and environment
- To impart knowledge on phytogeography and distribution
- To understand the concept, aim and principles of conservation
- To understand the causes and effects of pollution and climate change
- To create an awareness about the significance of forest and genetic resources
- To understand various rules and regulations for environment protection

Learning Outcomes:

The student will be able to

- understand the interactive phase of environment, biota and man
- understand the structural and functuional dynamics of different ecosystems
- develop strategies for the effective utilization and management of natural resources
- adopt suitable steps for the protection and conservation of environment and natural resourcces

A. ENVIRONMENTAL BIOLOGY54 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 – 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 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 itsmeasurement; edge effect and ecotone. (4 hrs)
5. E**c**osystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems:

   Grassland,terrestrial, forest, and aquatic (fresh water, marine, estuarine). Major terrestrial biomes; theory of island biogeography; biogeographical zones of India

   . (7 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. Disaster management, Global environmental problems- ozone depletion, greenhouse effect, global warming, acid rain, nuclear hazards – Climate change, Eutrophication. (5 hrs)
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. Green Protocol. (6 hrs)

Practical **36 hrs (2 hrs/wk)**

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

Report of the items 6 and 7 should be included in the record.

References

1.
1. Krohne D. T. 2017 Ecology: Evolution, Application, Integration. Oxford Univ. Press.
2. Poul V.I. 2013. Biodiversity: Issues, Impact, Remediations and Significance 1st Edition. V L Media Solutions
3. Stiling, P. 2012. Ecology: Global Insights and Investigations, McGraw- Hill Companies, NewYork.
4. Sharma, P. D. 2004. Environmental Biology, Himalaya Publications.
5. Kumar, H. D. 2000. Modern Concepts of Ecology. Vikas Publishing House, New Delhi.
6. Aradhana, P. S. (Ed). 1998. Environmental Management, Rajat Publications, Delhi.
7. Trivedi, R. K. & Goel, P.K. 2003. Introduction to Air pollution, Techno-Science Publication.
8. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001. Environmental Encyclopedia, Jaico Publ. House, Mumbai.
9. Chapman J. & Reiss M. 2000. Environmental Biology. Cambridge University Press.
10. Agarwal, K.C. 2001. Environmental Biology, Nidi Publ. Ltd. Bikaner.
11. Jadhav, H & Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi.
12. Brunner, R.C. 1989. Hazardous Waste Incineration, McGraw Hill Inc.
13. Odum, F. E. 1971. Fundamentals of Ecology. W.B. Saunders and Company.

B. FOREST BOTANY **9 hrs (½ 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. Shanmughavel, P. 2014. Forest Botany, Pointer Publishers.
2. Bor, N.L. 2008. A Manual of Indian Forest Botany International Book Distributors.
3. Singh M.P., Singh J. K., Mohanka N. & Sah R.B. 2007. Forest Environment and Biodiversity. 2nd Edition. Daya Publishing House.
4. Puri, G. S. 1989. Indian Forest Ecology, Vol. II, Oxford & IBH Co. Pvt. Ltd.
5. Agarwal, V. P. 1985. Forest in India, Oxford & IBH.

6. Champion, G. H. & Seth, K. A. 1968. A Revised Survey of Forest types of India.

C PHYTOGEOGRAPHY **18hrs (1 hr/wk)**

1. Define – Phytogeography - static and dynamic phytogeography. (1 hr)
2. Geological history and evolution of plant life. (3 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 (Vegetational belts). (4 hrs)
5. Soil, climate, flora, and vegetation of India. (4 hrs)
6. Scope and relevance of GIS and Remote sensing (2 hrs)

References

1. Cox C.B. and Moore P.D. & Ladle R. 2016. Biogeography: An Ecological and Evolutionary Approach. Wiley-Blackwell.
2. Huismann, O. & de By R. A. (Editors) 2009. Principles of geographic system- An introductory text book. ITC, The Netherlands.
3. Schatz, G.E. 1996. Malagasy / Indo-Australo-Malesian Phytogeographic Connections. http://www.mobot.org/MOBOT/Madagasc/biomad1.html
4. Bharucha, F. R. 1984. A Text Book of Plant Geography of India. Oxford University Press.
5. Puri, G.S. 1983. Indian Forest Ecology, Vol. I, II. Oxford, New Delhi.
6. Ronald Good. 1964. The Geography of Flowering Plants. Longmans.
7. The International Biogeography Society http://www.biogeography.org/
8. 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 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 hrs)

3. Conservation biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves). (3 hrs)

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 hrs)

5. Urbanization and Conservation – Planning for environmentally compatible human settlements and strategy for sustainable industrial development. (2 hrs)

6. Conservation and energy – Causes of energy crisis, Conventional and Non-conventional energy sources. (2 hrs)

7. Plant as a source of renewable energy. Development of non-polluting energy systems – Solar energy, Wind energy, energy recovery from solid wastes. (2 hrs)

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

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, Environmentprotection Act. (6 hrs)

10. Environmental awareness – role of Government and NGOs- Gaia hypothesis. (2 hrs)

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.

References

1. Shobh Nath Singh2015. Non Conventional Energy Resources. 1st Edition. Pearson.
2. Tasneem Abbasi, S. A. Abbasi 2011. Renewable Energy Sources Their Impact on Global Warming and Pollution PHI Learning Pvt. Ltd
3. Mahendra Chaturvedi 2010.Biodiversity and Conservation 1st Edition D.P.S. Publishing

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4. Van Dyke, F. 2008. Conservation Biology, foundation, concept, applications, Springer.
5. Hunter, M.L. Jr. and J.P. Gibbs. 2007. Fundamentals of conservation biology, 3rd edition. Blackwell Publishing, Oxford, United Kingdom, 497pp.
6. MacDonald & Katrina Service. 2007. Key Topics in Conservation Biology, Blackwell Publishing.
7. Bharucha & Jayalaxmi Rai (2002) The Biodiversity of India. Erach Grantha Corporation.
8. Andrew, S. Pullin. 2002. Conservation Biology, Cambridge University Press.
9. Fiedler, P.I. & Kareiva P.M. 1998. Conservation Biology for the coming decade. Chapman and Hall.
10. Dasman, R.F. 1976. Environmental Conservation, John Wiley and Sons, New York.

PAPER BO223: CELL BIOLOGY, GENETICS AND EVOLUTION
153 hrs (Theory 108 hrs; Practical 45 hrs)

Objectives:

- To learn the concepts on cell organelles, cell cycle,cell differentiation and interactions
- To acquire practical skill in cytological preparations
- To get knowledge about Mendel's Experimental approach
- To understand concepts on linkage, microbial genetics and biochemicalgenetics
- To impart knowledge on molecular genetics and protein synthesis
- To understand the concept on population and developmental genetics
- To understand mechanism of evolution

Learning Outcomes:

The student will be able to

- understand the concept on the cellular and molecular mechanisms involved in heredity and variation
- get the knowledge on population and developmental genetics
- learn the causes of genetic disorders at chromosomal level
- understand the origin and establishment of new life forms on earth

A. CELL BIOLOGY — 36 hrs (2 hrs/week)

1. Introduction to cell biology – Cellular organization; Prokaryotic and Eukaryotic cells. Cytoskeleton; Its role in cell organization and mobility. (3 hrs)

2. Structure and organization of nucleus, nucleolus (NOR). Nuclear-Cytoplasmic transport (Nuclear localization signals, NPC Proteins, Nuclear import and export receptors). (3 hrs)

3. Chromosomes – Structure and organization of chromatin, packaging of DNA into chromosomes. Organization and role of centromere and telomere (centromeric and telomeric sequences). Mitochondrial and Chloroplast genome organization. (6 hrs)

4. Structural and Numerical variations in chromosomes –Structural: Deletions, Duplications, Inversions and translocations. Meiotic behavior of structural variants. Numerical: Euploids and aneuploids. Meiotic behavior of numerical variants. Evolutionary significance of chromosomal variations. (4 hrs)

5. Cell cycle and its regulation - Stages of cell cycle (Mitosis and Meiosis). Spindle formation and its disintegration, mechanism of chromosome movement and separation during anaphase, Role of cohesins and condensins, Role of motor proteins. Cell cycle and its control mechanisms (Check points); Role of cyclins and cyclin dependent kinases, cdk activating kinase (CAK), cdk inhibitory proteins (CKIs). (6 hrs)

6. Cell interactions – Extra cellular matrix, Cell adhesion molecules; cadherins, integrins, selectins, fibronectins, laminin and Immunoglobin superfamily. Cell-cell adhesions (Junctional and non-junctional

adhesive mechanisms; occluding junctions, anchoring junctions, communicating junctions (Connexons) and plasmodesmata). (4 hrs)

7. Apoptosis – Mechanism of programmed cell death; Extrinsic and intrinsic pathways, Inhibitors of apoptosis. Mechanism of ageing. (4 hrs)

8. Cell differentiation – Stem cells, Cell potency, Molecular mechanism of cell differentiation (Brief account), Transcriptional control, Translational control, Gene amplification, Gene rearrangement and Transposition. (6 hrs)

Practical **(18hrs; 1 hr/week)**

1. Meiosis - *Rhoeo, Chlorophytum, Crotalaria, Datura* (at least one should be recorded).
2. Mitosis – Metaphase and Anaphase
3. Calculation of Mitotic index.

References

1. Becker, W. M. Hardin, J. & Bertoni G. 2018. Becker's World of the Cell. Pearson Education Ltd.
2. Janet, I. & Wallace, M. 2017. KARP'S Cell and Molecular Biology. John Wiley & Sons, Inc.
3. Sen, S., Kar, D. K. & Johri, B. M. 2005. Cytology & Genetics. Alpha Science International Ltd.
4. De Robertis & De Robertis. 1998. Cell and Molecular Biology. B.I. Waverly Pvt. Ltd. New Delhi.
5. Cooper, G. M. 1997. The Cell – A Molecular approach. ASM Press, Washington.
6. Strickberger, M. W. 1985. Genetics. Macmillan India, New Delhi.
7. Jurgen Schulz-Scaffer, 1985. Cytogenetics- Plants Animals and Humans. Springer Verlag, Berlin.

B. GENETICS **54 hrs (3 hrs/week)**

I. Classical Genetics

1. Mendelian principles–Brief account and critical evaluation. (2hrs)
2. Sex determination- Mechanisms of sex determination- Brief account of genetically, hormonally, environmentally and chromosomally controlled mechanisms. A detailed account of the following chromosomal mechanisms- XX-XY, XX-XO, ZZ-ZW. Dosage compensation, Barr body, Lyon's hypothesis. (4 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, recombination linkage maps, three point test crosses, interference, coefficient of coincidence and negative interference. (3 hrs)
4. Microbial Genetics – Genetic recombination in viruses – lysogenic and lytic cycles in bacteriophages. 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. (4 hrs)

5. Biochemical Genetics –Inborn errors of metabolism- Major types of metabolic errors in man: Phenylketonuria, Alkaptonuria, Albinism, Tyrosinosis, Goitrous cretinism. (2 hrs)
6. Gene concept – Allele, Multiple alleles, pseudoallele, polygenes. 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, Barbara Mc Clintock's 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 and Z-DNA. (2hrs)
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, Okazaki 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. (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, Xeroderma pigmentosum, 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. (3 hrs)
5. Genetic code –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. Epigenetics.

(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 its applications. Factors affecting gene frequencies – mutation, migration, selection, genetic drift, genetic polymorphism and selection, founder effect, genetic load. (3 hrs)
2. Consanguinity and its genetic effect**.** (1 hrs)
3. Human genetics: Pedigree analysis, Karyotypes, genetic disorders. (2 hrs)
4. Developmental genetics- Genetic control of development in plants and animals with stress to developmental genes in *Arabidopsis* and *Drosophila.* Role of cytoplasm in development. (3 hrs)

Practical **27 hrs (1.5 hrs/wk)**

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

References

1. Krebs, J. E., Goldstein, E. S. & Kilpatrick, S. T. 2018. LEWIN'S GENES XII. Jones & Bartlett Learning.
2. Janet, I. & Wallace, M. 2017. KARP'S Cell and Molecular Biology. John Wiley & Sons, Inc.
3. Watson, J.D., Baker T.A., Bell S.P., Gann A., Levine M. & Losick R. 2014. Molecular biology of the gene. 7th Edition. Cold Spring Harbor Laboratory, Tania, MIT
4. Snustad, P. D. & Simmons, M. J. 2012. Principles of genetics 6th Edition. John Wiley & Sons, Inc.
5. Benjamin A. Pierce. 2012. Genetics. A Conceptual Approach 4th Edition. W. H. Freeman and Company.
6. Klug, W. S., Cummings, M. R., Spencer, C. A. & Palladino. M. A. 2012. Concepts of genetics. Pearson Education, Inc.
7. Lodish, H., Berk, A., Kaiser, C. A. & Krieger, M. 2012 Molecular Cell Biology. 7th Edition, W. H.

Freeman, NY, USA.

8. Hartwell, L. H., Hood, L., Goldberg, M. L., Reynolds, A. E. & Silver, L. M. 2011. The McGraw Hill Companies, Inc.
9. Russell, P. J. 2010. Genetics: A molecular approach. 3rd Edition. Pearson Education, Inc.
10. Alberts, B., Bray, D., Hopkin, K. & Johnson, A. D. 2009. Essential Cell Biology. 3rd Edition, Garland Science, NY, USA.
11. Strickberger, M. W. 2008. Genetics 3rd Edition. Pearson Education India.
12. Weaver, R. F. 2008. Molecular Biology. 5th Edition. McGraw-Hill, New York.
13. Brown, T.A. 2006. Genomes. 3 Garland Science.
14. Tamarin, R. 2001. Principles of Genetics 7th Edition. McGraw Hill Education.
15. Goodenough, U. Genetics. 1984. Holt Saunders, New York.
16. Sinnot, E. W. Dunn, L. C. & Dobzhansky, T. 1958. Principles of Genetics. McGraw Hill, New Delhi.

C. EVOLUTION **18 hrs (1 hr / Wk)**

1. Origin and evolution of life. (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. Charlesworth B. & Charlesworth D. 2017. Evolution: A Very Short Introduction, 2nd Edition Oxford University Press.
2. Willis K. &McElwain M. C. 2014. The Evolution of Plants. Oxford University Press.
3. Herron, J. C., Freeman, S.m Hodin, J., Miner, B. & Sidor, C. 2014. Evolutionary Analysis. 5th Edition. Pearson Education, Inc.
4. Futuyma D.J. 2013 Evolution. 3rd edition Sinauer Associates, Inc.
5. Shapiro, J. A. 2011. Evolution- A view from the 21st Century. Publishing as FT Press Science.
6. Barton N.H., Briggs E.G., Eisen J. A. Goldstein D. B. & Patel N.H. 2007 EvolutionCold Spring Harbor Laboratory Press; 1st edition (June 26,)
7. Sproule, A. 1998. Charles Darwin: Scientist who have Changed the World. Orient Longman, New

Delhi.

8. Strickberger, M. W. 1996. Evolution, Jones and Bartlett Publishers, New York.
9. Briggs, D. & Walters, S. M. 1984. Plant Variation and Evolution, Cambridge University Press, London
10. Calow P. 1983. Evolutionary principles, Blackie & Son Limitted.
11. Wooley, P. 1983. Molecular theory of evolution, Springer-Verlag, Berlin.
12. Echrlich, P. R. & Holm, R. H. 1974. Process of evolution, Oxford &IBH, New Delhi.
13. Savage, J. M. 1969. Evolution, Oxford &IBH, New Delhi.

SEMESTER III

PAPER. BO 231. PLANT BREEDING, HORTICULTURE AND BIOSTATISTICS

135 hrs (Theory 108 hrs; Practical 27hrs)

Objectives:

- To provide basic knowledge in plant breeding, biostatistics and horticulture
- To understand different breeding methods used in crop improvement
- To develop practical skills in plant breeding
- To apply the statistical methods for data analysis
- To attain the skill and knowledge for the cultivation/ propagation and management of garden plants

Learning Outcomes:

The student will be able to

- acquire knowledge and skill for crop improvement programme
- undertake the cultivation and management of vegetable garden/ ornamental garden
- to analyse scientific data statistically

A. PLANT BREEDING (54 hrs; 3 hrs/wk)

1. Definition, Objectives. Importance of floral biology in plant breeding. (2 hrs)
2. Methods of crop improvement

i. 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. International exchange of germplasm. (4 hrs)

ii. Selection: Principles, genetic basis and methods: Mass selection, pure line selection, clonal selection. (5 hrs)

iii. 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. (6 hrs)

3. Genetics of incompatibility and sterility. Role in crop improvement Types of male sterility:
4. Gametic and zygotic sterility. Somatoplastic sterility. Cytoplasmic and genetic sterility. Methods to overcome incompatibility. (4 hrs)
5. Backcross breeding: Theory and procedure. (4 hrs)

6. 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. Ideotype breeding: Concept, Achievements: (Wheat – Asana, Donald. Rice – Super Rice). (6 hrs)
7. Polyploidy breeding: induction of autopolyploidy and allopolyploidy. Role of chromosome manipulation. Chromosome addition and substitution lines. Achievements. (5 hrs)
8. Mutation breeding: Principles, objectives, procedure. Induction of mutations: Physical and chemical mutagens - Recurrent irradiation, Split dose irradiation, Combination treatment. Achievements. (5 hrs)
9. 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. (6 hrs)
10. Seed production and certification. (2 hrs)
11. Centres of crop breeding: International and National (with special reference to Kerala) (3 hrs)
12. Plant breeder's rights Act. National Biodiversity Policy. (2 hrs)

Practical **9 hrs (½ 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. Study of pollen types using acetolysed and non-acetolysed pollens
5. Developmental stages of anther, ovule, embryo and endosperm.

References

1. Chopra, V. L. 2012. Plant Breeding Theory & Practice Oxford & Ibh Publishing Co Pvt Ltd
2. Ghahal, G. S. & Gosal, S. S. 2002. Principles and Procedures of Plant Breeding. Narosa Publishing House.
3. Singh, B. D. 1996. Plant Breeding: Principles and Methods. Kalyani Publications.
4. Allard, R. W. 1995. Principles of Plant Breeding. John Wiley and Sons, Inc.
5. Sharma, J. R. 1994. Principles and Practices of Plant Breeding. Tata McGraw-Hill Publishers Company Ltd.
6. Hayward, M. D., Bosemark, N.O. & Romagosa, T. 1993 (Eds.) Plant Breeding. Principles and Prospects. Springer.

B. HORTICULTURE **18 hrs (1 hr/wk)**

1. Concept and Scope – Familiarization of famous gardens in the world and in India. (1hr)
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. (2 hrs)
5. Cultural practices – Thinning, training, trimming and pruning. (2 hrs)
6. Fertilizers: NPK, biofertilizers, green manure, compost, vermicompost. (2 hrs)
7. Outdoor horticulture: Components and designs of gardens. Types of gardens: (3hrs) 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)

Practical **9 hrs (½ hr/wk)**

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
5. Familiarization of tools and implements used in Horticulture.

References

1. Gupta, S. N. 2018, Handbook of Horticulture, 1st Edition, Jain Brothers.
2. Shry, C. & Reiley. 2016. Introductory Horticulture; 9th Edition. Cengage Learning.
3. Singh, J. 2014. Fundamentals of Horticulture, Kalyani Publishers.

C. BIOSTATISTICS **36 hrs (2 hrs/wk)**

1. Sampling methods and errors (3 hrs)
2. Collection, classification and tabulation of data –Diagrammatic and graphic representation.

Line diagram, Bar diagram, Pie diagram, Histogram, Frequency curve, frequency polygon Ogives. (3 hrs)

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

Practical **9 hrs (0.5 hrs/wk)**

1. Using the given data from plant science, calculate dispersion.
2. Find out chi square value of the given data.
3. Find out broad sense heritability of data from plant science.
4. Preparation of graphs using EXCEL or similar packages

References

1. Veer Bala Rastogi, 2015. Biostatistics. 3rd edition. Medtech.
2. Norman Bailey, T. J. 2012. Statistical methods in Biology. Cambridge University Press.
3. Khan, I. A. and Khanum, A. 2008. Fundamentals of Biostatistics, 3rd edition.
4. Richards, J. & Sunder Rao, P. S. S. 2006. An introduction to Biostatistics and research methods.
5. Dutta, N. 2002. Fundamentals of Biostatistics: Practical approach.

PAPER. BO 232. BIOCHEMISTRY, PLANT PHYSIOLOGY AND RESEARCH METHODOLOGY
162 hrs (Theory 108 hrs; Practical 54 hrs)

Objectives:

- To understand the different metabolism in plants
- To trace the relationship between biochemical pathways in plants and the physiological processes.
- To introduce the basic concepts in research methodology
- To prepare the students to draft a project proposal

Learning Outcomes:

The student will be able to

- understand the biochemical processes in plants
- conduct the qualitative and quantitative experiments in plants
- understand the mechanism of various physiological processes involved in the growth and development of plants
- set up plant experiments related to plant physiological processes
- prepare a project proposal

A. BIOCHEMISTRY 36 hrs (2 hr/wk)

1. pH and buffers. Properties of water, acids bases and buffers. Henderson-Hasselbalch equation, pH, pKa. Common buffers (2 hrs)
2. Structure, function and metabolism of carbohydrates – Synthesis of starch, cellulose and sucrose. Interconversion of hexoses and pentoses. (7 hrs)
3. Structure, function and metabolism of lipids: Biosynthesis of fatty acids. Biosynthesis of Triacyl glycerol, diacyl glycerol, monoacyl glycerol. Gluconeogenesis. Membrane lipids. Lipid oxidation. (8 hrs)
4. Proteins and amino acids: Structure and classification of amino acids. Biosynthesis of aminoacids. Classification of protein based on structure, function and localization sites. Primary, secondary, tertiary and quaternary structure. Protein domains. Ramachandran plot. Purification of proteins. (6 hrs)
5. Enzymes: IUB system of classification and nomenclature. Distribution of plant enzymes. Soluble and membrane bound enzymes. Co enzymes, substrate specificity, regulation of

enzyme activity, Inhibitors, allosteric enzymes. Isozymes. Ribozymes. Abzymes. Enzyme kinetics. the Michaelis–Menten equation, Lineweaver-Burk plot, Km and Vmax. Multienzymes (7 hrs)

6. Secondary metabolites- Classification. Pathways of synthesis (3 hrs)

7. Biosynthesis of purines and pyrimidines. Metabolism of nucleotides. (3 hrs)

Practical **27 hrs (1.5 hrs/wk)**

1. Preparation of buffers. Phosphate, carbonate, Tris HCl.
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, protease, peroxidase and polyphenol oxidase.
6. Isolation and quantification of plant lipids by dry and wet methods.

References

1. Becker, W. M., Hardin & Bertoni G. 2018. Becker's World of the Cell. Pearson Education Ltd.
2. Nelson D. L. & Cox, M. M. 2017. Lehninger Principles of Biochemistry. 7th Edition. W H Freeman & Co.
3. Appling D. R., Anthony-Cahill S.J. & Mathews, C.K. 2016. Biochemistry. Concepts and Connections. Pearson Education Limited.
4. Berg, J. M., Tymozko. J. L. & Stryer, L. 2015. Biochemistry, 8th Edition. W. H. Freeman and Company.
5. Voet, D., Pratt C.W. & Voet, J. G. 2008. Principle of Biochemistry, 4rd Edition. John Wiley Sons Inc.
6. Jain, J.L. 2000. Fundamentals of Biochemistry. S. Chand & Co. New Delhi.
7. Hames, B.D., Hooper, N.M., & Houghton, J.D1999. Instant notes in Biochemistry. Viva books Pvt. Ltd. New Delhi.
8. Harborne, J.B. 1999. Plant Biochemistry. Chapmann & Hall, New Delhi.
9. Campbell, M.K. 1999. Biochemistry. Saunders College Publishing, New York.
10. Fisher J. & Arnold J.1999. Instant Notes in Chemistry for Biologists. Viva Books Pvt. Ltd. New Delhi.
11. Goodwin, T. W. & Mercer, E. I. 1996. Introduction to plant Biochemistry. CBS Publishers and Distributors, New Delhi.

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13. Plummer, D.T. 1996. An Introduction to Practical Biochemistry. McGraw Hill.
14. Dennis, D. T. & Trurpin, D. H. (Eds.) 1993. Plant Physiology. Biochemistry and Molecular Biology. Longmann Scientific and Technical, Singapore.
15. Wilson, K. & Goulding, K. H. 1992. Biologists Guide to Principles and Techniques of Practical Biochemistry. Cambridge University Press.
16. Conn, E.E., Stumpf, P.K. Bruening G. & Doi R.Y.1987. Biochemistry. John Wiley and Sons. New Delhi.

B. PLANT PHYSIOLOGY **54 hrs (3 hrs/week)**

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. Respiration. Anaerobic, aerobic. Glycolysis, TCA cycle, ETS and ATP synthesis, transporters involved in exchange of substrate of products, Pentose phosphate pathway. (10 hrs)
4. Transport of metabolites – Xylem and Phloem sap translocation. (3 hrs)
5. Photoregulation and growth responses. Plant morphogenesis. Physiology of flowering, fruit ripening, senescence and abscission. (4 hrs)
6. Biological clock and circadian rhythm. (3 hrs)
7. Seed metabolism, glyoxylate cycle in fatty seeds during germination. (4 hrs)
8. Nitrogen metabolism. Nitrate and ammonium assimilation. Symbiotic and non symbiotic. Role of leg hemoglobin. (4 hrs)
9. Physiological response of plants to stresses like drought, heat and cold. Salt tolerance in plants. (5 hrs)
10. Role of phytoalexins. Defense mechanism. Phenyl propanoid pathway in plants. (3 hrs) Allelopathy – Plant derived compounds.
11. Plant hormones – Physiological effects and mechanism of action. (2 hrs)

Practical **27 hrs (1.5 hrs/wk)**

1. Extraction and estimation of total proteins by TCA precipitation and Lowry's 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.
7. Setting up of Plant Physiology experiments.

References

1. Jain, J.L. 2017. Fundamentals of Plant Physiology 19th Edition. S Chand Publishing.
2. Sinha S.K. 2013. Modern Plant Physiology 2nd Edition. Narosa Publishers.
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4. Hopkins W.G. & Hüner N. P.A. 2008. Introduction to Plant Physiology. 4th Edition John Wiley & Sons
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7. Salisbury, F.B. & Ross. C. 2000. Plant physiology. John Wiley & Sons, New Delhi.
8. Hall, D.O. & Rao, K.K. 1999. Photosynthesis. Cambridge University Press.
9. Noggle, G. R. & Fritz, G. J. 1999. Introductory Plant Physiology. Prentice hall, London.
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11. Brett, C.T. & Waldron, K.K. 1996. Physiology and Biochemistry of Plant Cell Walls, Chapman and Hall London.
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13. Daphne. J. Osborne, Micheal. & Jackson, B. 1989. Cell Separation in Plants Physiology, Biochemistry and Molecular Biology. Springer – Verlag. Berlin.
14. Conn, E.E., Stumpf, P.K. Bruening G. & Doi R.Y.1987. Biochemistry. John Wiley and Sons. New Delhi.
15. Fitter, A.H. & Hay R.K.M. 1987. Environmental Physiology of Plants. Academic Press.
16. Wilkins, M.B. (Ed.) 1984. Advanced Plant Physiology, Pitman Publishing Co. New York.

17. Strafford, G.A. 1979. Essentials of Plant Physiology. Heinemann Publishing Co. New York.
18. Hess, D. 1975. Plant physiology. Narosa Publishing House, New Delhi.
19. Hatch, M.D. Osmond, C. B. & Slatyer, R. O. 1971. Photosynthesis and Photorespiration.

C. RESEARCH METHODOLOGY **18 hrs (1 hr/wk)**

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. (4 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, preparing the reference section. Common tools for reference preparation. (4 hrs)

References:

1. Kothari, C.R. & Garg, G. 2018. Research Methodology. New Age International Publishers.
2. Gurumani, N. 2009. Research Methodology: for Biological Sciences. MJP Publishers, New Delhi.
3. Kumar, R. 2014. Research Methodology. Sage Publishing; 4th Edition.

PAPER BO 233. MOLECULAR BIOLOGY, IMMUNOLOGY AND PLANT BIOTECHNOLOGY
153 hrs (Theory 108 hrs; Practical 45 hrs)

Objectives:

- To get an overview on Molecular Biology and Immunology
- To impart knowledge about various techniques in Molecular Biology
- To bestow practical skill in isolation of DNA, RNA and Protein
- To acquire an in depth knowledge on plant biotechnology and its application

Learning Outcomes:

The student will be able to

- get the knowledge on various techniques in molecular biology
- get the skill in isolation and quantification of DNA and proteins
- understand the knowledge on immunology,types of immune response and immunotechniques
- produce tissue cultured plants and artificial seeds

A. MOLECULAR BIOLOGY 36 hrs (2 hr/wk)

I. Basics in Molecular Biology

1. The RNA World. Molecular Clock. (1 hr)
2. DNA Topology- Twist and Writhe. Supercoiling. (1 hr)
3. Proteins involved in DNA Replication, Telomere and Telomerase. (1 hr)
4. Protein Folding. Role of Molecular Chaperones. (1 hr)
5. Isolation and purification of RNA, DNA (genomic and plasmid), different separation methods. (2 hrs)
6. Molecular cloning of DNA. Cutting and joining DNA Molecules, Restriction endonucleases.

   Cloning vectors-features. Plasmids, Cosmids, Bacteriophage vectors, Phagemids, Yeast artificial chromosome (YAC), Bacterial artificial chromosome (BAC) and P1 phage vectors. Selection and analysis of cloned DNA sequences. (6 hrs)

II. Techniques in Molecular Biology

1. Polymerase chain reaction (PCR) Procedure and Components. Types of PCR i) inverse PCR. ii) Rapid amplification of cDNA ends (RACE) iii) Real-time quantitative PCR. PCR applications (6 hrs)
2. Generation of genomic and cDNA libraries. (2 hrs)

3. Restriction digestion and ligation; Restriction mapping. (2 hrs)
4. Sequencing genes and short stretches of DNA including Sanger dideoxy sequencing and Next Generation Sequencing (NGS brief account only). (3 hrs)
5. In vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms. (2 hrs)
6. Protein sequencing methods, detection of post translation modification of proteins. Foot Printing Assay. (1hr)
7. Methods for analysis of gene expression at RNA and protein level, large scale expression such as micro array based techniques. (2 hrs)
8. Molecular markers - RFLP, RAPD and AFLP techniques. (2 hrs)
9. Blotting techniques Sothern, Western, Northern and Dot Blot. Labeling of Nucleic acids. (2 hrs)
10. New Trends in Gene modification:- CRISPER/CAS System (2 hrs)

Practical **(9 hrs ½ hr/wk)**

1. Isolation and purification of genomic DNA.
2. Demonstration of electrophoresis – Horizontal and Vertical.
3. Isolation of total RNA (Demonstration only).
4. Isolation and Partial purification of Proteins.

References

1. Krebs, J. E., Goldstein, E. S. & Kilpatrick, S. T. 2018. LEWIN'S GENES XII. Jones & Bartlett Learning.
2. Becker, W. M. Hardin, J. & Bertoni G. 2018. Becker's World of the Cell. Pearson Education Ltd.
3. Iwasa, J. & Marshall, W. 2017. KARP'S Cell And Molecular Biology John Wiley & Sons, Inc.
4. Lodish, H., Berk, A., Kaiser, C. A. & Krieger, M. 2012 Molecular Cell Biology. 7th Edition, W. H. Freeman, NY, USA.
5. Alberts, B., Bray, D., Hopkin, K. & Johnson, A. D. 2009. Essential Cell Biology. 3rd Edition, Garland Science, NY, USA.
6. Watson, J.D., Baker T.A., Bell S.P., Gann A., Levine M. & Losick R. 2014. Molecular biology of the gene. 7th Edition. Cold Spring Harbor Laboratory, Tania, MIT
7. Cooper, G. M. & Hausman R. E. 2013. The Cell – A Molecular Approach. Sinauer Associates
8. Jones, R. L. 2012. The Molecular Life of Plants. Wiley-Blackwell.
9. Clark, D. P. 2010. Molecular Biology Elsevier Inc.

10. Weaver, R. F. 2008. Molecular Biology. 5th Edition. McGraw-Hill New York.
11. Primrose S. B. & Twyman, R.M. 2006. Principles of Gene Manipulation and Genomics. Blackwell Publishing.
12. De Robertis & De Robertis. 1998. Cell & Molecular Biology. B.I. Waverly Pvt. Ltd. Delhi.

B. IMMUNOLOGY **18 hrs (1hr/wk)**

1. Immunity-mechanism; Innate and adaptive immune system: cells and molecules involved in innate and adaptive immunity. (2 hrs)
2. Antigens, antigenicity and immunogenicity. B and T cell epitopes. (2 hrs)
3. Structure and function of antibody molecules, generation of antibody molecules, generation of antibody diversity. (2 hrs)
4. Antigen antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cell, B&T cell receptors. (3 hrs)
5. Humoral and cell mediated immune responses, primary and secondary immune modulation, the complement system, Toll like receptors cell mediated effector functions. (3 hrs)
6. Inflammation, hypersensitivity and auto immunity, immune response during bacterial (tuberculosis) parasitic (malaria) and viral (HIV) infections, congenital and acquired immune- deficiencies, Vaccines. (4 hrs)
7. Immunotechniques. Monoclonal antibodies, Antibody engineering Immuno Assays – RIA and ELISA (2 hrs)

References:

1. Abbas A.K., Lichtman A. H. H. & Pillai, S. 2018. Cellular and Molecular Immunology, Elsevier, Inc. USA.
2. Madigan M. T., Bender K.S., Buckley D.H., Sattley, W.M. & Stahl D.A. 2017 Brock Biology of Microorganisms. Pearson Education, Inc.
3. Gupta, S. K. 2014. Essentials of Immunology. Arya Publications.

4. Pommerville, J. C. 2011. Alcamo's fundamentals of microbiology, 9th Edition.
5. Male, D., Brostoff, J., Roth, D. B. and Roitt, I. 2006. Immunology, 7th Edition. Elsevier Limited.
6. Black, J. G. 1999. Microbiology –Principles and Explorations, Prentice Hall, London.

C. PLANT BIOTECHNOLOGY **54 hrs (3 hrs/wk)**

1. Definition Scope and 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. Somaclonal and Gametoclonal variations. Genetic basis. Applications (3 hrs)
4. Somatic embryogenesis. Artificial seeds. Applications. Protoplast culture, Somatic hybridization and its impact on plant breeding. Use of protoplasts in genetic transformations. (5 hrs)
5. Haploid production: anther and ovule culture. Dihaploids and polyhaploids. Applications. (2hrs)
6. Production of secondary metabolites. Cell immobilization. Bioreactor technology. (3 hrs)
7. Cryopreservation Technology- In-vitro strategies for conservation of germplasm. (2 hrs)
8. Genetic engineering: Methods and applications. Applications of gene cloning techniques in plants. Gene targeting and sequence tags. (6 hrs)
9. Methods of gene transfer in plants. Agrobacterium and CaMV mediated gene transfer; direct gene transfer using PEG, microinjection, electroporation, microprojectile (biolistics) method, liposome mediated DNA delivery, Transposons as vectors. (8 hrs)
10. Application of Plant Biotechnology: - Transgenic plants -Traits for improved crop production- Field testing of transgenic plants. Herbicide Resistance, Vaccines for Plants, Genetic Pesticides, Pathogen resistance Molecular farming of antibodies in plants and Enhanced Nutrition . Technique and Controversy of Terminator Gene Technology. (10 hrs)
11. Genetically modified organisms and foods (GMO/GMF) - Social and ethical considerations. IPR issues. Patents. Biopiracy. (3 hrs)

Practical **36 hrs (2 hrs/wk)**

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. Jaiswal S. Singh P. & Kumar K. 2017. Instant Biotechnology a competitive approach. New Vishal Publication.
2. Abdin M.K., Kiran U. Kamaluddin & Ali, A. 2017. Plant Biotechnology: Principles and Applications. Springer.
3. Thieman, W. J. & Palladino, M. A. 2013. Introduction to biotechnology. 3rd Edition Pearson Education, Inc.
4. Chawla, H.S. 2009. Introduction to Plant Biotechnology. 3rd Edition. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
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6. Trivedi, P.C. (Ed.) 2000. Plant Biotechnology - Recent Advances. Panima Publishing Co. New Delhi.
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8. Griffiths *el al*., 1999. Modern Genetic Analysis. W.H. Freeman & Co. New York.
9. Gupta, P.K. 1999. Elements of Biotechnology. Rastogi Publications, Meerut.
10. Gamborg, O.L & Phillips, G.C. 1998. Plant Cell, Tissue Organ Culture. 1998. Narosa Publishing House, NewDelhi.
11. Mertins, T. R. & Hammorsmith, R. L. 1998. Genetics a Laboratory Investigation.
12. Backer, J. M. Caldwell G.A. & Zachgo E.A. 1996. Biotechnology- A Laboratory Course. Academic Press, New York.
13. Dixon, R.A. & Gonzales, R. A. (Eds.) 1994. Plant Cell Culture - A Practical Approach. Oxford University Press, New York.
14. Pamela Peters. 1993. Biotechnology-A Guide to Genetic Engineering. Wim.C Brown Publishers, USA.
15. Old R.W. & Primrose. S.B. 1991. An Introduction to Genetic Engineering. Blackwell Scientific Publications, Oxford, London.
16. Brown, C.M., Campbell, I. & Priest, F.G. 1990. Introduction to Biotechnology. Blackwell Scientific Publications, Oxford, London.
17. Primrose, S.B. 1989. Modern Biotechnology. Blackwell Scientific Publications, Oxford, London.

18. Brown, C. M. 1987. Introduction to Biotechnology. Blackwell Scientific Publications, Oxford, London.
19. Thorpe, T.A. 1981. Plant Tissue Culture Academic Press, London.

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SEMESTER IV
SPECIAL PAPER – I BO 241: BIOINFORMATICS AND BIOPHYSICS
180 hrs (Theory 144 hrs; Practical 36 hrs)

Objectives:

- To provide the knowledge on Bioinformatics and its applications
- To familiarise the students on protein and nucleic acid data bases and genomics & proteomics.
- To get the skill in phylogenetic tree construction
- To impart information of computer aided drug designing and practice of molecular docking using suitable software.
- To learn the fundamentals of instruments and techniques used in Biology
- To familiarise the modern instruments of significance in analytic methods To understand the principles and applications of tracers techniques in biology

Learning Outcomes:

The student will be able to

- familiarise protein and nucleic acid data bases and genomics & proteomics.
- acquire the skill in phylogenetic tree construction
- understand basics of computer aided drug designing
- pursue research in Botany and advanced learning in Botany by knowing the principles of Bioinformatics.
- to explain key concepts in Biophysics
- to familiarise the modern instruments and techniques in Biology, their principles and applications
- to develop skill in handling various instruments related to Biophysics

A. BIOINFORMATICS **90 hrs (5 hrs/wk)**

1. Introduction to Bioinformatics: Definition and History of Bioinformatics - Internet Computational Biology and Bioinformatics. (3hrs)

2. Biological databases- Types of data and databases, Nucleotide sequence database (EMBL,GENBANK, DDBJ)- Protein sequence database (PIR, SWISS-PROT, TrEMBEL), SecondaryDatabases (PROSITE, PRINTS, BLOCKS), Protein Structure .Database (PDB) (9hrs)

3. Information retrieval from databases – search concepts, Tools for searching, homology searching, finding Domain and Functional site (6hrs)

homologies

4. Structural Bioinformatics – Molecular Structure viewing tool –Rasmol, Protein Structure Prediction – Secondary Structure prediction (Chou Fasman method and other Bioinformaticstools for secondary structure prediction) and Tertiary structure prediction (Comparativemodeling, Abinitio prediction, Homology modeling)

(9hrs)

5. Genomics - Types (Structural and Functional), Genome Annotation, Gene Finding, Comparative genomics, Single nucleotide Polymorphism Gen-SNIP. (9hrs)

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

7. Sequence Analysis – Global Alignment, pairwise analysis, Scoring Matrices (an introduction), Multiple Sequence Analysis (9hrs)

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. (12hrs)

9. Computer Aided Drug Design and Molecular Docking, Breif study about Docking tools, AutoDock, molegro virtual docker, GOLD (9hrs)

10. Tools (Softwares) used in Bioinformatics - BLAST (including ALGORITHM of BLAST), Sequin, ClustalX, Clustal W, RasMol, Treeview, Phylip, GRAIL, GENSCAN, BIO-PERL. (9hrs)

11. Applications of Bioinformatics – Transcriptomics, Metabolomics, Pharmocogenomics, combinational synthesis (Brief Accounts). (6hrs)

Practical **18 hrs (1hr/wk)**

1. Blast search with Protein Sequence (*Magnolia latahensis* sequence)
2. Blast search with Nucleic Acid Sequence (Neanderthal man's Paleo DNA)
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. Rocha, M. & Ferreira, P.G. 2018. Bioinformatics Algorithms: 1st Edition. Academic Press.
2. Momand, J. & McCurdy, M. 2017. Concepts in Bioinformatics and Genomics. Oxford University Press.
3. Jeremy, R. 2015. Bioinformatics: An Introduction. Springer Publishing Co.
4. Choudhuri, S. 2014. Bioinformatics for Beginners. 1st Edition. Academic Press.
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6. Xiong, J. 2007. Essential Bioinformatics, Cambridge University Press India, Pvt Ltd. Higgs, P. G. 2005. Bioinformatics and Molecular Evolution, Ane Books India Pvt Ltd.
7. Vyas, S.P. & Kohli, D.V. 2007. Methods in Biotechnology and Bioengineering. CBS Publishers and Distributors.
8. Evens, W.J. & Grant, G.R. 2005. Statistical Methods in Bioinformatics: An Introduction. Springer.
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10. Mount, D.W. 2001. Bioinformatics – Sequence and GenomeAnalysis, 1st Edn, Cold Spring Harbor Laboratory Press, New York, USA.
11. Pierre Baldi & Soren Brunak. 2001. Bioinformatics: The Machine Learning Approach. 2nd Edition. The MIT Press
12. Lesk, A.M. 2002. Introduction to Bioinformatics, 1st Edn. Oxford University Press, Oxford, UK. 13. Patterson, B.K. 2000. Techniques in Quantification and Localization of Gene Expression.
14. Liu, B.H. 1998. Statistical Genomics: Linkage Mapping and QTL Analysis. CRC Press.

B. BIOPHYSICS **54 hrs(3 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. Bond length. Bond angle. Dissociation and association constant. (6 hrs.)

2. Bioenergetics: Concepts of free energy, Thermodynamic principles in Biology. Energy rich bonds. Coupled reactions and group transfers. Biological energy transducers**.** (6 hrs)

3. Principles and applications of light and electron microscopy, resolving power, depth of field. bright field and dark field, phase contrast (negative and positive phase contrast), fluorescence, fluorescence resonance energy transfer (FRET), differential interference contrast (DIC) microscopy, scanning and transmission electron microscopy. different fixation and staining

techniques for EM, freeze-etch and freeze- fracture methods for EM, atomic force microscopy (AFM). Flow cytometry, confocal microscopy- different types, FISH, GISH.

(10 hrs)

4. Chromatography: Planar and column chromatography, Adsorption and partition chromatography, partition coefficient, Principle and applications of Gel filtration, Ion exchange and affinity chromatography, Thin layer chromatography, gas chromatography, HPLC,HPTLC, LCMS, GCMS.

(8 hrs)

5. Electrophoresis. Horizontal and vertical gel electrophoresis, PAGE, SDS- PAGE, DIGE (Differential gel electrophoresis), PFGE (Pulsed field gel electrophoresis), Immuno electrophoresis. Enzyme localization by electrophoresis. Zymogram and isozyme analysis. ELISA. Isoelectric focusing.

(8 hrs)

6. Centrifugation. Basic principles of centrifugation, RCF (relative centrifugal force), sedimentation coefficient, Ultra centrifugation - Differential centrifugation, density gradient centrifugation (zonal and isopycnic).

(4 hrs)

7. Principles of biophysical methods used for analysis of biopolymers: X-ray diffraction Bragg equation, fluorescence, UV, visible, IR,NMR, ESR Spectroscopy, ORD/CD, Fourier transform techniques, hydrodynamic methods, plasma emission spectroscopy. Atomic absorption
spectroscopy, Mass spectroscopy (8hrs)

8. Principles and applications of tracer techniques in biology. Radiation dosimetry. Radioactive isotopes. Autoradiography. Cerenkov radiation. Liquid scintillation. (4 hrs)

Practical **18 hrs (1hr/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. Upadhyay, A., Upadhyay, K. & Nath, N. 2017. Biophysical Chemistry –Principles and techniques. Himalaya Publishing House.
2. Narayanan, P. 2000. Essentials of Biophysics. New Age International Publishers, New Delhi.
3. Daniel, M. 1999. Basic Biophysics for Biologists. Agro Botanica, Bikaner.
4. Roy, R.N.1999. A Text Book of Biophysics. New Central Book Agency(P) Ltd., Calcutta.
5. Hoppe, W. Lohmann, W. Markl, H. & Zieghr, H. Eds.1983. Biophysics. Springer Verlag, New York.
6. David Freifelder. 1982. Physical Biochemistry - Application to Biochemistry and Molecular Biology. W. H. Freeman.
7. Slayter, F.M. 1970. Optical Methods in Biology. Wiley Inter Science.
8. Casey, E.J. 1962. Biophysics: Concepts and Mechanics**.**Chapman & Hall, Ltd., London.

PAPER BO 242a: SPECIAL PAPER –II ELECTIVE

BIOTECHNOLOGY

234 hrs (Theory 144 hrs; Practical 90 hrs)

Objectives:

- To make awareness about the fundamentals of Biotechnology and
- To impart knowledge on Microbial genetics with respect to bacterial gene expression, regulation and gene manipulation.
- To familiarise the students with the tools and techniques of genetic engineering and gene transfer technologies
- To understand the techniques and applications of plant tissue culture
- To acquire basic practical skills in Biotechnology

Learning Outcomes:

The student will be able to

- understand the concept of biotechnology and microbial genetics
- get the knowledge on plant tissue culture and gene transfer technology
- acquire the skill in producing tissue cultured plants and artificial seeds
- get an understanding on the application of biotechnology in the production of secondary metabolites

144 (8hrs/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: 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
4. amino acids, antibiotics, microbial enzymes, organic acids.
5. Methods for laboratory fermentations, isolation of fermentation products, Elementary principles of microbial reaction engineering.
6. Microbial culture selection, fermented foods, probiotics.

Unit III: 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 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 resistance. 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.

Practical **90 hrs (5 hrs/wk))**

a. Preparation of stock solutions for tissue culture.
b. Preparation of solid and liquid media for test tube cultures and petri plate culture.
c. Induction of callus culture and suspension culture.
d. Encapsulation of embryos using sodium alginate.
e. Isolation and quantification of genomic DNA.
f. PAGE and AGE – demonstration.
g. Restriction digestion and ligation using kits – demonstration.

References:

1. Krebs, J. E., Goldstein, E. S. & Kilpatrick, S. T. 2018. LEWIN'S GENES XII. Jones & Bartlett Learning.
2. Jaiswal S. Singh P. & Kumar K. 2017. Instant Biotechnology a competitive approach. New Vishal Publication.
3. Abdin M.K., Kiran U. Kamaluddin & Ali, A. 2017. Plant Biotechnology: Principles and Applications. Springer.
4. Watson, J.D., Baker T.A., Bell S.P., Gann A., Levine M. & Losick R. 2014. Molecular biology of the gene. 7th Edition. Cold Spring Harbor Laboratory, Tania, MIT
5. Thieman, W. J. & Palladino, M. A. 2013. Introduction to biotechnology. 3rd Edition Pearson Education, Inc..
6. Chawla H.S. 2009. Introduction To Plant BiotechnologyOxford & IBH Publishing Co Pvt.Ltd
7. Freifelder, D. 1993. Molecular Biology, Jones and Bartlett, Publishers, London.
8. Primrose, S.B. 1989. Animal Biotechnology Blackwell Scientific Publication, London.
9. Old, R. W. & Primrose, S.B. 1989. : Principles of Gene Manipulation, Blackwell scientific Publication, London.

PAPER BO 242b: SPECIAL PAPER –II ELECTIVE

ENVIRONMENTAL BIOLOGY

(Theory 144 hrs; Practical 90 hrs)

Objectives:

- To familiarise the fundamentals of the concept of ecosystem along with its structural and functional attributes.
- To understand the different aspects of environmental ecology with emphasis on pollution and waste management.
- To expose the students to the various areas of applied ecology such as physiological, industrial and molecular ecology.
- To acquire practical skills for water analysis to estimate phosphate and nitrate content planktons, major elements and to get experience in quadrant study

Learning Outcomes:

The student will be able to

- understand the concept on environmental ecology and waste management
- get the skill in water analysis
- identify the environmental problems at local level and suggest remedial measures

Unit I: Ecological Concepts

1.Concept of Biosphere (1hr)

2.Ecological processes: basic laws of energy flow, flow of energy, law of ten percent, Odum's Box pipe model of energy flow. (8 hrs)

3 Biogeochemical cycling: Major sedimentary and gaseous types, turnover rate and turn over time, residence time, nutrient budgeting and nutrient sink. (8 hrs)

4 Environmental factors: climatic, edaphic, topographic and biotic factors. (7 hrs)

Unit II: Population ecology

1. Quadrat sampling technique, line transect method, mark-recapture technique; Habitat destruction-fragmentation, perforation; Metapopulation- different types (10 hrs)
2. Population attributes – biotic potential, natality, mortality, demography- survivorship curves, life tables, age structure **(**9 hrs)

3. Population growth- Geometric, exponential and logistic, Time Lag, Grimes triangle, Carrying capacity, r and k selection (8 hrs)

Unit III: Community Ecology

1. Community structure: Species diversity – Berger Parker Index, Shannon index, Regional diversity – alpha, beta and gamma; Succession – Primary and Secondary, Facilitation, Inhibition, Tolerance. (10 hrs)
2. Species interactions – Competition, Predation, Herbivory, Parasitism, Commensalism, Ammensalism, Mutualism. (10 hrs)
3. Island biogeography (4hrs)

Unit IV: Ecosystem Ecology

1. Types of ecosystem – Major terrestrial and aquatic ecosystems. (8 hrs)

2. Components of ecosystem ; Functional attributes – Concept of productivity, trophic levels, trophic relations, food chain and food web, ecological pyramids; Keystone species, dominant species, ecosystem engineers, Indicator, Umbrella and flagship species (8 hrs)

3. Behavioural Ecology : Altruism, Kin Selection, Group selection, Individual selection, Foraging(5 hrs)

Unit V: Environmental Ecology

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. (3 hrs)

Unit VI: Applied Ecology

Microbial Ecology

1. Microbial ecology: Concepts, microbial behavior in ecosystems, microbial biodiversity, interaction among the microbial populations, development of microbial communities. Oxygenic photosynthetic microbes and anoxygenic photosynthetic microbes. Oxidative transformation of metals: sulfur

oxidation, iron oxidation, ammonia oxidation and hydrogen oxidation. Environmental stresses.

(5 hrs)

2. Wastewater treatment system (unit process): Physical screening, flow equalization, mixing, flocculation, flotation, sedimentation, granular medium filtration, adsorption, Bioremediation and phytoremediation.

(3 hrs)

3. Chemical precipitation, gas transfer, disinfection, dechlorination. (2 hrs)

4. Effluent and sludge disposal, control and reuse. Water pollution control, Regulation and limit for disposals in the lakes, rivers, oceans, and land. Direct and indirect reuse of treated effluents and solid wastes. (4 hrs)

Industrial Ecology

5 Current industrial wastewater treatment and disposal processes (Sugar and distillery, Textile, dyestuff, dairy, paper and pulp manufacturing industries)

(3 hrs**)**

6. Approaches to solid waste management using composting, vermiculture and biomethanation methods and their suitability to environment

(4 hrs)

Practical **90 hrs (5 hrs/wk)**

1. 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. Quadrat study of a given area to find out the Importance Value Index (IVI) of the community.
8. Analysis of water samples for coliform bacteria.
9. One day visit to any tribal locality / areas with relevant environmental issues
   One day visit to an industry with relevance to wastewater treatment.

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PAPER BO 242c: SPECIAL PAPER –II ELECTIVE
PLANT BIOCHEMISTRY AND ENZYMOLGY
(Theory 144 hrs; Practical 90 hrs)

Objectives:

- To understand the basic organisation of cell and biochemical energetics.
- To know about the primary and secondary metabolites and their interrelationships.
- To learn about the details of protein structure and characterization
- To understand the fundamentals of enzyme kinetics in detail

Learning Outcomes:

The student will be able to

- learn the concept on metabolism, biochemical energetics and metabolic pathways
- understand the method of protein purification and characterization
- identify key enzymes of plant metabolism
- equip the students to follow the protocols for protein purification, isozyme analysis and enzyme separation

144hrs (8hrs/wk)

Plant Biochemistry

UNIT: Introduction

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)

UNIT:II Metabolic Pathways

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)

UNIT:III Protein

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

Enzymology

UNIT IV: Classification and Characterization of Enzymes

9.Plant enzymes – general properties, classifications and nomenclature. (6 hrs)

10. Structural and functional organization of enzymes – primary, secondary and tertiary, structure, molecular characterization of functional organization. (10 hrs)

11.Sub cellular localization of enzymes by LM and TEM. Histochemistry of enzyme reaction. (8 hrs)

12.Enzyme purification and characterization – desalting methods, isolation and assay of plant enzymes and enzyme kinetics. (10 hrs)

13.Michaelis Menton equations and its significance, Lineweaver plots, enzyme inhibitions, activation.

UNIT V: Enzyme Regulation, Localization and Applications (6 hrs)

14. Allosteric enzymes, metabolic regulation – sigmoid, kinetic, steady state metabolic pathways by control of enzymatic pathways. (10 hrs)

15.Native PAGE in enzyme localization, principles and methodology, zymogram. (8 hrs)

Iso Electric Focusing (IEF). (6 hrs)

16.Immobilization of enzymes, enzyme engineering – techniques and applications. (8 hrs)

17.Biotechnological applications of enzymes. (8 hrs)

Practical **90 hrs (5 hrs/wk)**

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:

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BO 242 D: SPECIAL PAPER II
CYTOGENETICS

(Theory 144 hrs; Practical 90 hrs)

Objectives:

- To understand the fundamentals of cytogenetics with emphasis on chromosome structure and meiotic behaviour
- To get the knowledge on chromosomal aberrations
- To learn the cytogenetics of polyploids and aneuploids.
- To get the skill in induction of polyploidy
- To study the sex determination mechanisms operating in different plants and animals
- To understand karyotype analysis and chromosome banding

Learning Outcomes:

The student will be able to

- learn the fundamentals of cytogenetics
- understand the concept on the structural and numerical variations in chromosome numbers and their applications and limitations
- understand the mechanism of sex determination
- analyse the banding pattern in human karyotype
- get the skill in doing cytology of plants and production of polyploids

144hrs(8hrs/wk)

Unit I - Introduction:

Basic trends in cytogenetics – genetic continuity and variation. Meiotic behavior & (16 hrs)

Chromosome abnormalities, Special types of chromosomes. (14 hrs)

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.

UNIT II - Chromosome Structural and Numerical Variations

Structural variations in chromosomes – origin and meiotic characters.

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. (20 hrs)

UNIT III Haploids and Polyploids

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 (13 hrs)

Polyploidy – types of polyploids, numerical variation in chromosomes.

d. Autopolyploids, allopolyploids, segmental allopolyploids, autoallopolyploids.
e. Origin of polyploids, meiosis in polyploids, cytological and genetic effects of polyploids.
f. Role of polyploids in plant diversity and evolution.
g. Induction of polyploidy – methods of induction, morphological and cytological analysis of induced polyploids, significance of induced polyploidy in plant improvement.

(13 hrs)

UNIT IV - 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. Cytogenetic effects – effect on crossing over, position effect, translocation complex, Renner complex, Renner effect, Breakage, Fusion Bridge cycle. Cytogenetics of hybrids. (28hrs)

UNIT V- Sex Chromosome and Sex determination Mechanism

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. Sexual dimorphism –

Genetic theory, cytological basis (22 hrs)

UNIT VI - Karyotype and Banding

Karyotype analysis and karyotype evolution. Chromosome banding – techniques and their applications,
Human cytogenetics. (18hrs)

Practical(90 hrs)

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.

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MSc. BOTANY II SEMESTER PRACTICAL EXAMINATION
(2019 admission onwards)
PAPER I- BO 214 –MODEL QUESTION
PHYCOLOGY, MYCOLOGY, PLANT PATHOLOGY, MICROBIOLOGY, BRYOPHYTA, PTERIDOPHYTA, GYMNOSPERMS, REPRODUCTIVE BIOLOGY, HISTOLOGY, MICROTECHNIQUE AND HISTOCHEMISTRY

Time:4hours **Max. marks:75**

1. Prepare a double stained permanent free hand section of **A**. Draw labeled diagrams.
(Preparation-3 marks, diagram-1 mark, reasons-2 marks, identification-1 mark)
1x7=7 marks

2. Separate and identify any two algal filaments from **B**. Give reasons with labelled diagrams
(Preparation ½ mark, reasons- ½ mark, diagram-½mark)
2x1 ½=3marks

Make suitable micro preparations of **C&D** , Identify giving reasons
2x4=8marks
(Preparation-1 mark, diagram-1 mark, reasons-1 mark, identification-1 mark)

3. Bring out the pathological interest of **E**.
1x4=4marks
(*Name of disease-1mark; etiology-2 marks; name of pathogen-1mark)*

4. Make suitable micro preparations of **F&G**, Identify giving reasons
2x4=8marks
(preparation-1 mark, diagram-1 mark, reasons-1 mark, identification-1 mark)

6. Make suitable micro preparations of **H,** showing T.S,. Identify giving reasons
(*T.S-1, diagram-1 mark, reasons-1 mark, identification-1mark*)
1x4=4 marks

7.Identify and write critical notes on **I.** *(Identification -1mark, critical note-1mark*)
1x2=2 marks

8. Estimate the in-vitro viability of pollen through germination Or Identify the ornamentation and sculpture patterns of pollen grains by a suitable method Or Detect any one developmental stage of embryo in the sample given. (Methodology-1. marks.Preparation-1mark).
1x2=2 marks

9.

a. Identify the Bacteria in **J** by Gram's staining method
(*Prep:-2 marks,procedure-2,identification-1***)** **1x5=5marks**

b. Macerate **K** and identify two xylem elements
(Prep:-1 mark, procedure-1mark, diag-1,identification-1) **1x4=4marks**

c. Prepare a serial sections of paraffin block **L** using Rotary microtome
(*cutting & mounting the ribbon=2 mark*) **1x2=2marks**

d. Spot at sight **M, N, O, P**and**Q** **1x5=5marks**
(*Genus -½ mark, Group- ½ marks*)

e.Write critical notes on **R** **1x1=1mark**

Record =10 Marks **Submission of permanent slides =10marks**

M. Sc. BOTANY II SEMESTER PRACTICAL EXAMINATION
(2019 admission onwards)
PAPER II BO 224 - MODEL QUESTION
TAXONOMY, ECONOMIC BOTANY, ETHNOBOTANY, ENVIRONMENTAL BIOLOGY, CONSERVATION BIOLOGY, PHYTOGEOGRAPHY, CELL BIOLOGY, GENETICS & EVOLUTION

Time:4hours **Max:marks-75**

i. Using The Flora of Presidency of Madras, identify the specimen **A** up to species (*Derivation-3marks, Family-1, Binomial with author citation-1 mark*).**1x5=5marks)**

ii. Identify the specimen **B** to its family (*Derivation -3 marks, Identification-1mark*) (**1x4=4 marks**)

iii. Draw the L.S of the given flower **C,** construct the floral diagram and write the floral formula. (*L.S-1½ marks, Floral diagram-1 mark, Floral formula ½mark*).

(**1x3=3marks)**

iv. Using vegetative and floral characters, prepare a dichotomous key for **D, E, F,G** *(Analysis of characters - 2marks, Preparation of key-2marks*) (**1x4=4marks**)

v. Write binomial, family and morphology of the useful parts of **H &I.** *(Binomial-1mark, family-½ mark, usefulpart-½mark)* (**2x2=4marks)**

vi. Make acetocarmine smear preparation of **J** to demonstrate any two stages of meiosis. (*Preparation 2marks, Diagrams 2x1=2 marks, identification ½x2 =1mark)* (**1x5=5marks)**

vii. Work out the problems **K&L** (**6+3=9marks)**

viii. Select an experiment from **M,** intend your requirements and conduct the experiment. (*Requirements 1mark, procedure 2 marks, conduct of experiment 2 marks, Result1mark*). **(1x6=6marks)**

ix. Write critical notes on **N, O,P,Q** **(4x1.5= 6marks)**

x. Nomenclatural problem **R** (**1x2=2marks**)

xi. Write ethnobotanical significances of **S.** (**1x2=2marks)**

xii. Expansion of floral formula **T** **(1x2=2marks)**

xiii. Identify **U&V**

(*Binomial 1mark,Family-½mark*) **(1½ x 2=3marks)**

Record **10marks**

Herbarium & field book (8+2) **10marks**

M. Sc. BOTANY IV SEMESTER PRACTICAL EXAMINATION
(2019 admission onwards)
PAPER III BO 234 - MODEL QUESTION

PLANT BREEDING, HORTICULTURE, BIOSTATISTICS, BIOCHEMISTRY, PLANT PHYSIOLOGY, MOLECULAR BIOLOGY AND PLANT BIOTECHNOLOGY

Time:4Hours Maximum marks:75

1.Emasculate the flower in the inflorescence given

OR

Estimate the percentage of pollen fertility in the given plant by suitable staining.

(Methodology-2 marks. Preparation- 2 marks)

4marks

2. Demonstrate any one propagation method - Budding OR Grafting OR layering.

(Methodology- 2 marks. Preparation- 2marks)

4marks

3. Select an experiment from the lot and work out as per the objective.

(Procedure- 4 marks, Requirements- 2 marks, Result- 4 marks. Calculation- 4 marks)

14 marks

4. Isolate the genomic DNA from the given tissue and estimate the DNA content.
(Procedure- 4 marks, Requirements- 2 marks, Result- 4 marks.
Calculation- 4marks)

14 marks

5. Demonstrate the inoculation of explants to a suitable culture medium aseptically.
(Demonstration- 4Marks)

4 marks

6. Select an experiment from the lot and workout

(Procedure- 4 marks, Requirements- 2 marks, Result- 2 marks, Calculation- 2 marks)

10 marks

7. Setting up of plant physiology experiment **4marks**

8. Work out the given problem **5 marks**

9.Casting and loading of samples in Horizontal gel electrophoresis

(Methodology- 2 marks, gel casting- 2 marks, sample loading- 2 marks)

6 marks

Record 10marks

M. Sc. BOTANY IV SEMESTER PRACTICAL EXAMINATION
(2019 admission onwards)
PAPER IV BO 243 - MODEL QUESTION

BIOINFORMATICS BIOPHYSICS ANDBIOTECHNOLOGY.

Time:4Hours Maximum marks:75

BIOINFORMATICS&BIOPHYSICS: 35 Marks.

I. BIOINFORMATICS

A) Construct a phylogenetic tree using CLUSTAL X/W (10 marks)

B) Search the protein sequence using BLAST. (5 marks)

C) Write critical notes on the given materials C1and C2. (2x2.5= 5marks)

II. BIOPHYSICS:

a. Select an experiment from the lot and work out as per the objective and submit the result for evaluation.
(Methodology- 7 marks.Result-3marks) (10 marks)

b. Critically explain the relevance/working of E1 andE2
(2×2.5= 5 Marks)

III. BIOTECHNOLOGY(Elective): 30Marks.

c. Isolate the genomic DNA from the given tissue and estimate the DNA content. (Procedure: 5 marks, Result: 5 marks, Calculation5 marks)
(1x15=15marks)

d. Encapsulate the given embryos/explants using sodium alginate.
(Procedure: 3 marks, Result:2 marks) (1x5= 5 marks)

e. Critically explain the biotechnological relevance of H1 and H2.
(2×2.5= 5 marks)

f. Submit two live tissue culture tubes for evaluation. (5 marks)

Record 10marks

INSTRUCTIONS TO THEEXAMINERS

Paper I - BO214 : PHYCOLOGY, MYCOLOGY, PLANT PATHOLOGY, MICROBIOLOGY, BRYOPHYTA, PTERIDOPHYTA, GYMNOSPERMS, REPRODUCTIVE BIOLOGY, HISTOLOGY, MICROTECHNIQUE AND HISTOCHEMISTRY

A. Histology : fresh angiosperm root/stem,(normal or anomalous, primary/secondary)
B. Algal Mixture: give mixture of 3 algae & identification of any2members
C. Algae with reproductive structure for sectioning
D. Fungi/Lichen with reproductive structure for sectioning.
E. Plant pathology- fresh or well preserved & diseased specimen.
F. Bryophyte for sectioning (fresh or well preserved)
G. Pteridophyte for sectioning (fresh or well preserved).
H. Gymnosperms for sectioning (fresh or well preserved)
I. Fossil specimens :Pteridophyte/ Gymnosperms
J. Microbiology : Bacterial smear
K. Maceration : show two xylem elements.
L. Serialsectioning:Paraffinblockembeddedwithgoodqualityspecimensfixedonb lock holder should be supplied

M, N, O, P &Q. Spot at sight (M-Algae, N-Fungi/Lichen, O-Bryophyta, P-Pteridophyta and Q- Gymnosperm)
R. Stains/ Fixatives/Chemicals/Instruments.

Practical work **55marks**

Valuation of Practical RecordI **10marks**
Valuation of permanent slides **10marks**

[Free hand section	(4)	=4marks
Serial section	(2)	=2 marks
Smear	(1)	=1 mark
Squash	(1)	=1 mark
Whole mount/sledge	(1)	=1 mark
Histochemistry	(1)	=1mark **]**

TOTAL **75marks**

PAPER II BO 224: TAXONOMY, ECONOMIC BOTANY, ETHNOBOTANY, ENVIRONMENTAL BIOLOGY, CONSERVATION BIOLOGY, PHYTOGEOGRAPHY, CELL BIOLOGY, GENETICS & EVOLUTION

A. **Taxonomy- Identification up to species using the Flora of the Presidency of Madras**: Give fresh flowering twigs (select genera up to 20 species from the families of Dicotyledonae with bisexual flowers, centre should provide three volumes of Flora of the Presidency of Madras, and the binomial should be followed by author citation. Deduct ½ marks if author citation is not given by the candidate).

B. **Taxonomy- Identification up to family:** Give fresh flowering twigs from the Class Dicotyledonae mentioned in the syllabus.

C. **Taxonomy- Floral details, floral formula and floral diagram**: Give flowering twigs with buds from the families mentioned in the syllabus.

D, E, F, G- **Taxonomic key**: Give 4 flowering twigs with clear vegetative and floral features.

H& I. **Economic Botany**: any plant part /product of economic importance mentioned in the syllabus

J. **Cell biology**: Show two meiotic stages

K. **Genetics**: Problem related to linkage

L**. Genetics**: Problem related to molecular or population genetics

M. **Environmental biology**: Select experiment and estimate Dissolved oxygen/ organic carbon/carbonate/bicarbonate.

N, O, P, Q. Critical notes from **Ecology, Phytogeography, Conservation biology and Evolution**.

R. Nomenclatural problem.

S. Ethanobotanical significance

T. Expansion of floral formula

U. &V. Herbarium sheets

Distribution of marks:

Practical work		**55marks**
Valuation of Practical record of SemesterII	10 marks	
Submission of 50herbarium sheets (Collected and identified by the candidate with field book and tour report)		10 marks
	TOTAL	**75marks**

Paper - III - BO 234: PLANT BREEDING, HORTICULTURE, BIOSTATISTICS, BIOCHEMISTRY, PLANT PHYSIOLOGY, MOLECULAR BIOLOGY AND PLANT BIOTECHNOLOGY

Time:4Hours Maximum Marks:75

1. Emasculation-Prepare the inflorescence for pollination.

or

Estimation of pollen fertility/sterility procedure.

2.Budding- T budding and patch budding.

a. Layering- any one method.

b. Grafting- Any one method.

3.The student has to perform any one of the experiment selected by lot method.

i)Extraction and estimation of soluble proteins by Bradford method.

ii) Estimation of reducing sugars by DNS method.

iii)Isolation assay and determination of specific activity of plant enzymes of germination, growth and fruit ripening viz. amylase, protease, peroxidase and poly phenoloxidase.

4. For isolation of DNA, the examiner should provide a standard value of DNA.

5. Demonstration of inoculation of any given plant material.

6. The student has to perform any one of the experiment selected by lot method. List of experiments

a. Evaluation and estimation of total protein by TCA method and Lowry method.

b. Isolation of chloroplast from fresh leaves and estimation of chlorophyll proteins.

c. Chlorophyll spectra of five plants - quantification, absorption spectra of chlorophyll and carotenoids using different wavelengths.

d. Hill activity by DCPIP/ Ferricyanide reduction.

e. Extraction and estimation of total phenols.

f. Physiological identification of CAM in plant species.

7. Setting up of plant physiology experiment. The requirements have to be provided by the center.

8. Work out problems related to mean, median, standard deviation and Chi square test.

9. The requirements have to be provided by the center.

Paper - IV BO 243: BIOINFORMATICS BIOPHYSICS ANDBIOTECHNOLOGY.

Time: 4HoursMarks. Maximum marks:75

BIOINFORMATICS & BIOPHYSICS: 35 Marks.

I. BIOINFORMATICS

A. Phylogenetic tree creation using CLUSTALX.

B. Blast search with protein sequence.

C1 and C2. Critical notes on any two items related to Bioinformatics.

II. BIOPHYSICS

c. Each student should carry out any one of the following experiment.

i. Separation of plant pigments by column chromatography.

ii. Separation of amino acids by paper chromatography.

iii. Separation of plant pigments by micro TLC.

d. Any chemical, equipment or photograph related to Biophysics.

III. BIOTECHNOLOGY

e. Isolate the genomic DNA and quantify the same.

f. Encapsulation of embryos using sodium alginate.

g. H1 and H2. Any chemical, equipment or photograph of related to Biotechnology.

h. Submission of live tissue culture tubes for evaluation.