FATIMA MATA NATIONAL COLLEGE
KOLLAM, KERALA
(Autonomous)

MSc Degree in Botany

(Semester System)

Course Structure and Syllabus

Board of Studies in Botany
March, 2019

PREFACE

Plants are the creatures which are solely responsible for maintaining life in this universe. They are ranging from unicellular prokaryotic forms to much organized and complex eukaryotic angiosperms. Their diversity is astonishing, inhabiting all and every possible habitats of the world. Enjoying both the autotrophic and heterotrophic mode of life, they are now the rulers of the earth. Plants are in one way or other, directly or indirectly, influencing the day to day life all other living beings including the much hyped human beings. Plants are the primary source of food, fuel, energy, shelter, clothing, fodder, medicines and such an unending list of materials we may require for successfully leading life in this universe. So the potentials of plants are beyond the scope of linguistic description. Botany is the science which in detail explore the various phases of plant growth, differentiation, productivity, diversity, characterization and such other phenomenons and activites of plants. We are proposing the detailed curriculum and syllabi of master's programme in Botany, by considering all these aspects, exposing the students to the prospecting and challenging fields of plant science. The Board of Studies has meticulously organized the sequence and contents of the programme in tune with the latest trends in Plant Science research. Every traditional, classic and emerging areas of Plant Science have been properly and systematically stringed together for getting an enhanced appeal for the learners in properly understanding the principles, phenomenon and techniques in plant science.

The Board of Sudies has identified the following thrust areas, based on which the entire exercise has worked out-

1. Plant Diversity: Cellular and organism level
2. Plant characterization; Cellular and organism level
3. Plant Interactions: with the environement and with other orgainsms
4. Plant Conservation
5. Mechanism and nature of inheritance
6. Physiological and Biochemical aspects of Plant Life
7. Plant Products: Types and Diversity
8. Manipulation of the Plant Cell for the benefit of human beings
9. Plants of agricultural and horticultural significance
10. Plant Science Research: Concepts and Methods

The Board of Studies has prepared the syllabi and curriculum with clearly defined objectives that were identified for making post graduates with a deep insights in the concepts, theories and mechanism of plant life-

1. To equip the learner for attaining a clear, authentic, comprehensive and advanced mastery in Plant Science.
2. To inculcate the basic theories and principles in plant science.

3. To make an indepth understanding about the structure and diversity of plant life, both at the cellular and organims level.
4. To aware the lerner the astonshing intricacies of plant forms at the cellular, molecular and biochemical level.
5. To develop the passion for leading an active role in conserving and documenting the spectacular plant diversity for future generation.
6. To develop skills and expertise in executing research in plant science.
7. To familiarise the leaerners to the emerging and promising areas of plant science, and thereby fascinating them to pursue the exploration in plant science for the creation of new knowledge and techniques which in turn will improve the present standard of living.

The Board of Studies acknowledges the valuable contributions, suggestions, comments and corrections from colleaugues and authorities.

COURSE STRUCTURE

Sem	Paper code	Title of the paper	Hrs/ Sem	Hrs/Week		ESA Hrs	Maximum Marks		
				T	P		CA	ESA	Total
I	19PBO11	Phycology, Mycology & Plant Pathology	108	6	2	3	25	75	100
	19PBO12	Bryophyta, Pteridophyta& Gymnosperms	108	6	2	3	25	75	100
	19PBO13	Microbiology, Histology&Microtechnique	108	6	3	3	25	75	100
	19PBO14	Practical I	126		7	4	25	75	100
	19PBO15	Submissions					5	20	025
	19PBO16	Viva Voce					00	25	025
	Total for Semester I		**450**	**18**	**7**	**13**	**105**	**345**	**450**
II	19PBO21	Reproductive Botany & Crop Improvement	108	6	1.5	3	25	75	100
	19PBO22	Environmental Biology, Forest Botany, Phytogeography & Conservation Biology	108	6	2	3	25	75	100
	19PBO23	Cell Biology & Genetics	108	6	3.5	3	25	75	100
	19PBO24	Practical II	126		7	4	25	75	100
	19PBO25	Submissions					5	20	025
	19PBO26	Viva Voce					00	25	025
	Total for Semester II		**450**	**18**	**7**	**13**	**105**	**345**	**450**
III	19PBO31	Angiosperm Systematics,Economic Botany, Ethnobotany & Evolution	108	6	2.5	3	25	75	100
	19PBO32	Biophysics & Bioinformatics	108	6	2.0	3	25	75	100
	19PBO33	Research Methodology, Biostatistics & Plant Biotechnology	108	6	2.5	3	25	75	100
	19PBO34	Practical III	126			4	25	75	100
	19PBO35	Submissions					5	20	025
	19PBO36	Viva Voce					00	25	025
	Total for Semester III		**450**	**18**	**7**	**13**	**105**	**345**	**450**
IV	19PBO41	Special Paper –I- Plant Physiology& Biochemistry	144	8	4	3	25	75	100
	19PBO42	Special Paper –II Elective – Advanced Biotechnology	144	8	3	3	25	75	100
	19PBO43	Practical IV	126		7	4	25	75	100
	19PBO44	Submissions					5	20	025
	19PBO45	Viva Voce						25	025
	19PBO46	Dissertation	36	2				100	100
	Total for Semester IV		**450**	**18**	**7**	**10**	**80**	**370**	**450**
							395	**1405**	**1800**

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

SHEDULE OF WORKLOAD

Sem.	Paper Code	Subject	Total Hrs.		T Hrs./Week	P Hrs./Week
			T	P		
I	19PBO211	Phycology	54	27	3.0	1.5
		Mycology	36	09	2.0	0.5
		Plant Pathology	18	00	1.0	0.0
	19PBO212	Bryophyta	27	09	1.5	0.5
		Pteridophyta	45	18	2.5	1.0
		Gymnosperms	36	09	2.0	0.5
	19PBO213	Microbiology	36	09	2.0	0.5
		Histology	27	09	1.5	0.5
		Microtechnique&Histochemistry	45	36	2.5	2.0
II	19PBO221	Plant Breeding	63	09	3.5	0.5
		Horticulture	18	09	1.0	0.5
		Reproductive Botany	27	09	1.5	0.5
	19PBO222	Environmental Biology	54	36	3.0	2.0
		Forest Botany	09	00	0.5	0.0
		Phytogeography	18	00	1.0	0.0
		Conservation Biology	27	00	1.5	0.0
	19PBO223	Cell & Molecular Biology	54	27	3.0	1.5
		Genetics	54	36	3.0	2.0
III	19PBO231	Angiosperm Systematics	72	36	4.0	2.0
		Economic Botany	09	09	0.5	0.5
		Ethnobotany	09	00	0.5	0.0
		Evolution	18	00	1.0	0.0
	19PBO232	Biophysics	27	09	1.5	0.5
		Bioinformatics	81	27	4.5	1.5
	19PBO233	Research Methodology	18	00	1.0	0.0
		Biostatics	27	09	1.5	0.5
		Plant Biotechnology	63	36	3.5	2.0
IV	19PBO241	Plant Physiology	45	36	2.5	2.0
		Biochemistry	54	18	3.0	1.0
		Enzymology	45	18	2.5	1.0
	19PBO242	Biotechnology	144	54	8.0	3.0
		Dissertation	18	00	2.0	0.0

Elective Special Papers

- 19PBO 241:Plant Physiology and Biochemistry
- 19PBO 242:Advanced Biotechnology

Study Tour

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

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

Submissions

Semester I: 19PBO15			
		CA	**ESA**
1	Submission Algae (2)	0.5	02
2	Submission Fungi (1); Pathology (1)	0.5	02
3	Submission Bryophytes (2)	0.5	02
4	Submission Pteridophytes (2)	0.5	02
5	Submission Gymnosperms (2)	0.5	02
6	Permanent Slides (10 slides)	2.5	10
Total		5.0	20

Semester II: 19PBO25			
		CA	**ESA**
1	Visit to Botanic Garden Report	1.0	05
2	Ecology Tour Report	2.0	05
3	Report on the conservation strategies of any two RET plants	2.0	10
Total		5.0	20

Semester III: 19PBO35			
		CA	**ESA**
1	Taxonomy Tour Report	0.0	06
2	Report of Herbarium visit	0.0	04
3	Research Proposal	0.0	05
4	Submission of Economic Botany specimens (5)	5.0	05
Total		5.0	20

Semester IV: 19PBO44			
		CA	**ESA**
1	Research Station Visit Report	0.0	5.0
2	Tissue Culture Specimens 5 Nos.	5.0	10.0
3	Bioinformatics Lab Visit Report	0.0	5.0
Total		5.0	20.0

Dissertation/ Project work

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

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

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

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

Internship

With a motive of familiarising the academic and research environment in the field of Plant Science, it is making compulsory for every semester 2 students should undertake an internship for a minimum of 2 weeks by collaborating with institutions of national and international repute, doing research and teaching in the field of Plant Science. Second and Third week of May is earmarked for internship, that can be altered on special circumstances. A valid internship certificate from the institution is a must for pass in semester II.

Assignments

The entire processes related with assignments will be through online/offline. The allotment, submission, valuation and publication of results will be through an online/offline platform. It will be the discretion of the department each and every time to choose either online/ offline mode.

Class Room Seminars

This will be conducted on a common platform and has to be presented on a board of internal examiners (not less than three). Marks will be awarded based on the detailed analysis on content, mode of presentation, clarity of ideas and language, communication and clarification with the listeners and overall performance.

Scheme for Practical Examinations

	Duration	CA	ESA	Total
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

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

SCHEME OF EXAMINATION AND MARK DISTRIBUTION

Sem.	Paper code	Title of the paper	Hrs/ Sem	ESA Hrs	Maximum Marks		
					CA	ESA	Total
I	19PBO11	Phycology, Mycology & Plant Pathology	108	3	25	75	100
	19PBO12	Bryophyta, Pteridophyta& Gymnosperms	108	3	25	75	100
	19PBO13	Microbiology, Histology&Microtechnique	108	3	25	75	100
	19PBO14	Practical I	126	4	25	75	100
	19PBO15	Submissions			05	20	025
	19PBO16	Viva Voce			00	25	25
	Total for Semester I		**450**	**13**	**105**	**395**	**450**
II	19PBO21	Reproductive Botany & Crop Improvement	108	3	25	75	100
	19PBO22	Environmental Biology, Forest Botany, Phytogeography & Conservation Biology	108	3	25	75	100
	19PBO23	Cell Biology & Genetics	108	3	25	75	100
	19PBO24	Practical II	126		25	75	100
	19PBO25	Submissions			05	20	025
	19PBO26	Viva Voce			00	25	25
	Total for Semester II		**450**	**13**	**105**	**395**	**450**
III	19PBO31	Angiosperm Systematics,Economic Botany, Ethnobotany & Evolution	108	3	25	75	100
	19PBO32	Biophysics & Bioinformatics	108	3	25	75	100
	19PBO33	Research Methodology, Biostatistics & Plant Biotechnology	108	3	25	75	100
	19PBO34	Practical III	126	4	25	75	100
	19PBO35	Submissions			05	20	025
	19PBO36	Viva Voce			00	25	25
	Total for Semester III		**450**	**13**	**105**	**395**	**450**
IV	19PBO41	Special Paper –I- Plant Physiology& Biochemistry	144	3	25	75	100
	19PBO42	Special Paper –II Elective – Advanced Biotechnology	144	3	25	75	100
	19PBO43	Practical IV	126	4	25	75	100
	19PBO44	Submissions			05	20	100
	19PBO45	Viva Voce			00	25	025
	19PBO46	Dissertation	36		00	100	025
	Total for Semester IV		**450**	**10**	**80**	**370**	**450**
Grand Total					**395**	**1405**	**1800**
ESA-End Semester Assessment, CA-Continuous Assessment(internal)							

DISTRIBUTION OF MARKS IN EACH SEMESTER EXAMINAION

Semester	Continuous Assessment		End Semester Assessment		Total Marks
	Theory	Practical	Theory	Practical	
I	75	25	225	75	400
II	75	25	225	75	400
III	75	25	225	75	400
IV	50	25	150	75	300
	Dissertation				100
	Submissions 4 x 25				100
	Viva Voce 4 x 25				100
Grand Total					**1800**

DISTRIBUTION OF MARKS IN PRACTICAL EXAMINATION

Practical	Total Marks	Examination	Record/Submissions
I	75	65	Record- 10
II	75	65	Record- 10
III	75	50	Record- 15, Herbarium/ Field Note- 10
IV	75	65	Record- 10

SEMESTER- I

19PBO11
PHYCOLOGY, MYCOLOGY& PLANT PATHOLOGY

Distribution of Hours	Theory	Practical
Phycology	54 Hrs	27 Hrs
Mycology	36 Hrs	09 Hrs
Plant Pathology	18 Hrs	00 Hrs
TOTAL	**108 Hrs**	**36 Hrs**

Aim and Objectives of the Course

- To make an understanding on the thallus structure, mode of reproduction and ecological adaptations of lower plant forms
- To develop the expertise and skill in identifying lower plant forms
- To develop a concise account on the biological mechanism behind plant diseases

PHYCOLOGY- (3hrs/wk)

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

Practicals(1.5 hrs/wk)

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

References

- Bhattia A (2004)Treatise on Algae.S.Chand&Company,New Delhi.
- Bilgarmi KS and Saha LC (2010) A text book of Algae. CBS Publishers, New Delhi.
- Bold HC& Wynne MJ(1995) Introduction to Algae. Prentice Hall of India, New Delhi.
- Kashyap, A. K. and Kumar, H. D. (1994) Recent advances in Phycology. Rastogy&company.
- Kumar HD (1999) Introductory Phycology.East West Pvt. Ltd., New Delhi.
- Lee RE (2018) Phycology 5th Edition, 2018 Cambridge University Press, New Delhi.
- Pandey BP (2004) Algae. S. Chand & Company Ltd. New Delhi.
- Prescott,G.W. (1984) The Algae: A review.Lubrecht& Cramer Ltd.
- Round FE (1984) The Ecology of Algae. Cambridge University Press, London.
- Sharma, O.P. (2011). Text book of Algae. Tata McGraw Hill Publ. Comp. Ltd. New Delhi.
- Sharma PD (2003) A Text book of Botany-Lower plants. Rastogi Publications, Meerut.
- Smith GM (1976) Cryptogamic Botany Vol.1.Tata Mc Graw Hill Publ. Co. Ltd.,New Delhi.
- Vashishta BR (1999) Algae.S.Chand&Company, New Delhi.
- Fritsch (1935, 48) Structure and reproduction of algae. Cambridge University Press.
- BarsantiL & Gualtieri P (2014) Algae: Anatomy, Biochemistry, and Biotechnology, 2nd Edition CRC Press.

MYCOLOGY- (2hrs/wk)

- Principles and modern trends of classification of Fungi (Ainsworth 1973, Carl Woese, 1990). Contributions of Indian Mycologists (3 hrs).
- Structure, reproduction and phylogeny of-

  Kingdom Protista

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

Kingdom Straminopila

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

Kingdom Fungi

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

(6 hrs)

- Thallus structure, reproduction and life cycle of the following types- (20 hrs)
  Phytophthora, Albugo, Pilobolus, Penicillium, Aspergillus, Uromyces, Polyporus, Lycoperdon, Geaster, Dictyophora, Nidularia, Schizophyllum, Colletotrichum, Alternaria, Helminthosporium, Cercospora.
- Economic importance of fungi with special reference to secondary Metabolites; Fungi asbiocontrol agent (2 hrs).
- Classification, thallus structure, reproduction, ecological significance and economic importance of Lichens- *Usnea, Graphis.* (2 hrs)

Practical - (0.5 hr/wk)

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

References

- Ainsworth GC, Sparrow FK and Sussman AS(1973)The Fungi- An advanced Treatise. Academic Press, New York.
- Alexopoulose CJ, Mims C, Blackwell M (1996) Introductory Mycology. John Wiley & Sons, New York.
- Bessy EA (1979) Morphology and Taxonomy of Fungi. Vikas Publishing House, New Delhi.
- Burnett JH (1968) Fundamentals of Mycology. Edward Arnold Ltd., London.
- Chopra GL(1998)A text book of Fungi. S. Nagin & Co. Meerut.
- Dube H.C. (2013) An Introduction to Fungi. 4th Edition. Scientific Publishers India.
- Moore-Landeeker E(1996) Fundamentals of Fungi. Prentice Hall, New Jersey.

- Hale ME (1983) Biology of Lichens. Edward Arnold, London.
- Hudson HJ(1986)Fungal Biology. Hodder Arnold H & S, London.
- Kirk, P.M., Cannon, P.F., David, J.C. &Stalpers, J.A.(2001). Ainsworth &Bisby's Dictionary of the Fungi, 9th Edition. CABI Publishing.
- Kirk P, Cannon P.F., Minter D.W., Stalpers J.A. (2008) Ainsworth &Bisby's Dictionary of Fungi. 10th edn CAB International, Oxon UK:
- Moore D*et al* (1986) Developmental Biology of higher Fungi. Cambridge University Press, London.
- Mehrothra RS and Aneja KR (1990) An Introduction to Mycology. Wiley Eastern Ltd. New Delhi.
- Sharma OP (2007) Text book of Fungi. Tata McGraw Hill, Publishing Co. Ltd., New Delhi.
- Sharma PD (2004) The Fungi for University students. Rastogi Publications, Meerut.
- Srivastava JP (1998) Introduction to Fungi. Central Book Depot, Allahabad.
- Sumbali G (2005) The Fungi. Narosa Publishing House, New Delhi.

PLANT PATHOLOGY- (1hr/wk)

- History of Plant pathology, General principles and concepts of host-parasite interaction (2 hrs).
- Defense mechanisms - Systemic Acquired Resistance and Induced Systemic Resistance, major signaling pathways of plant defense mechanism (4 hrs)
- Epidemiology and quarantine (1 hr).
- 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).
- Study of the following plant diseases with reference to symptoms causal organism, disease cycle and control measures.

  a. Paddy : Brown spot and false smut
  b. Coconut : Root wilt
  d. Rubber : Powdery mildew
  e. Coffee : Rust
  f. Tea : Red rust
  g. Sugarcane : Red rot

h. Mango : Leaf spot
i. Ladies finger : Yellow vein mosaic
j. Pepper : Quick wilt (9 hrs)

Practical

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

References

- Agrios GN (1997) Plant pathology. Academic Press, New Delhi.
- Bilgrami KS& Dube HC (1990) A text book of modern plant pathology. Vikas Publishing House, New Delhi.
- Butler EJ& Jones (1949) Plant Pathology. Mc Millan,London.
- Chatterjee PB (1997) Plant Protection Techniques. Bharatibhavan, Patna.
- Chattopadhayay SB (1991) Principles and procedures of plant protection Oxford &IBH, New Delhi.
- Manners JG (1982) Principles of Plant Pathology. Cambridge University Press, London.
- Marshall H (1999) Diseases of plants. Anmol Publications Pvt. Ltd., New Delhi.
- Mehrotra RS (2000) Plant pathology. Tata McGraw Hill, Publishing Co. Ltd., New Delhi.
- Mundkur BB (1982)Text book of Plant diseases. Macmillan India Ltd., New Delhi.
- Pathak VN, Khatri NK and Pathak M (1996) Fundamentals of Plant pathology. Agrobotanical publishers (India), Bikaner.
- Rangaswamy G and Mahadevan A (2002) Diseases of crop plants in India. Prentice Hall of India, New Delhi.
- Sharma PD(2005) Plant pathology. Narosa Publishing House, New Delhi.
- Singh RS (2000) Introduction to the principles of Plant pathology. Oxford IBH, New Delhi.
- Swarup*et al.* (1999) Plant diseases. Anmol Publications Pvt. Ltd., New Delhi.

Course Outcome

- Students will get an understanding on the evolution of thallus and reproductive structures of lower forms of plant life, their diversity, economic and ecological significance

19PBO12

BRYOPHYTA, PTERIDOPHYTA AND GYMNOSPERMS

Distribution of Hours	Theory	Practical
Bryophyta	27 Hrs	09 Hrs
Pteridophyta	45 Hrs	18 Hrs
Gymnosperms	36 Hrs	09 Hrs
TOTAL	**108 Hrs**	**36 Hrs**

Aim and Objectives of the Course

- To make an understanding on the vegetative structure, mode of reproduction and ecological adaptations of bryophytes, pteridophytes and gymnosperms
- To develop the expertise and skill in identifying plants belonging to bryophytes, pteridophytes and gymnosperms

BRYOPHYTA - (1.5 hrs/wk)

- General characters and recent systems of classification; Contributions of Indian Bryologists (2 hrs).
- 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).
- Life cycle study of the following types: *Lunularia, Targionia, Cyathodium, Reboulia, Pallavicinia, Porella, Notothylas, Sphagnum, Polytrichum* (12 hrs).
- Origin and evolution of Bryophytes, Brief account on Fossil Bryophytes (2 hrs).
- Bryophytes as indicators of water and air pollution (1 hr).

Practical - (0.5 hr /wk)

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

References

- Chopra RN(1998) Topics in Bryology. Allied Printers, New Delhi.
- Chopra RNand Kumara PK (1988) Biology of Bryophytes. Wiley East New Delhi.
- Parihar NS(1980) An introduction to Embryophyta Vol. I. Bryophyta. Central Book Depot, Allahabad.

- Prem Puri (1981) Bryophytes:Morphology ,Growth and differentiation. Atma Ram and Sons, New Delhi
- Rashid A (1998) An introduction to Bryophyte. Vikas Publishing House, New Delhi.
- Smith,G.M. (1976). Cryptogamic Botany Vol.II. Tata Mc Graw Hill. Publishing Co. Ltd., New Delhi.
- Singh S.K (2015) Liverworts and Hornworts of India: An annotated check list, Botanical Survey of India.
- Vanderpoorten A and Goffinet B (2010) Introduction to Bryophytes, Cambridge University Press.
- Watson,E.V. (1968) The structure and life of Bryophytes.CambridgeUniversity,London.
- Goffinet B & Shaw A.J (2009)Bryophyte Biology, Cambridge University Press

PTERIDOPHYTA- (2.5 hrs/wk)

- General characters, classification (Bierhost1971) and life cycle of Pteridophytes; Contributions of Indian Pteridologists. (3 hrs)
- Comparative morphology,structure, ecology and phylogeny of the following groups: Psilopsida, Lycopsida, Sphenopsida, Pteropsida. (8 hrs)
- Structure,reproduction and life cycle of the following types: *Isoetes,Ophioglossum,Angiopteris,Osmunda,Ceratopteris,Blechnum, Lygodium,Adiantum,Dicranopteris,Acrostichum,Salvinia,Marselia*(24 hrs)
- 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)
- Conservation of Pteridophytes; Pteridophytes as ecological indicators. (2 hrs)
- Principles of Paleobotany, Fossil pteridophytes: *Rhynia, Lepidocarpon, Sphenophyllum, Zygopteris* (4 hrs)

Practical (1hr/wk)

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

References

- Arnold,C.A.1947. An introduction to Paleobotany. McGraw Hill,NewYork.
- Bierhost,D.W.1971.Morphology of vascular plants. Macmillan,London.
- Eames EJ (1983) Morphology of vascular plants. Standard University press.
- Parihar NS (1980)An introduction to Embryophyta Vol. II. Pteridophyta Central Book Depot, Allahabad.
- Rashid A (1999) Pteridophyta. Vikas Publishing House, New Delhi.
- Scott DH (1962) Studies in Fossil Botany. Hafner Publishing Co., New York.
- Shukla AC and Misra SP (1975) Essentials of Paleobotany. Vikas Publishing House, New Delhi.
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- Sporne KR(1986) Morphology of Pteridophytes. Hutchinson University Library, London.
- Stewart WN (1983) Paleobotany and evolution of plants. Cambridge University Press, London.
- SundaraRajan S (1999)Introduction to Pteridophyta. New Age Publications, New Delhi.

GYMNOSPERMS (2hrs/wk)

- General characters, affinities, distribution and classification (Chamberlain, 1934; Sporne,1965); phylogeny and economic importance of Gymnosperms. (6 hrs)
- Structural details of vegetative and reproductive parts, phylogeny and inter relationships of the following orders: Cycadofilicales, Caytoniales, Bennettitales, Pentoxylales, Cycadales, Ginkgoales, Coniferales, Gnetales. (16 hrs)
- Structure,reproduction and life cycle of the following types: *Zamia, Auracaria, Cupressus, Podocarpus, Agathis, Ephedra* (12 hrs)
- Fossil Gymnosperms (Brief account) (2 hrs)

Practical (0.5 hr/wk)

- Structural details of the following fossil types: *Heterangium*,*Medullosa*.
- Anatomy of stem (TS,RLS,TLS), leaf and reproductive structures of the types mentioned in the syllabus.

References

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- Christenhurz et al (2011) A new classification and linear sequence of extant gymnosperms Phytotaxa 19: 55-70. Magnolia Press
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- Sporne KR (1986) Morphology of Gymnosperms, Hutchinson University Library, London.
- Vashishta PC (1999) Gymnosperms, S. Chand &Company, New Delhi.

Course Outcome
Students will get an idea on the diversity, economic and ecological significance of primitive vascular plants and their evolutionary relationships with angiosperms

19PBO13
MICROBIOLOGY, HISTOLOGY&MICROTECHNIQUE

Distribution of Hours	Theory	Practical
Microbiology	36 Hrs	09 Hrs
Histology	27 Hrs	09 Hrs
Microtechnique	45 Hrs	36 Hrs
TOTAL	**108 Hrs**	**54 Hrs**

Aim and Objectives of the Course

- To develop an understanding on the diversity, structural features, and mode of reproduction of microbial forms
- To familiarise the theory of immunology and the working of immune system
- To develop the expertise and skill in botanical microtechnique

MICROBIOLOGY- (2hrs/wk.)

- Brief history of microbiology. Experiments of Pasteur and Tyndall. Koch's postulates. Methods of sterilization. (4 hrs)
- Changing concepts in microbial taxonomy- molecular taxonomy- Jackard's similarity coefficient. (2 hrs)
- Brief account of major classes of microorganisms. (4 hrs)
- Growth and nutrition of microorganisms. (2 hrs)
- Microbial diseases in plants, animals and humans (any two). (4 hrs)
- Microbes in Agriculture: Rhizosphere, Nitrogen fixation, Mycorrhiza, Cyanobacteria (2 hrs)
- Industrial Microbiology: Major industrial products from microbes: Beverages, Antibiotics, Secondary metabolites, Recombinant products (2 hrs)
- Environmental Microbiology: Anthropogenic wastes. Municipal Wastes, Xenobiotics, Xenobiotic degrading consortia, Bioremediation (2 hrs)
- Immunology (14 hrs)
    - Immunity-mechanism; Innate and adaptive immune system: cells and molecules involved in innate and adaptive immunity.
    - Antigens, antigenicity and immunogenicity. B and T cell epitopes.

- Structure and function of antibody molecules, generation of antibody molecules, generation of antibody diversity, monoclonal antibodies, antibody engineering.
- Antigen antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cell, B&T cell receptors.
- Humoral and cell mediated immune responses, primary and secondary immune modulation, the complement system, Toll like receptors cell mediated effector functions.
- Inflammation, hypersensitivity and auto immunity, immune response during bacterial (tuberculosis) parasitic (malaria) and viral (HIV) infections, congenital and acquired immune-deficiencies, vaccines.

Practical (0.5 hr /wk)

- Practicals involving preparation of media, principles of isolation, pure culturing aspects and maintenance of culture.
- Methods of study: Hanging drop for demonstrating bacterial motility; differential staining – gram and acid fast.
- Isolation of *Rhizobium* from root nodule of Legumes.
- Test for coliforms in contaminated water.
- Isolation of pure bacterial culture by streak plate method.

References

- Atlas M and Bartha R (2000) Microbial Ecology, Longmann New York.
- Black JG (1999) Microbiology–Principles and Explorations, Prentice Hall, London.
- Brock TD (1996) Biology of microorganisms Prentice Hall, London.
- Casida LE (1997) Industrial microbiology. New Age Publishers, New Delhi.
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- Kumar HD and Kumar S (1999) Modern concepts of Microbiology, Vikas Publishing House, New Delhi.

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- Michael T. Madigan *et. al.,* (2015) Brock Biology of Microorganisms. Pearson Education, Inc.
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- Rao AS (2001) Introduction to Microbiology. Prentice Hall of India, New Delhi.
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- StainerR.Y*et al.* (1990) The microbial world. Prentice Hall of India, New Delhi.

HISTOLOGY-(1.5 hrs/wk)

- Origin, structure and function of cambia and their derivatives (6hrs)
- Seasonal variation in cambial activity, role of cambium in wound healing and grafting (2 hrs)
- Anomalous cambial activities in *Nyctanthus, Amaranthus, Mirabilis, Bougainvillea, Piper, Aristolochia, Thunbergia, Pothos* (6 hrs)
- Structure of wood- Soft wood, hard wood, Sap wood, Heart wood and role of extractives in wood quality. Wood anatomy of the following wood yielding plants of Kerala: *Artocarpusintegrifolia, Tectonagrandis,Dalbergialatifolia, Ailanthus malabarica*(6 hrs)
- Nodal anatomy, root –stem transition, transfer cells. (2 hrs)
- Floral anatomy. (1 hr)
- Histochemical and ultra structural aspects of development, differentiation and morphogenesis. (3 hrs)
- Anatomy in relation to Taxonomy. (1 hr)

Practical (0.5 hr/wk)

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

References

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- Cutler,E.G. 1978. Plant Anatomy(Vol.I,II.) Edward Arnold,London.
- Crang R, Lyons-Sobaski S & Wise R (2018) Plant Anatomy: A concept based approach to the structure of Seed Plants. Springer.
- Dickison WC (2000) Integrative Plant Anatomy. Academic Press, UK.
- Eames A.J& Mac Daniels L.H(1979)An introduction to Plant Anatomy. Mc. Graw Hill New York.
- Esau K (2002)The anatomy of seed plants. John Wiley &Sons, New York.
- Fahn A(1989) Plant Anatomy, Pergamon press, Oxford, New York.
- Foster A.S(1960) Practical Plant Anatomy. Van Nostrand & East West, New Delhi.
- Metcalfe C.R. and Chalk L (1950) Anatomy of the Dicotyledons and Monocots (Vol.I, II), Oxford University Press, London.

MICROTECHNIQUE AND HISTOCHEMISTRY-(2.5 hrs/wk)

- Scope of Histochemistry and Cytochemistry in Biology. (2 hrs)
- Tissue processing steps (10 hrs)
  Killing and fixing –reagents and fixative formulations, chemistry of fixation; Dehydration-reagents; Infiltration and embedding; Sectioning and mounting
- Tissue processing techniques for light microscopy, electron microscopy, hand and serial sections, squashes, smears and maceration (9 hrs)
- Microtomy: Rotary, Sledge, Freezing, Cryostat and Ultratomes(5 hrs)
- Biological stains: Classification and chemistry of biological stains; general and specific; vital stains and flurochromes. (5 hrs)
- Micrometry, camera lucida, photomicrography. (3 hrs)
- Detection and localization of primary metabolites (5 hrs)
  Carbohydrates (PARS reaction),
  Proteins (Coomassie brilliant blue staining)
  Lipids(Sudan Black method)

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

Practical (2hrs/wk)

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

References

- Gahan PB (1984) Plant histochemistry and Cytochemistry. Academic Press, London.
- Gary P(1964) Hand book of Basic microtechnique. John Wiley & Sons, New York.
- Harris R(1991) Electron Microscopy in Biology- a practical approach. IRL press, Oxford, UK.
- Johanson WA (1982) Botanical Histochemistry.-Principles and Practice Freeman Co.
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- Kierman JA (1999) Histological and Histochemical Methods. Butterworth Publ. London.
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- Ruzin ZE (1999) Plant Microtechnique and Microscopy. Oxford Press, New York.

- Yeung ECT, Stasolla C, Sumner MJ and Huang BQ (2015) Plant Microtechniques and Protocols, Springer

Course Outcome
Students will get an idea on the diversity and economic importance of microorganisms, and will develop scientific skill in microscopy and other allied laboratory techniques

SEMESTER II

19PBO21

REPRODUCTIVE BOTANY& CROP IMPROVEMENT

Distribution of Hours	Theory	Practical
Plant Breeding	63 Hrs	09 Hrs
Horticulture	18 Hrs	09 Hrs
Reproductive Botany	27 Hrs	09 Hrs
TOTAL	**108 Hrs**	**27 Hrs**

Aim and Objectives of the Course

- To develop an understanding on the concepts, theories and mechanism of angiosperm reproduction
- To get a detailed knowledge on the crop breeding programmes
- To develop the expertise and skill in crop breeding programmes

PLANT BREEDING (3.5 hrs/wk)

- Definition, Objectives. Importance of floral biology in plant breeding. (3 hrs)
- Methods of crop improvement
  - Plant Introduction: Definition, types and procedure. Sources of germplasm.Centres of genetic diversity. Concepts of de Candolle and Vavilov. Primary, secondary and microcenters.Geneticerosion.Preservation and utilization of germplasm. Gene banks. NBPGR. (4 hrs)
  - Selection: Principles, genetic basis and methods: Mass selection, pure line selection, clonal selection. (6 hrs)
  - Hybridization: Objectives. Procedure. Major achievements. Problems and causes of failure of hybridization. Handling of hybrids - Bulk method and pedigree method of selection. Distant hybridization - Role of interspecific and intergeneric hybridization in crop improvement. (7 hrs)
- Role of incompatibility and sterility in crop improvement.(3 hrs)
- Backcross breeding: Theory and procedure. (5 hrs)
- Inbreeding: inbreeding consequences. Heterosis-Definition. Genetic and physiologic basis. Application in plant breeding. Steps in the production of single cross, double cross, three way cross, synthetic cross, multilines. Idiotype breeding: Concept, Achievements: (Wheat–Asana, Donald. Rice– Super Rice). (7 hrs)

- Polyploidy breeding: induction of autopolyploidy and allopolyploidy. Role of chromosome manipulation. Chromosome addition and substitution lines. Achievements. (6 hrs)
- Mutation breeding: Principles, objectives, procedure. Induction of mutations: Physical and chemical mutagens - Recurrent irradiation, Split dose irradiation, Combination treatment. Achievements. (6 hrs)
- Resistance breeding: Principles. Methodology. Basis of resistance: structural, biochemical, physiological and genetic. Gene for gene systems of plants. Vertical and horizontal resistance. Artificial production of epiphytotic conditions and screening procedures for resistance. (7 hrs)
- Seed production and certification. (4 hrs)
- Centres of crop breeding: International and National (with special reference to Kerala). (3 hrs)
- Plant breeder's rights Act. National Biodiversity Policy. (2 hrs)

Practicals(0.5 hr/wk)

- Emasculation; preparation of the inflorescence for crossing
- Estimation of pollen sterility and fertility percentage
- Pollen germination: *in vitro* and *in vivo* viability tests
- Demonstration of hybridization in Pea/Taro/Cahew/Anthurium

References

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- Allard R W(1999) Principles of Plant Breeding. John Wiley &Sons. Inc. New York.
- Hagberg A and Akerberg E (1962) Mutation and polyploidy in plant breeding. Heimeman Educational Books Ltd., London.
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- Roy D(2000) Plant Breeding. Narosa Publishing House , New Delhi.
- Briggs F.W and Knoles, P. F(1967) Introduction to Plant Breeding. Reinhold Publishing Corporation , New York.
- Jensen N. F(1988) Plant Breeding methodology. Wiely Inter-Science Publ. New York.
- Mandal A. K(2000) Advances in Plant Breeding . CBS Publishers, New Delhi.
- Sing B. D(1999) Plant Breeding . Kalyani Publishers, New Delhi.
- Xu Y (2010) Molecular Plant Breeding. CAB International, UK.

HORTICULTURE (1 hr/wk)

- Concept and Scope – Familiarization of famous gardens in the world and in India. (2 hrs)
- Tools and Implements- spade, pick axe, weed cutter, trimmer, sprayer (rocker & power sprayer), hand shear, budding knife, garden tiller, lawn mower. (2 hr)
- Plant growing structures – Greenhouse, Glasshouse and Mist chamber; Hydroponics. (2 hr)
- Plant propagation: Seed propagation and vegetative propagation- natural andartificial. Artificial methods of vegetative propagation: Cuttage, layerage, graftage, budding, micropropagation (2 hrs)
- Cultural practices – Thinning, training, trimming and pruning. (1 hr)
- Outdoor horticulture: Components and designs of gardens. Types of gardens: Vegetable/ medicinal/ floral/ Home gardens/ public gardens/ vertical gardens/ roof gardens/ Lawns andlandscapes. (3 hrs)
- Commercial horticulture: Nurseries, Orchards; Floriculture: Production of cut flowers. Floral decorations (Brief account only). Indoor plants. (3 hrs)
- Arboriculture: Pruning, bracing, feeding and transplanting. Bonsai: Principles and procedure. (3 hrs)

Practicals(0.5 hr/wk)

- Budding – 'T' Budding and Patch Budding
- Layering – Any two methods.
- Grafting – Any two methods.

References

- George A (2009) Horticulture- Principles and practices. Phi Learning Publishers,New Delhi.
- Kumaresan V (2001) Horticulture. Saras Publications, Nagercoil, Tamilnadu
- Chadha KL (2001) Handbook of Horticulture, ICAR, New Delhi.
- Christopher E. P (1981) Introductory Horticulture, McGraw Hill, New Delhi.
- Hartmann et al. (1997) Plant propagation: Principles and Practices, Prentice Hall.

- Reiley E and Shry C (2000) Introductory Horticulture. Thomas Delmer, New York.
- Preece JE and Read PE (1993) The Biology of Horticulture: an introductory text book. Wiley Eastern.
- Manibhushan Rao K (1991) Text book of Horticulture. Macmillan India, NewDelhi.

REPRODUCTIVE BOTANY- (1.5 hrs/wk)

- Asexual reproduction:Vegetative apomixes, Adventive embryony, Non recurrent apomixis, diplospory, apospory, parthenogenesis, androgenesis, gynogenesis, automixis, semigamy, agamic complex. (5 hrs)
- Sexual reproduction: Development of flower -Transition from vegetative to flowering stage, gender expression in monoecious and dioecious plants (2 hrs)
- Microsporogenesis: Male gametophyte - pollen fertility and sterility Types of male sterility: Gametic and zygotic sterility. Somatoplasticsterility.Cytoplasmic and genetic sterility. Pollen storage. Pollen viability and germination. (4 hrs)
- Megasporogenesis: Embryosacdevelopment and types. (3 hrs)
- Pollination:Primary and secondary attractants of pollination, ultra structural and histochemical details of style and stigma, significance of pollen-pistil interactions. (3 hrs)
- Fertilization:Barriers to fertilization, genetics of incompatibility, methods to overcome incompatibility- intra ovarian pollination and in vitro fertilization, embryo rescue. (3 hrs)
- Embryo, endosperm and seed development, Polyembryony, Parthenocarpy. (3 hrs)
- Application of palynology in Taxonomy (2hrs)
- Economic importance of pollen grains: Pollen Allergy; pollen grains in honey; role of apiaries in crop improvement (2 hrs)

Practical (0.5 hr/wk)

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

References

- Maheswari P (1980) Recent Advances in the Embryology of Angiosperms.
- Johri BM (1984) Embryology of Angiosperms. Springer Verlag. Berlin.

- Pandey AK (1997) Introduction to Embryology of Angiosperms. CBS Publishers and Distributors, New Delhi.
- Bhojwani SS and Bhatnagar SP (2000) The Embryology of Angiosperms, Vikas Publishing House Pvt. Ltd., New Delhi.
- Pandey SN and Chadha A (2000) Embryology. Vikas Publishing House Pvt. Ltd., New Delhi.
- Fosket D.E (1994) Plant, Growth and Development: A Molecular Approach, Academic Press.
- O'Neill S.D & Roberts J.A (2002) Plant Reproduction, Sheffield Academic Press.
- Raghavan V (2000) Developmental Biology of Flowering Plants, Springer, Netherlands.
- Raghavan V(1997) Molecular Embryology of Flowering Plants. Cambridge University Press.

Course Outcome

- Students will acquire various horticultural skills and get exposed to different plant propagation methods
- Students will get a proper understanding on the angiosperm reproduction

19PBO22
ENVIRONMENTAL BIOLOGY, FOREST BOTANY, PHYTOGEOGRAPHY & CONSERVATION BIOLOGY

Distribution of Hours	Theory	Practical
Environmental Biology	54 Hrs	36 Hrs
Forest Botany	09 Hrs	00 Hrs
Phytogeography	18 Hrs	00 Hrs
Conservation Biology	27 Hrs	00 Hrs
TOTAL	**108 Hrs**	**36 Hrs**

Aim and Objectives of the Course

- To develop an idea on the relatioship between plants, animals and the environment
- To get an insight on the role of environment in maintaining life in this universe
- To familiarise various environment protection programmes
- To develop an understanding on the distribution and status of forest types in India
- To make the students aware about the concepts and principles of conservation

ENVIRONMENTAL BIOLOGY- (3 hrs/wk)

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

- Nature of communities; community structure and attributes; levels of species diversity and its measurement; edge effect and ecotone. (4 hrs)
- Major terrestrial biomes. (3 hrs)
- Species interactions - types of interactions, interspecific competition, herbivory, carnivory, symbiosis. (4 hrs)
- 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)
- Ecological concepts of species: Autecological level (genecology), Synecological level (Ecosystem level). Ecads (Ecophenes), Ecotypes, Ecospecies. (4 hrs)
- Ecological succession: Types; mechanisms; changes involved in succession; concept of climax (4 hrs)
- Applied ecology: Environmental pollution; global environmental change; biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Current environmental issues in India, Environmental education and awareness. (6 hrs)
- Disaster management, Environmental laws, Global environmental problems- ozone depletion, greenhouse effect, carbon credit, global warming, acid rain, nuclear hazards – Climate change, Eutrophication, landslides and floods. (5 hrs)

Practicals(2 hrs/wk)

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

References

- OdumE. P & Barrett G.W (2004) Fundamentals of Ecology. Cengage Learning, Boston, USA

- Sharma PD (1997) Enviornmnetal Biology, Rastogi Publications, New Delhi.
- Agarwal KC (2001) Environmental Biology, Nidi Publ. Ltd. Bikaner
- Brunner RC (1989) Hazardous Waste Incineration, McGraw Hill Inc.
- Jadhav H & Bhosale VM (1995) Environmental Protection and Laws. Himalaya Pub. House, Delhi.
- Trivedi RK and Goel PK (2003) An Introduction to air pollution, Techno-Science, ABD publishers, Jaipur.
- Cunningham WP, Cooper TH, Gorhani E & Hepworth MT (2001) Environmental Encyclopedia, Jaico Publ. House, Mumbai.
- Molles M.C & Simon A.S (2019) Ecology: Concepts and Applications, McGraW Hill, New York

FOREST BOTANY (0.5 hr/wk)

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

Practicals

- Collection and documentation of a minimum of 5 Major/ minor forest products

References

- Puri GS (1983) Forest Ecology, Oxford & IBH, New Delhi.
- Lal JB (2011) Forest Ecology, Natraj publishers, Dehradun.
- Chaubey OP, Sharma A, Prakash R (2014) Forest Ecology in India. Aavishkar publishers, Jaipur.
- Puri GS (1960) Indian forest ecology: a comprehensive of vegetation and its environment in Indian subcontinent. Oxford book and stationary Co., New Delhi.
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- Chaudhari AB & Naithani HB (1985) Environment and resources of tropical and temperate forests of India. International book distributors, Dehradun.

- Barnes B. V, Zak D.R, Denton S.R &Spurr S.H (1998) John Wiley & Sons, New York, USA
- Perry D.A. Oren R & Hart S.C (2008) Forest Ecosystems, The Johns Hopkins University Press, Baltimore, USA

PHYTOGEOGRAPHY (1 hr/wk)

- Define-Phytogeography-static and dynamic phytogeography(2 hrs)
- Geological history and evolution of plant life. (4 hrs)
- 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)
- Phytogeographic regions of the world (Vegetable belts) (4 hrs)
- Soil, climate, flora and vegetation of India. (4 hrs)

References

- Good R (1964) The geography of flowering plants. Lengmans.
- Bharucha FR (1984) A text book of plant geography of India. Oxford University Press.
- Croizat L (1952) Manual of Phytogeography: An account of Plant dispersal throughout the world, Springer Science+ Business Media Dordrecht
- Puri GS (1983) Indian Forest Ecology, Vol. I & II, Oxford & IBH.
- Schatz GE (1996) Malagasy/ Indo-Australo-Malesian Phytogeographic Connections. http://www.mobot.org/MOBOT/Madagasc/biomad 1.html.
- The international Biogeography Society. http://www.biogeography.org/
- Tree of Life .URL:http://tolweb.org/tree/phylogeny.html.

CONSERVATION BIOLOGY (1.5 hrs/wk)

- Concept, aim and principles of conservation. (1 hr)
- Convention on Biological Diversity-Objectives-Definition of biodiversity-Role of IUCN, MAB, Red Data Book, Threatened categories of plants.Conservationstrategies:In-situ and Ex-situ conservation-Sustainable development.Biodiversity International, BGCI, Global Strategy for Plant Conservation (GSPC), WWF, UN Strategies for Conservation. Biosphere reserves, Wild life sanctuaries and National parks in India with special reference to Kerala. (4 hrs)

- Indian case studies on conservation/management strategy (Project Tiger, Biosphererereserves). (1 hr)
- Agriculture and Industrialization and conservation of resources: Historical background of role of agriculture and industry in development,Novel agricultural technologies, Wind mills for irrigation,Solar energy for drawing ground water,Biogas for cooking and slurry left to be used as fertilizers.Impact of industrialization on agricultural development. (4 hrs)
- Urbanization and Conservation:Environmental problems of urban and rural areas.Natural resources and depletion -planning for environmentally compatible human settlements and strategy for sustainable industrial development. (3 hrs)
- Conservation and energy: Causes of energy crisis-Conservation of energy source in industry, agriculture & in the transport sector.(3 hrs)
- Renewable and Non-renewable energy:Development of non-polluting energy systems-Solar energy, Wind energy,energy recovery from solid wastes-Convention energy,Non-convention energy source. (4 hrs)
- Conservation of physical resources. (Mention all physical factors of environment). (2 hrs)
- Afforestation-Social forestry, agroforestry, International Biological programme (IBH), Man and Biosphere (MAB), IUCN, World environment day, wild life preservation act (1972), Indian forest conservation act (1980), United Nations Environmental Programme, Environment protection Act. (5 hrs)

Practicals

- One day visit to ecologically significant location (National parks/Mangroves/Estuaries/Freshwater lake).
- Each student should submit a document describing the distributional status, ecological and conservational aspects of any two plants belonging to the IUCN category.
- Each student has to plant at least two medicinal plants of rare category in the botanic garden and has to submit the document in respect ot this.

References

- Dasman RF (1976) Environmental conservation, John Wiley and Sons, New York.

- Malcom L, Hunter JR & Gibbs J (2007). Fundamentals of Conservation Biology, Blackwell Publishing.
- Pullin AS (2002) Conservation Biology, Cambridge University Press.
- Dyke FV (2008) Conservation Biology, Foundation, concept, applications, Springer.
- Mac Donald & Katrina Service (2007) Key Topics in Conservation Biology, Blackwell publishing.
- Fielder PI &Kareiva PM (1998) Conservation Biology for the coming decade, Chapman and Hall.
- Sher A. A & Primack R. B (2019) An Introduction to Conservation Biology, Oxford University Press, New York

Course Outcome

- Develop deep insight on conservation and sustainable utilization of our resources
- Help to identify and act on environmental issues and to play lead roles in conservation programmes

19PBO23
CELL BIOLOGY & GENETICS

Distribution of Hours	Theory	Practical
Cell and Molecular Biology	54Hrs	27Hrs
Genetics	54Hrs	36Hrs
TOTAL	**108Hrs**	**63Hrs**

Aim and Objectives of the Course

- To develop an understanding on the concepts, theories and phenomenon on Cell and Molecular Biology
- To get an expertise on the techniques in Cell and Molecular Biology
- To develop a concise idea on the theories and mechanisms of heredity and variation

CELL AND MOLECULAR BIOLOGY(3 hrs/wk)

- A brief account on the structural and functional organization of the cell and cell organelles. Prokaryotic and eukaryotic cells.Cytoskeleton- its role in cell organization and mobility. (5hrs)
- Ultra structure of the cell membrane, nuclear envelope, nuclear pore complex,chloroplast, mitochondrion, Endoplasmic reticulum, lysosomes and ribosomes. Nucleus – structural and functional organization. Mitochondrial and Chloroplast genome organization and function. Nucleolus – origin, ultra structure and function. (9hrs)
- Chemistry of chromosomes – DNA – organization, histone and non-histone proteins, RNA and organization of these in the three dimensional configuration of the chromosome. A study on thestructure and function of the kinetochore –NOR and other secondary constrictions, satellites, heterochromatic segments and telomeres. (7hrs)
- Cell Death and Cell renewal (4 hrs)
- Cell Divisions. Stages in cell cycle – G1, S, G2 – Interphase, Prophase, Metaphase, anaphase and Telophase.Mitotic apparatus.Cytokinesis. Meiosis – General description. Synaptonemal complex, structure and function with significance of the various stages of meiosis I and II. Theories and mechanisms of crossing over. Molecular mechanism of crossing over. (7hrs)
- Cell differentiation - General characteristics, molecular mechanism of cell differentiation. (3 hrs)

- Cellular communication-regulation of hematopoiesis, general principles of cell communication, cell adhesion and role of different adhesion molecules, gap junctions, extracellular matrix, intergrins, cadherins, selectins, Hb superfamily. (6hrs)
- Cell signaling- Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and two component systems, light signaling in plants, bacterial chemotaxis and quorum sensing (7 hrs)
- Cancer- genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and cell cycle, virus induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth. Carcinogens (physical, biological and chemical) (6 hrs)

Practical (1.5hrs/wk)

- Mitosis – All stages - *Allium cepa*, *Viciafaba* ; Calculation of Mitotic Index
- Meiosis – All stages - *Rhoeo, Chlorophytum, Crotalaria, Datura*(at least two should be recorded)
- Isolation and purification of genomic DNA.
- Isolation of total RNA (Demonstration only)

References

- De Robertis and De Robertis(1998) Cell and Molecular Biology. B. I. Waverly Pvt Ltd. New Delhi.
- J.D. Watson et. al., (2014) Molecular biology of the gene. 7th Edn. Cold Spring Harbor Laboratory, Tania, MIT
- Janet Iwasa and Wallace Marshall (2017) KARP'S Cell And Molecular Biology John Wiley & Sons, Inc.
- Harvey Lodish et.al. (2016) Molecular Cell Biology 8th Edn. W. H. Freeman and Company
- Jurgen Schulz-Scaffer (1985) Cytogenetics- Plants Animals and Humans. Springer Verlag, Berlin.
- Cooper G. M(1997) The Cell – A Molecular approach. ASM Press, Washington.
- Jocelyn E. Krebs, E. S. Goldstein & S. T. Kilpatrick (2018) LEWIN'S GENES XII Jones & Bartlett Learning.

- Bruce Alberts et.al., (2015) Molecular Biology of the Cell 6th Edn. Garland Science, Taylor & Francis Group, LLC,

GENETICS (3 h/week)

I. Classical genetics

- Mendelian Genetics – Critical Evaluation (2 hrs)
- Sex determination, Dosage compensation, Barr body, Lyon's hypothesis. (2 hrs)
- Linkage, recombination and linkage maps – Bateson's concept of coupling and repulsion. Morgan's concept of linkage, linear arrangement of genes, linkage groups, complete and partial linkage and recombination linkage maps, three point test crosses, interference coefficient of coincidence and negative interference. (4 hrs)
- Microbial Genetics – Genetic recombination in viruses – lysogenic and lytic cycles in bacteriophages. Benzer'sexperiment in the rII locus of T4 phage, retro viruses, reversetranscriptase, onco viruses, and oncogenes. Bacterial recombination - transformation experiment of Griffith, Avery *et al.* Conjugation – F+, F- and Hfr F- conjugations. Conjugation mapping – F–duction (sexduction). Transduction - generalized and specialized. Recombination in fungi (tetrad analysis in *Neurospora*). Complementation tests.(6 hrs)
- Biochemical Genetics – Contributions of Garrod, Beadle and Ephrussi, Beadle and Tatum. (1 hr)
- Gene concept – Factor concept of Mendel, Presence absence theory of Bateson. Gene –Enzyme relationship, One gene - One enzyme hypothesis. Benzer's concepts of Cistron, muton and recon.Brief description of the following types of genes- smart genes (luxury genes),housekeeping genes, transposons overlapping genes, split genes, homeotic genes, pseudogenes, orphan genes, selfish genes, gene cluster, gene families. (3 hrs)

II Molecular Genetics

- DNA as the genetic material, DNA constancy, C - Value paradox, structure of B-DNA, A-DNA, RL-Helix and Z – DNA. (2hrs)
- DNA replication – Stage, unit and mode of replication, Semi conservative mode of replication.Messelson – Stahl experiment. System of replication – template, deoxy nucleotide triphosphate pool, enzymes and protein factors. Mechanism of replication, unidirectional and bidirectional replication. Molecular assembly at

the replication fork, leading and lagging strands, Okasakifragments. DNA polymerases of prokaryotes and eukaryotes, topoisomerases, gyrases, ligases and nucleases. DNA polymerase function, proof reading and repair. Comparison of eukaryotic and prokaryotic DNA replication. Replication of ØX174 DNA. (6 hrs)

- DNA damage and repair- Photoreactivation repair, excision repair, recombinational repair, SOS repair. Genetic diseases caused by defects of DNA repair system – Blooms syndrome, Xerodermapigmentosum, Retinoblastoma. (2 hrs)
- Mutation – Types of mutations, methods of detection (CIB method, attached X method). Molecular mechanism of spontaneous and induced mutations, site directed mutagenesis. Environmental mutagenesis and toxicity testing, high radiation belts of Kerala. Mutagenic effects of food additives and drugs. Ames test. (4 hrs)
- Genetic code – Genetic code word dictionary. Features of the genetic code and its exceptions. (2 hrs)
- Protein synthesis - Central dogma, Transcription, organization of transcriptional units. Prokaryotic and eukaryotic RNA polymerases and their function. RNA processing and translation. (2 hrs)
- Gene Regulation – Gene Regulation in viruses - Cascade model of expression of early middle and late genes in viruses. Gene Regulation in Prokaryotes – Operon concept, positive and negative control attenuation, anti termination. Gene Regulation in Eukaryotes – Heterochromatinisation and DNA methylation- DNA methylases, DNA rearrangements.Transcriptional regulation – signal transduction - upstream and downstream.Regulatory sequences and transacting factors, activators and enhancers.DNA binding by transcription factors. Britten and Davidson model for eukaryotic gene regulation. Post transcriptional regulation – RNA processing – split genes, hn RNA, introns and exons, capping, polyadenylation, splicing, snRNAs and spliceosomes. Post transcriptional silencing, MicroRNAs, RNA inhibition. Translational regulation and Post Translational regulation –Cleavage and processing of proteins.Genetic imprinting. Environmental regulation of gene expression. (8 hrs)
- 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

- Population genetics – Systems of mating and their genetic effects. Hardy Weinberg law and itsapplications. Factors affecting gene frequencies – mutation, migration, selection, genetic polymorphism and selection. Genetic drift, founder effect, genetic load. Consanguinity and its genetic effect. (4hrs)
- Developmental genetics- Genetic control of development in plants and animals with stress to developmental genes in *Arabidopsis* and *Drosophila.* Role of cytoplasm in development. (2 hrs)
- Principles of Human Genetics: Consanguinity and its genetic effects, human karyotype, pedigree analysis and gene disorders (2 hrs)

Practicals36hrs (2.0hrs/wk)

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

References

- Goodenough U (1984) Genetics. Holt Saunders, New York.
- Karp G (2013) Cell and Molecular Biology: Concepts and experiments. Willey & Sons.
- Lewin B (2000) Genes VII. Oxford University Press, New York.
- Lodish*et al.*(2000) Molecular and Cell Biology. W. H. Freeman and Co, New York.
- Snustad, P.D. and Simmons M.J. (2012) Principles of genetics 6thEdn. John Wiley & Sons, Inc.
- Benjamin A. Pierce (2012) Genetics. A Conceptual Approach 4thEdn. W. H. Freeman and Company
- William S. Klug, Michael R. Cummings, Charlotte A. Spencer and Michael A. Palladino (2012) Concepts of genetics. Pearson Education, Inc.
- Peter J. Russell (2010) iGenetics : a molecular approach. 3rdEdn. Pearson Education, Inc.
- Monroe W. Strickberger(2008) Genetics 3rd Edition 3rd EditionPearson Education India.

- Strickberger M. W (1985) Genetics. Macmillian India, New Delhi.
- Gardner, Simmons MJ &Snustad DP (2006) Principles of Genetics, John Willey & Sons.

Course Outcome
• Help to broaden the understanding on cellular and molecular aspects of of life

SEMESTER III

19PBO31

ANGIOSPERM SYSTEMATICS,ECONOMIC BOTANY, ETHNOBOTANY AND EVOLUTION

Distribution of Hours	Theory	Practical
Angiosperm Systematics	72Hrs	36Hrs
Economic Botany	09Hrs	09Hrs
Ethnobotany	09 Hrs	00 Hrs
Evolution	18 Hrs	00 Hrs
TOTAL	**108Hrs**	**45Hrs**

Aim and Objectives of the Course

- To explore the diversity of Angiosperms
- To identify the principles and theories of Angiosperm Systematics
- To get skill and expertise in identifying the angiosperms up to species level
- To get an understanding on the economically significant angiosperms
- To develop an understanding on the ethnobotanically significant plants and also to develop an interest on knowing more about the ethnic people
- To have an understanding on the concepts and theories of evolution

TAXONOMY OF ANGIOSPERMS (4 hrs/wk)

- Principles of taxonomy as applied to the systematics and classification of Angiosperms - species concept, taxonomic structure. (2 hrs)
- Phylogenetic System of Classification: Bessey and Takhtajan Systems of Classification (Brief Account only); Angiosperm Phylogeny Group (APG) classification system (Detailed Account). . (6 hrs)
- Plant nomenclature, Evolution of ICBN, contents of ICBN, author citation, type concept and different types – publication of names, rule of priority, nominaconservanda and definition of nomenclature terms- autonym, homonym, basionym, tautonym and nomennudum. (3 hrs)
- History and development of taxonomy in India. Classification of taxonomical literature, general indices, floras, icons, monographs, reviews and journals; Herbarium – definition, steps involved in the development of herbarium, utility of herbarium and their maintenance, general account of National and regional herbaria

with special reference to Central National Herbaria, Calcutta (CAL) and Madras Herbarium (MH), Botanical Survey of India, Botanical gardens and importance of botanical garden in taxonomic studies, important National and International Botanical gardens, Royal Botanical Garden, Kew, Indian Botanical Garden, Calcutta, National Botanic Research Institute, Lucknow and Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Trivandrum. (4 hrs)

- Construction of taxonomic keys (indented and bracketed) and its utilization. (2 hrs)
- Role and organization of Botanical Survey of India. (1 hr)
- Modern concepts and trends in plant taxonomy. Elementary treatment of: (i) Cytotaxonomy (ii) Chemotaxonomy (iii) Numerical taxonomy (taximetrics) (iv) Molecular taxonomy- DNA Bar Coding (v) Biosystematics. (5 hrs)
- Critical study of the current ideas on the origin of angiosperms with special reference to their ancestral stock, time and place of origin. (2 hrs)
- Study of the following angiosperm families giving importance to morphological peculiarities if any (Special emphasis should be given on morphological and phylogenetic interrelationships, recent revisions and rearrangements between and within the families, and its critical analysis): (47 hrs)

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

Practicals (2 hrs/wk)

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

References

- Ambasta SP (1986) The useful plants of India, Publication and Information Directorate, CSIR, New Delhi.
- APG I (1998) An ordinal classification for the families of flowering plants. Ann. Missouri Bot. Gard. 85: 531-553.
- APG II (2003) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Bot. J. Linnean Soc. 141: 399-436.
- APG III (2009) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. Bot. J. Linnean Soc. 161: 105-121.
- APG IV (2016) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. Bot. J. Linnean Soc. 181: 1-20.
- Judd WS, Campbell CS, Kellog EA & Stevens PF (1999), Plant Systematics.Sinauer Associates, Inc., Massachusetts, USA.
- Lawrence GHM (1964) Taxonomy of Vascular Plants, Mac Millon Co., New York.
- Rendle AB (1967) Classification of flowering plants, Cambridge University Press.

- Sharma OP (1990) Plant Taxonomy, Oxford Publishers, New Delhi.
- Singh G. (1999) Plant systematics: Theory and Practice, Oxford IBH.
- Davis PH & Heywood (1963), Principles of Angiosperm Taxonomy, Oliver-Boyd.
- Gamble JS (1935), Flora of Presidency of Madras, London.
- Gibbs RD, Chemotaxonomy of flowering plants.
- Hooker JD (1879), Flora of British India. Reeve &Co., London.
- Hutchinson J (1959) Families of flowering plants, Cambridge University Press.
- Sivarajan VV (1991) An introduction to Principles of Taxonomy, Cambridge University Press, London.
- Sivarajan VV (1999) Principles of plat Taxonomy, Oxford and IBH Publishing Co.
- Stace C (1985) Plant Taxonomy and Biosystematics, London.
- Takhtajan AL (1969) Flowering plants. Origin and Dispersal, Oliver and Boyed.

ECONOMIC BOTANY (0.5 hr/wk)

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

  a) Cereals and Millets : Rice, Maize.
  b) Pulses : Soya bean, Winged bean and Sword bean
  c) Sugar yielding plants : Sugarcane and Sugar beet
  d) Beverage crops : Coconut, Cocoa, Coffee and Tea
  e) Spices and condiments: Pepper, Ginger, Turmeric, Cardamom and Nutmeg
  f) Tuber crops- : Potato, Sweet potato and Tapioca
  g) Fruits : Mango, Banana, Citrus, Guava, Grapes and Cashew nut
  h) Vegetables : Tomato, Brinjal, Cucumber, Cabbage, Drum stick and Bitter gourd
  i) Medicinal plants : *Rauvolfiaserpentina, Justicia adhathoda, Aristolochiaindia, Phyllanthusamarus.*
  j) Underutilized plants : Jatropha, Clove Bean
  k) Timber yielding plants: Rose wood, Teak Wood

Practicals (0.5 hr/wk)

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

References

- Pandey A et al. (2005) Wild relatives of Crops plants in India-collection and conservation, NBPGR Sci. Monograph No. 7.
- Ambasta SP (1986) The useful plants of India, Publication and Information Directorate, CSIR, New Delhi.
- Kochar LS (1981) Economic Botany in the Tropics, Macmillan.
- Hill AF (1952) Economic Botany, Tata McGraw Hill.
- Sen S (1992) Economic Botany, New Central Book Agency, Calcutta.
- Arora PK and Nayar EK. Wild relatives of Crops plants in India, NBPGR Sci. Monograph No. 7

ETHNOBOTANY (0.5 hr/wk)

- Plants and civilization
- Ethnobotany- relevance in Modern medicine
- Ethnic societies of Kerala and their traditional herbs
- Ethnobotanical documentation
- Medicines derived from herbal drugs
- Status of ethnobotanical studies in Kerala

References

- Jain SK (1987) A manual of Ethnobotany, Indus Intl. Publishers, New Delhi.
- Jain SK (2001) Medicinal Plants, National Book Trust, India
- Wood M (1997) The book of herbal wisdom: using plants as medicines, North Atlantic Books, California.
- Cunnigham A (2001) Applied Ethnobotany: people, wild plant use and conservation, Earthscan, UK.
- Martin GJ (2004) Ethnobotany: a methods manual, Earthscan, UK
- Jain SK &d Mudgal V (1999) A hand book of Ethnobotany. Indus Inst. Publishers, New Delhi.

EVOLUTION(1 h/wk)

- Origin and evolution of life-Introduction (including aspects of pre-biotic and molecular evolution) (2 hrs)

- Concepts and theories of evolution:Inheritance of acquired characters, Germplasm theory, Theory of Natural selection, Mutation theory, Modern theory of synthesis. (4 hrs)
- Forces of evolution: Mutation, gene flow, genetic drift, natural selection (3 hrs)
- Speciation: Allopatric, peripatric, parapatric and sympatric speciations; Reinforcement, ecological speciation, artificial speciation, speciation via polyploidization, hybrid speciation, speciation through gene transposition (3 hrs)
- Isolation mechanisms: Pre-zygotic isolation- Temporal/habitat isolation, behavioral isolation, mechanical isolation, gametic isolation; Post-zygotic isolation-zygote mortality, hybrid sterility, (2 hrs)
- Evolution above species level. (2 hrs)
- Molecular evolution: Genome architecture- genome size, repetitive elements, chromosome number and organization, gene content and distribution, organelle DNA; Origin of new genes- gene duplication, retrotransposition, chimeric genes; Molecular phylogenetics- nucleic acid level and protein level. (2 hrs)

References:

- Strickberger MW (1996) Evolution, Jones and Bartlett Publishers, New York
- Savage JM (1969) Evolution, Oxford &IBH, New Delhi.
- Sproule A (1998) Charles Darwin: Scientist who have changed the world. Orient Longman, New Delhi.
- Bergstrom CT &Dugatkin L.A (2011) Evolution, WW Norton & Co, New YorkJon C.
- Herron, Scott Freeman, Jason Hodin, Brooks Miner and Christian Sidor(2014) Evolutionary Analysis. 5thEdn.Pearson Education, Inc.
- James A. Shapiro (2011) Evolution A View from the 21st Century. Publishing as FT Press Science
- Blackle (1983) Evolutionary principles, Oxford & IBH, New Delhi.
- Briggs D & Walters SM (1984), Plant variation and evolution, Cambridge University Press, London.
- Echrlich& Holm (1974) Process of evolution, Oxford &IBH, New Delhi.
- Wooley P (1983) Molecular theory of evolution, Springer-Verlag, Berlin.

- Graur, D. & Li, W.-H. (2000). Fundamentals of molecular evolution. Sinauer. ISBN 0-87893-266-6

Course Outcome

- Develops an idea on angiosperm diversity, and develops a skill to identify and classify angiosperms
- Gets an understanding on economically and ethnobotanically significant plants
- Concieve the theories and mechanism of evolution

19PBO32
BIOPHYSICS & BIOINFORMATICS

Distribution of Hours	Theory	Practical
Biophysics	27Hrs	09Hrs
Bioinformatics	81Hrs	27Hrs
TOTAL	**108Hrs**	**36Hrs**

Aim and Objectives of the Course

- To characterize the basic biophysicsal principles and theories
- To get an understanding on the basic instruments and techniques in biological research
- To get skill and expertise in basic biochemical procedures
- To get an understanding on the role of information technology in solving biological problems
- To develop skill and expertise in bioinformtic tools and techniques

BIOPHYSICS (1.5 hrs/wk)

- Chemical bonds: Ionic bond, Covalent bond, Vander Vaal's forces, hydrogen bonding and hydrophobic interactions.Bonding in organic molecules. Effect of bonding on reactivity.Polarity of bonds. Bondlength.Bond angle, Dissociation and association constant. (3 hrs)
- Bioenergetics: Concepts of free energy, Thermodynamic principles in Biology. Energy rich bonds.Coupled reactions and group transfers. Biological energy transducers. (4 hrs)
- Microscopy: Principles and applications of bright field, phase contrast, fluorescence, confocal microscopy, TEM, SEM, cytophotometry, flow cytometry. (3 hrs)
- Chromatography: Principle and applications of gel filtration, Ion exchange and affinity chromatography, thin layer chromatography, gas chromatography, HPLC, HPTLC,LCMS, GCMS. (4 hrs)
- Electrophoresis: Types of electrophoresis-Vertical and horizontal, paper electrophoresis, capillary electrophoresis, 2D gel electrophoresis, Pulsed field gel electrophoresis, Electro focusing. (3 hrs)
- Sedimentation and filtration:Sedimentation, centrifugation, ultra centrifugation, ultrafiltration (3 hrs)
- Principles of biophysical methods used for analysis of biopolymers: UV, visible, IR,NMRX-ray diffraction, fluorescence, ORD/CD (4 hrs)

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

Practicals(0.5 hr/wk)

- Separation of leaf pigments by column chromatography
- Separation of amino acids by paper chromatography
- Separation of alkaloids, phenols and pigments by TLC
- 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.

References

- Daniel M (1999) Basic Biophysics for Biologists. Agro Botanica, Bikaner.
- David Sheehan (2009) Physical Biochemistry- Principles and Applications. Wiley-Blackwell.
- Ian Campbell (2012) Biophysical techniques.Cambridge University Press.
- Elizabeth M.Slayter and Henry S, Slayter(1992)Light and Electron microscopy. Cambridge University Press.
- Narayanan P (2000) Essentials of Biophysics. New Age International Publishers, New Delhi.
- Roy RN(1999) A Text Book of Biophysics. New Central Book Agency (P) Ltd., Calcutta.
- Prakash S. Bisen and Anjana Sharma (2012) Introduction to instrumentation in life sciences. CRC Press.
- Upadhyay & Nath (2009) Biophysical Chemistry –Principles and Techniques. Himalaya Publishing House.
- Keith Wilson & John Walker (2010) Principles and techniques of Biochemistry and Molecular Biology. Cambridge University Press.

BIOINFORMATICS (4.5 hrs/wk)

- Introduction to Bioinformatics: History of Bioinformatics. Basics of Internet, Computational Biology and Bioinformatics. Use of Linux and Bio-PERL in Bioinformatics (10 hrs)
- Biological databases- Types of data and databases, DBMS. Classification of biological databases- primary and secondary, biomolecular, model organism and biodiversity databases. Nucleotide sequence database (EMBL, GENBANK, DDBJ)- Protein

sequence database (PIR, SWISS-PROT, TrEMBEL), Secondary Databases (PROSITE, PRINTS, BLOCKS), Protein Structure Database (PDB) Information retrieval from databases - search concepts, Tools for searching, Homologysearching. (18 hrs)

- Structural Bioinformatics – Molecular visualization using Rasmol, Protein Structure Prediction - Secondary Structure prediction, Ramachandran plot, Bioinformatics tools for secondary structure prediction and Tertiary structure prediction (Comparative modeling, *Ab Initio* prediction, Homology modeling). (8 hrs)
- Sequence Analysis - Global and Local Alignment, pairwise analysis, ScoringMatrices (an introduction), Multiple Sequence Analysis.Tools used in Bioinformatics - BLAST, ClustalX, ClustalW. (10 hrs)
- Molecular Phylogeny - Gene and Species tree. Molecular evolution and Kimuras theory, Phylogenetic Trees, Terminology in Phylogenetic tree. Cladogram and Phylogram, Significance of Molecular Phylogeny.Software used in Phylogeny- Treeview, Phylip. (10 hrs)
- Computer Aided Drug Design and Molecular Docking, Brief study about Docking tools, AutoDock, GOLD (6 hrs)
- Genomics - Types (Structural and Functional), Genome Annotation, Gene Finding, Comparative genomics, Single nucleotide Polymorphism Gen-SNIP. (8 hrs)
- Proteomics - Protein expression analysis, Mass spectrometry in protein identification, Expasy tools, Protein Sorting, Metabolomics, Systems Biology-an introduction (6 hrs)
- Applications of Bioinformatics- Transcriptomics, Metabolomics, Pharmacogenomics, combinational synthesis (Brief Accounts) (5 hrs)

Practicals (1.5 hrs/wk)

- Blast search with Protein Sequence (*Magnolia latahensis*sequence)
- Blast search with Nucleic Acid Sequence (Neanderthal man's Palaeo DNA)
- Phylogenetic tree creation with CLUSTAL X, W and MUSCLE
- Identify a gene and construct a phylogenetic tree for selected families of eudicots
- Molecular docking (using either Free or commercial Software)

References

- Lesk AM (2002) Introduction to Bioinformatics, 1st Edition, Oxford University Press, Oxford, UK.
- JinXiong (2007) Essential Bioinformatics, Cambridge University Press India, Pvt LTD
- Higgs (2005) Bioinformatics and Molecular Evolution, Ane Books India Pvt LTD.
- Claverie JM &Notredame C (2003) Bioinformatics for Dummies. Wiley Editor. Vyas, S.P. and Kohli, D.V., Methods in Biotechnology and Bioengineering.
- Patterson BK (2000) Techniques in Quantification and Localization of Gene Expression.
- Mount DW (2004) Bioinformatics-Sequence and Genome Analysis, 1st Edition, Cold Spring Harbor Laboratory Press, New York, USA.
- Evens WJ. & Grant GR (2005) Statistical Methods in Bioinformatics: An Introduction.
- Liu BH (1997) Statistical Genomics: Linkage Mapping and QTL Analysis
- Pierre Baldi& Soren Brunak (2001) Bioinformatics: The Machine Learning Approach. MIT Press.

Course Outcome

- Understand the basic principles of the instruments used in biology and develops skill for basic bioinformatic analyses of nucleic acid and protein sequences

19PBO33
RESEARCH METHODOLOGY, BIOSTATISTICS & PLANT BIOTECHNOLOGY

Distribution of Hours	Theory	Practical
Research Methodology	18Hrs	00Hrs
Biostatistics	27Hrs	09Hrs
Plant Biotechnology	73 Hrs	36 Hrs
TOTAL	**108Hrs**	**45Hrs**

Aim and Objectives of the Course

- To identify the basic strategy for undertaking scientific research
- To familiarise the different phases of scientific research
- To develop skills and expertise in conducting scientific research
- To develop an understanding on the different statistical tools and principles in analysing data generated while doing scientific research
- To identify the different promising areas of Plant Biotechnology
- To develop skill and expertise in performing biotechnological procedures

RESEARCH METHODOLOGY- (1 hr/wk)

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

References

- Marder MP (2011) Research Methodology, Cambridge University Press, UK.
- Wilson BE Jr. (1990)An introduction to Scientific Research, Dover Publications, New York.
- Kothari C.R & Garg G (2013) Research Methodology; Methods and Techniques. New Age International Publishers, New Delhi.
- Ahuja R. (2001) Research Methods. Rawat Publications, Jaipur.

- Basten G. (2010) Introduction to Scientific Research Projects. (available free @ bookboon.com)
- N. Gurumani (2009) Research Methodology: for Biological Sciences.MJP Publishers, New Delhi
-

BIOSTATISTICS- (1.5 hrs/wk)

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

Practicals (0.5 h/wk)

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

References

- Attwood TK & Parry-Smith DJ (2004) Introduction to Bioinformatics, Pearson Education (Singapore) Pvt. Ltd.
- David Edwards (Ed.) (2007) Plant Bioinformatics: Methods and Protocols, Humana Press, New Jersey, USA.
- Pagano M, Gauvreau K (2007) Principles of Biostatistics. Thomson India Edition, New Delhi.
- Rex A. Dwyer (2004) Genomic Perl: From Bioinformatics Basics to Working Code,Cambridge University Press, 1st South Asian Edition.
- Rosenkrantz WA (2009). Introduction to Probability and Statistics for Science, Engineering
- Norman T. J. Bailey (2012) Statistical methods in Biology,

Cambridge University Press)

PLANT BIOTECHNOLOGY (3.5 hrs/wk)

- Definition. Impact of biotechnology - an overview. (2 hrs)
- 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)
- Somatic cell genetics and somaclonal variations. (3 hrs)
- Somatic embryogenesis. Artificial seeds.Applications. Protoplast culture, Somatic hybridization and its impact on plant breeding. Use of protoplasts in genetic transformations. (7 hrs)
- Haploid production: anther and ovule culture. Dihaploids and polyhaploids.Applications. (5 hrs)
- Conservation of germplasm: in vitro strategies, cryopreservation and international exchange of germplasm. (5 hrs)
- Genomic and organellar DNA isolation. Methods of gene identification. Vector mediated and vectorless methods. Polymerase chain reaction (PCR). Restriction digestion and ligation; Restriction mapping.Genomic and cDNA libraries. (10 hrs)
- Methods of gene transfer in plants. Agrobacterium and CaMV mediated gene transfer; direct gene transfer using PEG, microinjection, electroporation, microprojectile (biolistics), liposmemediated DNA delivery, protoplast transformation, plastid transformation, Transposons as vectors. Use of mixed vectors,binary vectors, Transient and stable gene expression in transgenic plants. (8 hrs)
- Analysis and expression of cloned genes. detection of transgene, identification of integration site, determination of copy number, inheritance of transgene.DNA markers; Restriction fragmentlength polymorphism (RFLP), Random amplified polymorphic DNA (RAPD). Amplified Fragment Length Polymorphism (AFLP), Ligase Chain Reaction (LCR), Antisense RNA. (5 hrs)
- Technique of DNA Analysis: Preparation of DNA and RNA Probes; Principles of hybridizations and hybridization based techniques (Colony& Plaque); Autoradiography;.DNA Fingerprinting (4 hrs)
- DNA sequencing, chemical synthesis of nucleotides (2 hrs)

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

Practicals (2hrs/wk)

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

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- Griffiths el al. (1999) Modern Genetic Analysis. W.H. Freeman & Co. New York.
- Gupta PK (1999) Elements of Biotechnology. Rastogi Publications, Meerut.

Course Outcome
• Students will be benefitted to tackle research problems and develop skill to write research proposals • Students will acquire hands on experience in plant tissue and organ culture

SEMESTER IV

19PBO41
Special Paper I
PLANT PHYSIOLOGY & BIOCHEMISTRY

Distribution of Hours	Theory	Practical
Plant Physiology	45Hrs	36Hrs
Biochemistry	54Hrs	18Hrs
Enzymology	45Hrs	18 Hrs
TOTAL	**144Hrs**	**72Hrs**

Aim and Objectives of the Course

- To identify the theories and principles of Plant Physiology
- To familiarise the different physiological processes
- To develop skills and expertise in conducting experiments in Plant Physiology, Biochemistry and Enzymology
- To develop an understanding on the chemistry behind the inception and diversification of plant life
- To identify the complex mechanism of enzyme action

PLANT PHYSIOLOGY (2.5 hrs/wk)

- 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: C3, C4 and CAM pathways. Energetics of CO_2 fixation. (8 hrs)
- Photorespiration and glycolate metabolism. Mechanism of photorespiration in C3 and C4 plants.Factors regulating photorespiration. (4 hrs)
- Transport of metabolites – Xylem and Phloem sap translocation – current trends. (4 hrs)
- Respiration. Anaerobic, aerobic. Glycolysis, TCA cycle, ETS and ATP synthesis, transporters involved in exchange of substrate of products, Pentose phosphate pathway (6 hrs).
- Photoregulation and growth responses. Growth regulators (Auxins, Cytokinins, Giberellins, Ethylene, Abscisic acid (ABA), Brassinosteriods) and their mode of action. Plant morphogenesis.

Physiology of flowering, fruit ripening senescence and abscission, Vernalisation. (5 hrs)

- Seed metabolism, Hydration Phase of germination, Inter relationship between growing seedlingand the storage tissues, glyoxylate cycle in fatty seeds during germination. (5 hrs)
- Physiological response of plants to stresses like drought, heat and cold. Salt tolerance in plants. (5 hrs)
- Role of phytoalexins. Defence mechanism. Phenyl propanoid pathway in plants. (2 hrs)
- Tree Physiology – Leaf canopies, Radiation environment, Effect of irradiance in plants; Tree and water relations. (4 hrs)
- Allelopathy – Plant derived compounds. (2 hrs)

Practicals (2 hrs/wk)

- Extraction and estimation of total proteins by TCA precipitation and Lowrys method.
- Isolation of chloroplast from fresh leaves and estimation of chlorophyll proteins.
- Chlorophyll survey of five plants. Quantification, absorption spectra of chlorophyll and carotenoids using different solvents.
- Hill activity by DCPIP/ ferricyanide reduction.
- Extraction and estimation of total phenols.
- Physiological identification of CAM in plant species.

References

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- William G Hopkins (2002) Introduction to Plant Physiology. John Wiley &Sons.Inc. New York.
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PLANT BIOCHEMISTRY (3 hrs/wk)

- Biochemical organization of the cell. (7hrs)
- Metabolism and biochemical energetics. (8 hrs)
- Intermediary metabolism (8 hrs)
    - Carbohydrate Metabolism: Photosynthesis; Glycolysis; Lactic acid fermentation; Citric Acid Cycle; Conversion of glucose to sucrose; HMP Shunt
    - Lipid Metabolism: Glycerol synthesis; Fatty acid synthesis; Esterification of glycerol and fatty acids; Hydrolysis of triglycerides; Oxidation of glycerol; Oxidation of fatty acids.
    - Amino acid Metabolism: Reductive amination and Trans amination.
- Primary metabolic pathways and their inter relationships (8 hrs)
    - Carbon assimilation pathways
    - Carbon storage pathways
    - Biosynthesis of disaaccharides

- Non photosynthetic energy generation pathways
- Polysaaccharides biosynthetic pathways
- Nitrogen assimilation

- Secondary metabolism (8 hrs)
  - Isoprenoid compounds: Mevalonic Acid Pathway; MEP Pathway
  - Phenolics: Malonic Acid Pathway
  - Nitrogen Containing Pathway: Shikimic Acid Pathway; Biosynthesis of alkaloids and cyanogenic glycosides
- Protein structure, purification andcharacterization. (8 hrs)
- Biomolecular interactions – general account (7 hrs)

Practicals (1 hr/wk)

- Preparation of buffers
- Preparation of standard solutions of BSA, Glucose, Catechol
- Extraction and estimation of soluble proteins by Bradford method
- Estimation of reducing sugars
- Estimation of free fatty acids

ENZYMOLOGY (2.5 hrs/wk)

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

Practicals (1 hr/wk)

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

References

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Course Outcome

- Understands the mechnism of plant growth and development and develops skill to execute basic tests to identify and characterize biological molecules

19PBO42
Special Paper II
ADVANCED BIOTECHNOLOGY

Distribution of Hours	Theory	Practical
Biotechnology	144Hrs	54Hrs
TOTAL	**144Hrs**	**54Hrs**

Aim and Objectives of the Course

- To identify the advanced and promising branches of Biotechnology
- To familiarise the principles and techniques in Biotechnology
- To develop skills and expertise in conducting experiments in Advanced Biotechnology
- To develop an understanding on the basic principles of Nanotechnology

BASICS OF BIOTECHNOLOGY (20 hrs)

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

PLANT TISSUE CULTURE (19 hrs)

- Suspension culture and development – methodology, kinetics of growth and production formation, elicitation methods, hairy root culture
- Protoplast culture – isolation , fusion, generation of hybrids, cybrids,preferential elimination of chromosomes, role in cytoplasmic male sterility and genetic transformation.
- Exploitation of somaclonal and gametoclonal variations for plant improvement

MICROBIAL GENETICS AND TECHNOLOGY (20 hrs)

- Replication, regulation of bacterial gene expression
- Mutations, genetic transfer, manipulation of gene expression in prokaryotes

- Microbial production of amino acids, antibiotics, microbial enzymes, organic Acids.
- Methods for laboratory fermentations, isolation of fermentation products, Elementary principles of microbial reaction engineering
- Microbial culture selection, fermented foods,probiotics.

GENETIC ENGINEERING (40hrs)

- Generation of Foreign DNA molecules, cutting and joining of DNA molecules – linkers, adapters, homopolymers.
- Gene isolation, gene cloning, cDNA and genomic DNA library, expression of cloned genes.
- Transposons and gene targeting
- DNAsynthesis techniques-Oligonucleotide synthesis methods, DNA labeling, Polymerase Chain Reactions (PCR), DNA sequencing,, DNA finger printing.
- Blotting techniques-Southern, Western and Northern blotting,Dot blots, in situ hybridization
- Molecular marker techniques – RFLP, RAPD, AFLP, SCAR, STR, SSR
- Site directed mutagenesis
- Techniques for gene expression analysis: reverse transcription PCR, Microarrays, Real Time PCR, Next generation sequencing, 2-D gel electrophoresis.
- Expression systems:Constitutive and inducible expression systems,transactivationsystems of plants, mGAL4-UAS/VP16-system, GVG/dex system, tTA/Top10/pTAx /Tet-ON/OFF systems.
- Mutagenesis: Mutagens, methods of treatment. T-DNA/transposon mutagenesis, selection of mutants from random library, promoter/enhancer trap, gene-trap constructs
- Genome editing:Zinc finger nuclease, TALEN, CRISPR technology, selection and application.

TRANSGENIC ORGANISMS (20 hrs)

- Microbes – production of pharmaceuticals (somatostatin, humulin, interferons). Genetically modified microbes – biodegradation, biopesticides, bioremediation, mineral leaching andbiofertilizers.
- Plants – insect resistance (Bt), virus resistance-coat protein, satellites, herbicide resistance, fungal resistance, draught, salinity and temperature. Increasing shelf life of foods – flavrsavr tomatoes,

control of seed germination, genetically modified organisms and foods.

- Animals – production of vaccine and pharmaceuticals, hybridomas, monoclonal antibodies.
- Transgenic organisms, Social and ethical issues, IPR, Patents and Biopiracy

PROCESS BIOTECHNOLOGY (20 hrs)

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

NANO BIOTECHNOLOGY (5 hrs)

- History and scope of nano-technology
- Properties of nanomataerials
- Nano-materials in diagnosis, and treatment
- Nano-materials in agriculture

Practicals (3.0 hrs/wk)

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

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Course Outcome

- Will get a detailed undertanding on gene transfer technologies, industrial biotechnology and an emerging field of nano science and technology