INSTITUTE OF SCIENCE, NAGPUR.

(An Autonomous Institute of Government of Maharashtra)

DEPARTMENT OF BOTANY

Syllabus
Master of Science (M.Sc.) Semester Pattern
Botany
(BOT/ PG/2021/01)

Approved by BoS 17/12/21 Page 1-84

Head, Department of Botany
Institute of Science, Nagpur-440001

(To be Implemented from 2021-2022)

A. M. Rahatgaonkar

APPENDIX – 1

Scheme of teaching under choice based credit system for M. Sc. Program in Botany.

S. No.	Semester	Course Code / Paper	Title of the Paper	Course /Paper	Teaching Scheme		
					Theory (Hours)	Practical (Hours)	Number of Credits
1	One	**MBFS11**	Microbiology, Algae and Fungi	I	04	04	04
2	One	**MBFS12**	Bryophytes & Pteridophytes	II	04	04	04
3	One	**MBFS13**	Paleobotany and Gymnosperms	III	04	04	04
4	One	**MBFS14**	Cytology and Genetics	IV	04	04	04
5	One	**MBFS15**	Algae, fungi, Bryophytes	Pract. I	-	-	04
6	One	**MBFS16**	Pteridophytes, Gymnosperms, Paleobotany, Cytology & Genetics	Pract. II	-	-	04
7	One	**MBFS17**	Seminar				01
8	Two	**MBFS21**	Plant Physiology and Biochemistry	I	04	04	04
9	Two	**MBFS22**	Plant Development and Reproduction	II	04	04	04
10	Two	**MBFS23**	Cell and Molecular Biology-I	III	04	04	04
11	Two	**MBFS24**	Angiosperms-I and Ethnobotany	IV	04	04	04
12	Two	**MBFS25**	Plant Physiology, Plant Biochem.,	Pract. I	-	-	04

			Plant Development & Reproduction				
13	Two	**MBFS26**	Cell and Molecular Biology I, Angiosperms I	Pract. II	-	-	04
14	Two	**MBFS27**	Seminar				01
15	Three	**MBSS31**	Plant Ecology and Conservation Biology	I	04	04	04
16	Three	**MBSS32**	Angiosperms-II	II	04	04	04
17	Three	**MBSS33PN**	Elective –I Palynology I	III	04	08	04
		MBSS33PP	Elective –I Plant Physiology I	III	04	08	04
		MBSS33RB	Elective –I Reproductive Biology of Angiosperms I	III	04	08	04
18	Three	**MBSS34**	Core: Aesthetic Botany I	IV	04	-	04
19	Three	**MBSS35**	Plant Ecology and Conservation Biology and Angiosperms II	Pract. I	-	-	04
20	Three	**MBSS36PN**	Elective PN	Pract. II	-	-	04
		MBSS36PP	Elective PP	Pract. II	-	-	04
		MBSS36RB	Elective RB	Pract. II	-	-	04
21	Three	**MBSS37**	Seminar				01
22	Four	**MBSS41**	Cell and Molecular Biology -II	I	04	04	04
23	Four	**MBSS42**	Plant Biotechnology and Plant Breeding	II	04	04	04
24	Four	**MBSS43PN**	Elective –II Palynology II	III	04	-	04
		MBSS43PP	Elective –II Plant Physiology	III	04	-	04

			II				
		MBSS43RB	Elective –II Reproductive Biology of Angiosperms II	III	04	-	04
25	Four	**MBSS44**	Core: Plant Resources	IV	04	-	04
26	Four	**MBSS45**	Cell and Molecular Biology-II, Plant Biotechnology and Plant Breeding	Pract. I	-	-	04
27	Four	**MBSS46**	Project	Pract. II	-	08	04
28	Four	**MBSS47**	Seminar				01

1. In each semester student will have to give seminar on any topic relevant to the syllabus encompassing the recent trends and development in that field. The topic of the seminar will be decided at the beginning of each semester in consultation with supervising teachers. The students have to deliver the seminar, which will be followed by discussion. The seminar will be open to all the teachers of the department invitees and students.

2. The students will have to carry out the research based project work in lieu of practical in the fourth semester in the department or depending on the availability of placement; he/she will be attached to any of the national/ regional/ private research institute / organization for the duration of the fourth semester. The student will be randomly allotted the priority number for the selection of the supervisor in the third semester. The student in consultation with supervisor will finalize the topic of the project work at the third semester.

3. These course can be taught by person having post graduate qualification in relevant / equivalent subjects/ or having teaching / research experience in that particular area.

APPENDIX – 2
Scheme of the examination for M. Sc. Program in Botany

S. No.	Semester	Course Code / Paper	Title of the Paper	Duration of Paper /hrs		Maximum Marks	Total Credits
				Theory	Practical		
1	One	**MBFS11**	Microbiology, Algae and Fungi	03		80 + 20	04
2	One	**MBFS12**	Bryophytes & Pteridophytes	03		80 + 20	04
3	One	**MBFS13**	Paleobotany and Gymnosperms	03		80 + 20	04
4	One	**MBFS14**	Cytology and Genetics	03		80 + 20	04
5	One	**MBFS15**	Algae, fungi, Bryophytes		06	100	04
6	One	**MBFS16**	Pteridophytes, Gymnosperms, Paleobotany, Cytology &Genetics		06	100	04
7	One	**MBFS17**	Seminar		01	25	01
8	Two	**MBFS21**	Plant Physiology and Biochemistry	03		80 + 20	04
9	Two	**MBFS22**	Plant Development and Reproduction	03		80 + 20	04
10	Two	**MBFS23**	Cell and Molecular Biology-I	03		80 + 20	04
11	Two	**MBFS24**	Angiosperms-I and Ethnobotany	03		80 + 20	04
12	Two	**MBFS25**	Plant Physiology, Plant Biochem., Plant Development & Reproduction		06	100	04

13	Two	**MBFS26**	Cell and Molecula rBiology I, Angiosperms I		06	100	04
14	Two	**MBFS27**	Seminar		01	25	01
15	Three	**MBSS31**	Plant Ecology and Conservation Biology	03		80 + 20	04
16	Three	**MBSS32**	Angiosperms-II	03		80 + 20	04
17	Three	**MBSS33PN**	Elective –I Palynology I	03		80 + 20	04
		MBSS33PP	Elective –I Plant Physiology I	03		80 + 20	04
		MBSS33RB	Elective –I Reproductive Biology of Angiosperms I	03		80 + 20	04
18	Three	**MBSS34**	Core: Aesthetic Botany	03		80 + 20	04
19	Three	**MBSS35**	Plant Ecology and Conservation Biology and Angiosperms II		06	100	04
20	Three	**MBSS36PN**	Elective PN		06	100	04
		MBSS36PP	Elective PP		06	100	04
		MBSS36RB	Elective RB		06	100	04
21	Three	**MBSS37**	Seminar		01	25	01
22	Four	**MBSS41**	Cell and Molecula r Biology-II	I	03	80 + 20	04
23	Four	**MBSS42**	Plant Biotechnolog yand Plant Breeding	II	03	80 + 20	04
24	Four	**MBSS43PN**	Elective –II Palynology II	III	03	80 + 20	04
		MBSS43PP	Elective –II Plant Physiology II	III	03	80 + 20	04
		MBSS43RB	Elective –II Reproductive Biology of Angiosperms II	III	03	80 + 20	04
25	Four	**MBSS44**	Core: Plant Resources	IV	03	80 + 20	04

26	Four	**MBSS45**	Cell and Molecular Biology-II, Plant Biotechnology and Plant Breedin g	Pract. I		100	04
27	Four	**MBSS46**	Project			100	04
28	Four	**MBSS47**	Seminar		01	25	01

1. In each semester student will have to give seminar on any topic relevant to the syllabus encompassing the recent trends and development in that field. The topic of the seminar will be decided at the beginning of each semester in consultation with supervising teachers. The students have to deliver the seminar which will be followed by discussion. The seminar will be open to all the teachers of the department, invitees and students.

2. The students will have to carry out the research based project work in lieu of practical in the fourth semester in the department or depending on the availability of placement; he/she will be attached to any of the national/ regional/ private research institute / organization for the duration of the fourth semester. The student will be randomly allotted the priority number for the selection of the supervisor in the third semester. The student in consultation with supervisor will finalize the topic of the project work at the third semester.

3. The regular full time teacher of the department / contributory teacher approved by university / scientist of government / private research laboratory appointed by university as a contributory teacher and having M. Phil. or Ph. D. degree can supervise the project work of the student.

Subject Wise Core Elective Papers:

M.Sc. Subject	Core elective paper to be opted in Semester III	Core elective paper to be opted in SemesterIV
Botany	Palynology - I **MBSS33PN**	Palynology - II **MBSS43PN**
	Plant Physiology – I **MBSS33PP**	Plant Physiology – II **MBSS43PN**
	Reproductive Biology of Angiosperms –I **MBSS33RB**	Reproductive Biology of Angiosperms – II **MBSS43PN**

SEMESTER I
PRACTICAL (1P1)
MBFS15

Time : 6 Hours | Full marks : 100

Q. 1 To identify the given Cyanobacterial material A.	10
Q.2 To identify two algal forms B, C, from the given mixture.	10
Q.3 To identify the given fungal culture D	10
Q. 4 To identify the given plant pathogen in the given material E.	10
Q. 5 To prepare a temporary microprepration of the given Bryophytic Material F and identify it	10
Q. 6 Comment on the given spot G (Cyanobacteria/Bacteria), H (Algae), I (Fungi), J (Bryophyte)	10
Q.7 Viva-voce	20
Q. 8 Practical Record and tour report	20

SEMESTER I
PRACTICAL (1P2)
MBFS16

Time : 6 Hours | Full marks : 100

Q. 1 To prepare a double stained microprepration of the given Pteridophytic materialA and identify it.	10
To prepare a double stained microprepration of the given gymnospermic material B and identify it.	10
Comment on the given fossil specimen C	10
Q. 4 One experiment from Cytology and Genetics D	10
Q. 5 Comment on the given spot E (Pteridophyte), F (Gymnosperm), G (Fossils), H (Cytology/Genetics)	20
Q.6 Viva-voce	20
Q. 7 Practical Recordand tour report	20

SEMESTER II

PRACTICAL (2P1)

MBFS25

Time : 6 Hours | Full marks : 100

Q. 1	To perform the given physiological experiment A and report the findings	10
	To quantify the given metabolite in the given sample B	5
	To study the cytohistological zonation in SAM of given material C	10
Q. 4	Toperform the given exercise based on plant development D	10
Q. 5	Write a note on given stage of micro-or megasporogenesis E	10
Q. 6	Spotting: F (Physiology), G (Plant development), H (Reproduction)	15
Q. 7	Viva-voce	20
Q. 8	Practical Record	20

SEMESTER II

PRACTICAL (2P2)

MBFS26

Time : 6 Hours | Full marks : 100

Q. 1	One experiment from paper VII A	15
	One experiment from paper VII B	10
	One experiment from paper VIII C	15
Q. 4	One experiment from paper VIII D	10
Q. 5	Spotting	10
Q. 6	Viva-voce	20
Q. 7	Practical Record and field diary	20

SEMESTER III

PRACTICAL (3P1)

MBSS35

Time : 6 Hours | Full marks : 100

Q. 1	To perform the given ecological exercise A	15
	To solve the given statistical problem B	15
	To describe the given plant in technical language with floral formula and floral diagram C	10
Q. 4	To prepare the generic/family key D	5
Q. 5	To identify species of the given plant using Flora	5
Q. 7	Spotting	10
Q. 8	Viva-voce	20
Q. 9	Practical Record	20

SEMESTER III

PRACTICAL 3P2 (ELECTIVE)

PALYNOLOGY

MBSS36PN

Time: 6 Hours | Full Marks: 100

1. Pollen preparation by standard method/s - Section „A".	15
2. Any ONE experiment from Section B.	15
3. Any ONE experiment from Section C.	15
4. Any ONE experiment from Section A/B/C (Minor) (Other than asked in Question 1 - 3)	5
5. Spotting	10
6. Practical Record, Permanent slides & field record	20
7. Viva-voce	20

SEMESTER III

PRACTICAL 3P2 (ELECTIVE)

PLANT PHYSIOLOGY

MBSS36PP

Time: 6 Hours | Full Marks: 100

1. One Major Experiment from Special paper- I A	15
2. One Minor Experiment from Special paper- IB	10
3. One Major Experiment from Special paper- II C	15
4. One Minor Experiment from Special paper- IID	10
5. Identification and comments on given two spots (E, F)	10
6. Practical record and Project/field report.	20
7. Viva-voce	20

SEMESTER III

PRACTICAL 3P2 (ELECTIVE)

REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

MBSS36RB

Time: 6 Hours | Full Marks: 100

1. Dissect and mount the endothecium/endosperm from the given materials.	10
2. Dissect and mount given stage of embryo from the material.	10
3. In vitro pollen germination percentage and pollen tube growth. Record the data under given conditions.	10
4. Study the Morphology of pollen grain.	10
5. A) Localize the Biochemical compounds in a given plant material.	5
B) Draw the camera lucida figure of a embryological stage focused under the microscope.	5
6. Identification and comment on the given spots.(2 Spots)	10
7. Practical record & field Report.	20
8. Viva-voce	20

SEMESTER IV

PRACTICAL (4P1)

MBSS45

Time : 6 Hours | Full marks : 100

Q. 1	One experiment from Paper XIII A	15
Q.2	One experiment from Paper XIII B	10
Q.3	One experiment from Paper XIV C	15
Q. 4	One experiment from Paper XIV D	10
Q. 5	Spotting from Elective Paper II	10
Q. 6	Viva-voce	20
Q. 7	Practical record	20

SEMESTER IV PRACTICAL (4P2) MBSS46

Project (In lieu of Practical) **100**

M. Sc. Botany Syllabus

Semester I

MBFS11 : Microbiology, Algae and Fungi

Objectives:

Understanding & Application the structure, reproduction eco. imp. of bacteria, viruses and archaebacteria

Understanding & Application classification, life cycles, eco. imp. Of various groupsof algae and fungi

Understanding & Application symptoms, histopathology, etiology and identification of plant diseases and measurements

Outcomes:

After completion of the course, the student will be able to

Identify the structure, life cycles, economic importances etc of bacteria, virus, arhaebacteria, algae, fungi and apply this knowledge

Based on symptoms, identify plant diseases and apply knowledge for control of diseases

Perform various microbial culture techniques and apply for development ofvarious cultures.

Module I: Prokaryotes and viruses **(12 Hrs.)**

General Microbiology: History- Contributions made by Leeuwenhoek, Pasteur, Robert Hook, Jenner, Waksman, Iwanowsky. Koch"s Postulates.

Bacteria: Structure, morphology, reproduction.

Viruses: General account; Morphology and ultrastructure of TMV, Bacteriophage; Introduction to viroids, prions and interferon.

Archaebacteria and bacteria: General account; ultrastructure, nutrition and reproduction, biology and economic importance; Cyanobacteria:*Microcystis, Lyngbya, Nostoc, Scytonema, Gloeotrichia* and *Stigonema*.

Module II: Phycology **(12 Hrs.)**

Criteria for classification of algae: Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Pheophyta and Rhodophyta; pigments, reserved food, flagella.

Algae in diversified habitats (terrestrial, freshwater, marine), thallus organization; cell ultrastructure; reproduction (vegetative, asexual, sexual); algal blooms, algalbiofertilizers; algae as a food, feed and uses in industry.

Module III: Mycology **(12 Hrs.)**

General account: Classification of Fungi (recent trends and criteria used in classification); Physiology of Fungi (with reference to biotrophs, hemibiotrophs, symbionts); Fungal Cytology; Heterothallism, heterokaryosis, parasexual cycle.

Comparative study, classification and evolutionary trends in the following: Myxomycota: Protist characters and general account with special reference to *Physarium* and *Plasmodiophora*

Eumycota: i. Oomycetes: *Saprolegnia*, *Synchytrium*, *Phytophthora*, *Peronospora*,

ii. Zygomycetes: *Mucor, Rhizophus, Syncephalastrum, Cunninghamella*

Module IV: Mycology and plant pathology **(12 Hrs.)**

Mycology contd….: Comparative study, classification and evolutionary trends in the following:
iii. Ascomycetes: *Saccharomyces, Phyllactinia, Chaetomium, Xylaria*

iv. Basidiomycetes: *Melampsora, Puccinia, Ravenelia, Ustilago, Polyporus.*

v. Deuteromycetes: *Helminthosporium, Fusarium, Colletotrichum.*

Plant Pathology: Symptomology, histopathology, etiology and identification of diseases with reference to following fungal, bacterial and viral diseases (Paddy blast, wheat rust, bunt of wheat, smut of jowar, black arm of cotton, red rot of sugarcane, citrus canker, gummosis, leaf curl of papaya, potato blight.)

Practicals

Classification and type study of the following classes:

Prochlorophyta: *Prochloron*, Chlorophyta:*Pandorina, Eudorina, Stigeoclonium, Ulva, Chlorella*, Scenedesmus, Caulerpa, Valonia, Acetabularia; Phaeophyta:*Spacelaria, Padina,Turbinaria*; Rhodophyta: *Nemalion, Gelidium, Gracilaria, Corallina, Polysiphonia*; Euglenophyta:*Euglena*, *Phacus*; Bacillariophyta:*Cyclotella, Synedra, Cymbella, Navicula, Gomphonema.*

Morphological Studies of Fungi (any 15 of the following)

Stemonities, Perenospora, Phytopthora, Albugo, Mucor, Rhizopus, Yeast, Aspergillus, Penicillium, Chaetomium, Taphrina, Peziza, Erisyphe, Phyllactenia, Uncinula, Melamosora, Uromyces, Drechslera,Ravenallia, Ustilago, Polyporus, Morchella, Cyathus, Alternaria, Helminthosporium, Curvularia, Colletotrichum, Phoma, Plasmodiophora, Cercospora, Fusarium, Claviceps.

Symptomology of some diseased plants (any 7 of the following).
White rust of Crucifers, Downy mildew, powdery mildew, Rusts, Smuts, Ergot, Groundnut leaf spot (Tikka disease), False smut of paddy, red rot of Sugarcane, Wilt disease, Citrus canker, Angular leaf spot of cotton, Potato blight, Leaf mosaic of bhindi/ papaya, Leaf curl of tomato/Potato/Papaya, Little leaf of brinjal.

Identification of Fungal cultures (Any 5)

Rhizopus, Mucor, Aspergillus, Penicillum, Drechslera, Curvularia. Phoma, Colletotrichum, Alternaria, Helminthosporium.

Field study: For collection and studying fungal flora

Suggested Readings:

1. Kumar HD (1988) Introductory Phycology. Affiliated East-West Press Ltd. New Delhi
2. Morris I (1986) Introduction to the Algae. Cambridge University Press, UK
3. Round FE 1986 The Biology of Algae. Cambridge University Press, UK
4. Mandahar CL 1978 Introduction to Plant Viruses. Chand & Co. Ltd., New Delhi
5. Agrios, G.N. (1980) Plant Pathology, academic Press, INC, New York.
6. Ainsworth, G.C. and A.S.Sussman (eds). The Fungi, An advance Treatise Vol.I, II, III & IV Academic Press, New York.
7. Alexopoulos, C.J. (1962). Introductory Mycology John Wiley Eastern Pvt.Ltd.
8. Alexopoulos, C.J. and Mims C.W. (1979). Introductory Mycology 3rd Edition, John Wiley and Sons, Inc. Wiley, New York.
9. Alexopoulos, C.J., Mims and Black well (1996) 4th ed. John Wiley and Sons, Inc. Wiley, New York
10. Aneja, K.R. (1993) Experimental in Microbiology, Plant Pathology & Tissue Culture, Wiswa Prakashan, New Delhi.
11. Bessey, E.A. (1950) Morphology and Taxonomy of Fungi. The Blakiston co. Philadelphia.
12. Bilgrami, K.S. and H.C.Dube (1985) A text Book of Modern Plant Pathology, Vikas Publication House, New Delhi.
13. Barnett, J.H. (1968) Fundamentals of Mycology. The English Language Book Society and Edward Arnold Publication, Limited.
14. Dube, R.C. and D.K.Maheshwari (1999) A.Text Book of microbiology, S.Chand & Co. Ltd.
15. Dube, R.C. and D.K.Maheshwari (2000) Practical Microbiology -S.Chand & Co. Ltd.
16.Gupta, V.K. and M.K.Behl (1994) Indian Plant Viruses and Mycoplasma Kalyani Publishers, 1/1, Rejinder Nagar, Ludhiana.
17. Jha, D.K. (1993) A Text Book of Seed Pathology, Vikas Publication House.
18. Mehrotra, R.S. (1989) Plant Pathology, Tata McGraw Hill.
19. Mehrotra, R.S. and K.R.Aneja (1998) An Introduction to Mycology, New Age Intermidiate Press.
20. Pelzer, M.J. , Jr.Cahn, E.C.S. and N.R.Krieg (1993) Microbiology, Tata McGraw Hill.
21. Preece and Dickeson. Ecology of leaf surface microorganism Academic Press, New York.
22. Rangaswamy, G. and A.Mahadevan (1999) Diseases of Crop Plant in India, Prentice Hall of India.
23. Raychoudhari, S.P. and Nariani, T.K. (1977) Virus and Mycoplasma Diseases of Plant in India, Oxford and IBH Publication Co.
24. Schlegel, H.G. (1996) General Microbiology, 7th Edition, Cambridge University Press.
25.Snowdon, A.L. (1991) A colour Atlas of Post harvest diseases & disorders of fruits & vegetables Vol.I & II Wolfe Scientific, London.
26. On line Journals available on UGC -VSAT

Semester I

MBFS12: Bryophytes & Pteridophytes

Objectives:

- **Understanding general characters, ecology, fossil history, classification, various types of bryophytes, pteridophytes.**
- **Learn evolutionary trends of various orders of Bryophytes, Pteridophytes and their different organs**

Outcomes:
After successful completion of the course the students will be able to

- **Learn various types of bryophytes, Pteridophytes characters for identification in lab and nature.**
- **Understand various types of fossils in bryophytes and Pteridophytes**
- **Understand evolutionary trends in bryophytes and pteridophytes**

Module I: Bryophytes **(12 Hrs.)**

General characters, distribution, classification, ecology of Bryophytes, fossil history of bryophytes, cytology of bryophytes, regeneration in bryophytes, evolution of sporophyte-Retrogressive and Progressive theory.

Module II: Bryophytes contd….. **(12 Hrs.)**

General account of-Hepaticopsida: Sphaerocarpels, Takakiales; Anthocerotopsida: Anthocerotales; Bryopsida: Sphagnales, Polytrichales.

Module III: Pteridophytes **(12 Hrs.)**

General characters, distribution, classification, evolution of stele, heterospory and seed habit, apospory and apogamy; Important contributions of Indian Pteridologists, General account of Ryniopsida, Psilopsida, Lycopsida [protolepidodendrales, Lycopodiales, Selaginales, Isoetales].

Module IV: Pteridophytes contd… **(12 Hrs.)**

General account and evolutionary trends of Sphenopsida [Hyeniales, Equisetales], Filicopsida [Ophioglossales, Filicales, Salvinales, Marsileales], Tracheophyta [Progymnospermosida].

Practicals

Bryophytes:

Study of morphological and reproductive characters of representative members mentioned in the syllabus using cleared whole mount preparations, dissections and sections. Preparation of permanent slides is necessary.

Study of bryophytes in their natural habitats.

Botanical excursion outside the state is compulsory to study the bryophytes in their natural conditions.

Pteridophytes:

Study of fossil forms (specimens and permanent micropreparations).

Study of living forms: Morphological, anatomical and reproductive characters of the forms mentioned in the syllabus. Anatomical characters to be studied either by taking free hand sections (t.s./l.s.) and by observing the permanent micropreparations. Preparations of permanent slides are essential.

Study of pteridophytes in their natural habitats.

Botanical excursion outside the state is compulsory to study the pteridophytes in their natural conditions.

Suggested Readings

1. Andrews H.N. Jr. (1961) Studies in Paleobotany (Jonh Wiley & Sons, New York)

2. Arnold C.A. (1947) An introduction to Paleobotany (McGraw Hill, New York)

3. Banks H.P. (1968) The early history of Land plants. In evolution and environment, ed. E.T. Drake. New Haven: Yale Univ. Press, pp, 73-107.

4. Banks H.P. (1970) Evolution and plants of past. (Belmont, California, Wadsworth).

5. Banks, H. P. (1975). Reclassification of Psilophyta, Taxon.24, 401-13.

6. Berrie, G. K. (1963). Cytology and Phylogeny of liverwoets. Evolution 17, 347-357.

7. Bierhorst D.W (1971) Morphology of vascular plants, New York (Mac Millan)

8. Campbell, D. H. (1961). The evolution of the Land Plants (central Book Depot, Allahabad)

9. Cavers, F. (1910). The interrelationship of Bryophyta I-IV.New Phytologist.

10. Cavers, F. (1911). The interrelationship of Bryophyta VII-IX.New Phytologist.

11. Chrysler M.A. (1910) The fertile spike in Ophioglossaceae. Ann. Bot. 24:1-18.

12. Delevoryas T. (1962) Morphology and Evolution of fossil plants (Holt, Rinehart and Winston, New York).

13. Eames A.J (1936) Morphology of vascular plants, lower groups (McGraw Hill, New York).

14. Foster A.S.and E.M Gifford Jr. (1959) Comparative morphology of vascular plants Freeman, San Fransisco.

15. Grolle, R. (1963). Takakia in Himalayas, Ost. Bot. Zeitscher, 110:444-447.

16. Gupta K.M. (1962) Marsilea, Botanical monograph no. 2 (CSIR, New Delhi).

17. Ingold, C. T. (1939). Spores discharge in land plants (Oxford London)

18. Kashyap S.R. (1929). Liverworts of the western Himalayas and The Punjab Plain 1 (Chronica Botanica)

19. Kashyap S.R. (1933). Liverworts of the western Himalayas and The Punjab Plain 2(Chronica Botanica)

20. Lacey, W. A. (1969). Fossil Bryophytes.Biological Reviews, 44,189-205.

21. Mehra, P.N. and O. N. Handoo (1953). Morphology of Anthoceros erectus and A. himalayensis and the phylogeny of the anthocerotales. Bot. Gaz.114:371-382.

22. Parihar N. S. (1976). An introduction to Embryophyta, Bryophyta (Centaral Book House, Allahabad)

23.Parihar N.S. (1977) The biology and morphology of the Pteridophytes (Central Book Depot, Allahabad).

24.Pichi-Sermolli REG (1959) Pteridophyta in vistas in botany, WB Turrill, ed. (Pergamon Press, London) pp 421-493.

25. Proskauer J. (1951). Study in Anthocerotales, III, The Bryologist 53,165-172.

26. Puri Prem (1985) Bryophytes-A broad perspective.

27. Ramanujam CGK (1992) Origin and evolution of lycopods Paleobotanist 41, 51-57.

28. Rashid A. (1982) (4th edn) An introduction to pteridophyta (Vikas Publ House Pvt Ltd.)

29.Schuster R. (1966). The Hepaticae and Anthocerotae of North America.East of the Hundredth meridian, Newyork (Colombia University Press).

30. Scott D.H. (1908) Studies in fossil botany. London, Black Part 2.

31. Scott D.H. (1920-1923) Studies in fossil botany. (A & C Black London.)

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47. Wilson C.W. (1942) The telome theory and the origin of the stamen. Am. J Bot., 29, 759 764.

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Semester I

MBFS13: Paleobotany and Gymnosperms

Objectives:

- **Understand fossils formation, history, preservation, geological time scale, reconstruction and nomenclature of various types of fossils**
- **Learn the origin of gymnosperms, classification, evolution, eco. imp. of gymnosperms**

Outcomes:

After successful completion of the course the students will be able to

- **Identification, nomenclature, reconstruction of fossils and their significance in time scale**
- **Identification of various gymnosperms, evolution of gymnosperms and their relationships**

Module I: Paleobotany (12 Hrs.)

Introduction; Plant fossils- Preservation, preparation, age determination, geological time scale; Fossil record- systematics, reconstruction and nomenclature; Applied aspects of paleobotany.

Module II: Gymnosperms (12 Hrs.)

General account; distribution (living, Fossil); origin; systems of classification; economic importance.

Comparative morphology and evolutionary tendencies of:

1.Pteridospermales- Lyginoptridaceae (*Calymotheca hoeninghausii, Hetarngium, Spherostoma*); Medullosaceae (*Medullosa, Trignocarpus*).

2. Cycadales- Cycadaceae; Fossil history (*Baenia, Nilssonia, Androstrobus*)

3. Cycadeoidales- Williamsoniaceae, Cycadoeoidaceae

Module III:Gymnosperms contd… (12 Hrs.)

General account and relationships of- Cordaitales, Caytoniales, Glossopteridales, Pentoxylales, Gnetales

Module IV: Gymnosperms contd… (12 Hrs.)

Ginkgoales (*Ginkgo, Baiera, Trichopitys*); Coniferales (General characters, Embryogeny and phylogeny, evolution of ovuliferous scales, phylogeny); Taxales (*Taxus*, taxonomic position of taxales with respect to coniferales)

Laboratory exercise

Comparative Study of vegetative and reproductive parts of: *Cycas, Zamia, Cedrus,Abies, Pinus, Cupressus, Cryptomeria, Taxodium, Podocarpus, Agathis, Thuja, Gnetum,Ephedra, Juniperus,Cephalotaxus, Taxus*. Permanent micropreparatious to be submitted by the students.

Ginkgo: Morphology to be studied from Museum specimens & anatomy from permanent slides only.

Study of important fossil gymnosperms from material and permanent slides.

Visit to palaeobotanical Institutes, localities and collection of specimens.

Field visits to ecologically different localities to study living gymnosperms.

Suggested Reading

1. Stewart, W.N. and Rothwell G.W. (1993), Palaeobotany and the Evolution of Plants, Cambridge University Press.

2. Foster A.S. & Gifford F.M. (1967): Comparative morphology of vascular plants, FreemanPublishers, San Fransisco.

3. Eames, A.J.(1974): Morphology of Vascular Plants-lower groups, Tata Mc-Graw Hill publishing Co., New Delhi.

4. Arnold, C.A. (1947): Introduction to Palaeobotany, Mc-Graw Hill Book Co. Inc., New York and London.

5. Kubitzki K. (1990), The families and genera of vascular plants Pteridophytes and Gymnosperms, Springer Verlag, New York

6. Agashe, S.N. (1995), Palaeobotany, Oxford & IBH, New Delhi.

7. Biswas, C & Johri, B.N. (2004), The Gymnosperms, Narosa Publishing House, New Delhi.

8. Coulter J.M. & Chamberlain C.J.(1978): Morphology of Gymnosperms, Central Book Depot, Allahabad.

9. Kakkar, R.K.and Kakkar, B.R. (1995), The Gymnosperms (Fossils & Living), Central Publishing House, Allahabad.

10. Sharma O.P. (2002) Gymnosperms, Pragati Prakashan, Meerut.

11. Siddiqui, K.A. (2002) Elements of Palaeobotany, Kitab Mahal, Allahabad.

12. Bhatnagar, S.P. and Moitra A. (1996), Gymnosperms, New Age International Pvt. Ltd., New Delhi.

13. Singh, H. (1978), Embryology of Gymnosperms, Encyclopedia of Plant Anatomy X, Gebryder, Bortragear, Berlin.

14. Pant, D.D. (2003): Cycas and allied Cycadophytes, BSIP, Publications.

15. Bierhorst D.W. (1971): Morphology of vascular plants McMillan, New York.

16. Thomas, B.A. & Spicer R.A. (1987): The Evolution and Palaeobiology of land plants. Discordies Press, Fortland, USA.

17. Spicer, R.A. & Thomas, B.A. (1986) Systematic and taxonomic approaches in Palaeobotany. Systematic Association Special Volume.

18. Chamberlain C.J. (1986); Gymnosperms, structure and Evolution, CBS publishers anddistributors, New Delhi.

19. On line Journals available on UGC -VSAT

Semester I

MBFS14: Cytology and Genetics

Objectives:

- **Understand the laws of inheritance, various modifications, types of chromosomal inheritance patterns**
- **Understand multiple alleles and multiple gene inheritance, cytopplasmic inheritance**
- **Learn structural and numerical changes in chromosomes, mutations and inheritance patterns in various biological organisms and in their populations**

Outcomes:

After successful completion of the course the students will be able to

- **Know various types of inheritances in biological organisms and analyse inheritance patterns**
- **Understanding population genetics and equilibrium affecting various factors**
- **Understand the molecular mechanism of mutations and its role in crops improvement**

Module I

(12 Hrs.)

Mendel"s laws of inheritance; Deviations from Mendel"s findings: incomplete dominance, co-dominance,penetrance, expressivity, multiple alleles and isoalleles (example Corn, Drosophila and *Nicotiana*), gene interactions (non-epistatic and epistatic), Linkage; Chromosome theory of inheritance; Modifiers, suppressors and pleiotrpic genes; multigene families (globin and immunoglobin genes); sex determination in plants, *Drosophila, C. elegans.*

Module II

(12 Hrs.)

Cytoplasmic inheritance and maternal effect

Chromatin organization: Chromosome structure and packaging of DNA, molecular organization of centromere and telomere, rRNA genes, euchromatin and heterochromatin; Karyotype analysis and evolution, banding patterns; C-value paradox, Cot curve and its significance; specialized types of chromosomes: polytene, lampbrush, B-chromosome, sex chromosome; molecular basis of chromosome pairing.

Module III

(12 Hrs.)

Structural and numerical (heteroploidy) changes in chromosomes; origin, breeding behaviour of duplications, deficiency, inversion and translocation heterozygotes; effect of aneuploidy on plants; transmission of trisomics and monosomics and their use in chromosome mapping; complex translocation heterozygotes, translocation tester sets; Robertsonian translocation.

Population genetics: Hardy-Weinberg equilibrium; Factors affecting Hardy-Weinberg equilibrium; Quantitative trait loci (Kernel colour in wheat, corolla length in *Nicotiana longifera*).

Module IV **(12 Hrs.)**

Mutations: Spontaneous and induced; physical and chemical mutagens- classification, mode of action; molecular basis of gene mutations; transposable genetic elements; site directed mutagenesis- definition, applications and PCR based oligonucleotide mutagenesis; role of mutations in crop improvement; induction of polyploidy

Epigenetics: Introduction; histone code; base modification; paramutations in maize; Callipygh sheep; Epigenetics and Lamarckism; Epigenome and epigenomics (Introduction).

Practicals

1. To study cell division (mitosis and meiosis) in the given material.
2. To study the effect of mutagen treatment on germination and seedling height.
3. To study effect of mutagen on the rate of cell division.
4. To study effect of mutagen on genetic material by scoring the chromosomal aberrations.
5. To study the translocation heterozygote in *Rheo discolor* or any other suitable material.
6. To study polytene chromosomes in *Chironomas* larvae.
7. To solve the given problems on interaction of genes (atleast five).
8. To study the karyotype of given organism.
9. To study the chiasma frequency in the given material.
10. To solve the given problem on population genetics (atleast three).

Suggested Reading

Gupta P K 2007 Genetics: Classical to Modern. Rastogi Publications, Meerut.

Hexter W and Yost Jr. H T 1977 The Science of Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.

Hartl D L and Jones E W 1998 Genetics: Principles and Analysis (4thed.). Jones and Barflett Publishers, USA.

Khush G S 1973 Cytogentics of Aneuploids.Academic press, New York.

Snustad D P and Simmons M J 2000 Principles of Genetics (2nded.) John Wiley and Son Inc., USA.

Semester II

MBFS21: Plant Physiology and Biochemistry

Objectives:

- **Understanding photosynthesis and respiration in plants.**
- **Understanding mechanistic underpinnings of the plant hormones and sensory photobiology.**
- **Understanding Enzymology.**
- **Understanding the solute transport system and metabolism.**

Outcomes:

After successful completion of the course the students will be able to

- **Understand the aspects of plant respiration and photosynthesis.**
- **Understand the aspects of metabolism of different components**
- **Perform and check the enzymatic activities of different components.**

Module-I

The Scope of plant physiology (12 Hrs.)

Photosynthesis: Evolution of photosynthetic apparatus, pigments, Light, light harvesting complex, Mechanism of electron transport, Photo protective mechanism, CO2 fixation, C3, C4 and CAM pathway, Photorespiration, the chemiosmatic-coupling hypothesis and ATP Synthesis, , ATP Synthesis in chloroplast

Respiration:- introduction, ,Glycolysis, Citric acid cycle, oxidative pentose phosphate pathway, Plant mitochondrial electron transport and ATP synthesis (oxidative phosphorylation) alternate oxidase.

Module-II

(12 Hrs.)

Plant hormones:- biosynthesis, storage , breakdown and transport of hormones, physiological effect and mechanism of action of hormones auxins, gibberellins and cytokinine

Sensory photobiology:- structure, function and mechanism of phytochromes, cryptochromes and phototropins, stomatal movement. Photoperiodism and biological clock

Module-III

(12 Hrs.)

Enzymes: Nomenclature and classification of Enzymes enzyme kinetics, Michaelis –Menten equation, mode and mechanism of Enzyme action (Regulation of Enzyme activity), Activators & Inhibitors of enzymes, properties of Enzymes, factors affecting Enzyme activity, isozymes.

Solute transport and photo-assimilate translocation:-uptake transport and translocation of water, ion, solutes and macromolecules from soil through cell, across membranes, through xylem and phloem , transpiration, mechanism of loading and unloading of photo -assimilates

Module –IV **(12 Hrs.)**

Carbohydrate Metabolism: Composition, structure and function of carbohydrates, synthesis of starch and

Sucrose, catabolism (degradation) of starch and sucrose

Lipid Metabolism: Composition, structure and function of lipids, fatty acid biosynthesis, membrane Storage lipids.

Protein metabolism: Composition, structure (Ramchandra plot. secondary, tertiary and quaternary structure)and function of Proteins

Metabolism of amino acids: Composition, structure and function of amino acids, amino acid biosynthesis in Plants.

Nitrogen metabolism: Nitrate and ammonium assimilation

Secondary metabolites: Biosynthesis of terpenes, phenols. Nitrogenous compounds and their roles

Suggested laboratory exercises

1. To study the effect of time and enzyme concentration on the rate of reaction of enzyme (e.g. phosphatase, nitrate reductase).
2. To study the effect of substrate concentration on activity of enzyme and determination of its Km value.
3. Demonstration of the substrate inducibility of the enzyme nitrate reductase.
4. Determination of succinate dehydrogenase activity, its kinetics and sensitivity to inhibitors.
5. To determine the total carbohydrate content in the given sample
6. Estimation of Pectic Substances-gravitic method .
7. To prove Berr-Lambert.s law using a suitable solution.
8. Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum ofchlorophyll and carotenoids.
9. To determine the chlorophyll a/ cholorophyll b ratio in C3 and C4 plants.
10. Isolation of intact chloroplasts and estimation of choloroplast proteins by spot protein assay.
11. Preparation of standard curve of protein (BSA) and estimation of protein content in extractsof plant material by Lowry"s or Bradford"s method.
12. Preparation of Leaf Protein Concentrates from green vegetables.
13. Determination of reducing sugars by Nelson – Somogyi Method.

Suggested reading (for laboratory exercises)

1 Bajracharya, D. 1999. Experiments in Plant Physiology: A Laboratory Manual. Narosa Publishing House, New Delhi.

2 Cooper, T.G. 1977. Tools in Biochemistry.John Wiley, New York, USA.

3Copeland, R.A. 1996. Enzymes: A Practical Introduction to Structure, Mechanism andData Analysis. VCH Publishers, New York.

4Dennison C. 1999.A guide to Protein Isolation. Kluwer Academic Publishers, Dordrecht,The Netherland.

5Devi, P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios, Jodhpur, India.

6 Dryer, R. L. and Lata, G. F. 1989.Experimental Biochemistry. Oxford UniversityPress, New York.

7Hames, B.D.(Ed.).1998. Gel Electrophoresis of Proteins: A Practical Approach, 8th edition. PAS, Oxford University Press, Oxford, UK.

8Harborne, T.C. 1981. Phytochemical Methods: A Guide to Modern Techniques of Plants Analysis. Chapman& Hall, London.

9Moore, T.C. 1974. Research Experiences in Plant Physiology: A Laboratory Manual.Springer-Verlag, Berlin.

10Ninfa, A. J. and Ballou, D. P. 1998. Fundamental Laboratory Approaches forBiochemistry and Biotechnology. Fitzgerald Science Press, Inc., Maryland, USA.

11 Plummer, D.F. 1988. An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

12Scott, R.P.W. 1995. Techniques and Practice of Chromatography.Marcel Dekker, Inc., New York.

13Wilson, K. and Goulding, K.H.(Eds), 1986. A Biologists Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold, London,UK.

14Wilson, K. and Walker, J. 1994. Practical Biochemistry: Principles and Techniques, 4th edition. Cambridge University Press, Cambridge, UK.

15 Sadasivam and Manikum: Biochemical Methos , New Age International (p) Limited Publishers 4835/24, Ansari Road, Daryaganj, New Delhi-110002

Suggested readings (for theory)

1 Buchanan, B. B., Gruissem, W. and Jones, R.L. 1989.Biochemistry and Molecular Biology of plants.American Society of Plant Physiologists, Maryland, USA.

2Dennis, D.T., Turpin, D. H., Lefebvrc, D.D. and Layzell, D.B. (eds).1997. Plant Metabolism (2nd Ed.)Longman, Essex, England.

3 Gaiston, A.W.1989. Life Processes in Plants. Scientific American Library, Springer-Verlag, New York, USA.

4 Hooykass P.J.J., Hall, M. A. and Libbenga, K.R.(eds).1999. Biochemistry and Molecular Biology of plant Horm. Elsevier, Amsterdam, The Netherlands.

5 Hopkins, W.G. 1995. Introduction to Plant Physiology.John Wiley & Sons, Inc., New York, USA.

6 Jones R, Ougham H, Thomas H and Waaland S 2013 The Molecular life of plants. Wiley-Blackwell Publ., USA

6 Lodish, H., Berk, A., Zipursky S.L., Matsudaira, P., Baltimore, D and Darnell, J. 2000.Molecular Cell Biology (4thed). W. H. Freeman and Company. New York ,USA.

7 Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones (2nded). Springer-Verlag, New York, USA.

8 Nobel, P.S.1999. Physicochemical and Environmental Plant Physiology (2nd ed). Academic Press, Diego, USA.

9 Salisbury, F.B. and Ross, C.W.1992: Plant Physiology (4thed). Wadsworth Publishing Co., California, USA.

10 Singhal G.S., Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee.1999: Concepts in Photobiol Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.

11 Taiz, L. and Zeiger, E. 1998: Plant Physiology. Sinaucr Associates, Inc., Publishers, Massachus, USA.

12 Thomas,B. and Vince-Prue,D.1997: Photoperiodism in Plants (2nd ed). Academic Press, San Diego, USA.

13 Westhoff, P.1998: Molecular Plant Development: From gene to plant. Oxford University Press, Oxford, UK.

14 Dey, P. M. And Harborne, J. B. 2000: Plant Biochemistry ,Harcourt Asia PTE Ltd. A Harcourt Publishers International Company, 583 Orchard Road 09-01 Forum Singapore

15 Ranjan, purohit, Prasad 2003: Plant Hormones Action and Application, Agrobios(India), agro house, behind Nasrani cinema Chopasani Road, Jodhpur -34

Semester -II

MBFS22: Plant Development and Reproduction

Objectives:

- **Understanding the basic growth kinetics and growth patterns in plants**
- **Understanding the plant growth regulators with respect to plant growth and metabolism**
- **Understanding dormancy, senescence and their influences on plant growth and reproduction.**

Outcomes:
After successful completion of the course the students will be able to

- **Know the basic growth kinetics and role of phytohormones in plant development**
- **Know the molecular mechanism of growth and differentiation of root, leaf flowers and seeds**
- **Learn to use biomolecules for flower formation, seed setting, senescence effects.**

Module I: Plant development (12 Hrs.)

Plant growth kinetics and patterns of growth.

Seedling growth: Tropisms; Photomorphogenesis of seedling; hormonal control of seedling growth.

Shoot Development: Organization of shoot apical meristem (SAM); cytological and molecular analysis of SAM; regulation of cell fate in meristem; tissue differentiation in the shoot.

Phytohormones: Classification, chemical nature and their role in plant development.

Module II:Plant development contd.... (12 Hrs.)

Leaf growth and differentiation: Determination; phyllotaxy; control of leaf form; differentiation of epidermis (with special reference to stomata & trichomes) and mesophyll.

Root Development: Organization of root apical meristem (RAM); vascular tissue differentiation; lateral root hairs; root microbe interactions.

Flower Development: Physiology of flowering, florigen concept and photoperiodism, Genetics of floral organ differentiation; homeotic mutants in *Arabidopsis* and *Antirrhinum*.

Pollination mechanisms and vectors.

Module III: Reproduction (12 Hrs.)

Male Gametophyte: Structure of anther, microsporogenesis, tapetum; pollen development and gene expression; male sterility; sperm dimorphism; pollen germination; pollen tube growth and guidance.

Female Gametophyte: Ovule types; megasporogenesis; organization of embryo sac; structure of embryo sac cells.

Pollen-pistil interaction, self-incompatibility and fertilization; Structure of the pistil; pollen-stigma interactions, double fertilization; *in vitro* fertilization.

Module IV:Reproduction contd….. **(12 Hrs.)**

Seed Development and fruit growth: Endosperm development; embryogenesis; ultrastructure and nuclear cytology; storage proteins of endosperm and embryo; polyembryony; apomixes; embryo.

Fruit development and growth

Latent life: Dormancy; Importance and types of dormancy; seed dormancy; overcoming seed dormancy; bud dormancy.

Senescence and Programmed Cell Death (PCD): Basic concepts; types of cell death, PCD in life cycle of plants; metabolic changes associated with senescence and its regulations; influence of hormones and environmental factors on senescence.

Suggested readings

1) Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th revised and enlarged edition). Vikas Publishing House, New Delhi.

2) Fageri, K. and Van der Pol, L. 1979. The Principles of Pollination Ecology. Pergamon Press, Oxford.

3) Fahn, A. 1982. Plant Anatomy, (3rd edition). Pergamon Press, Oxford.

4) Fosket, D.E. 1994. Plant Growth and Development.A molecular Approach. Academic Press, San Diego.

5) Howell, S.H. 1998, Molecular Genetics of Plant Development. Cambridge University Press, Cambridge.

6) Leins, P., Tucker, S.C. and Endress, P.K. 1988. Aspects of Floral Development. J. Cramer, Germany.

7) Lyndon, R.F., 1990. Plant Development.The Cellular Basis. Unnin Hyman, London.

8) Murphy, T.M. and Thompson, W.F. 1988. Molecular PlantDevelopment. Prentice Hall, New Jersey.

9) Proctor, M. and Yeo, P. 1973. The Pollination of Flowers.William Collins Sons, London.

10) Raghavan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge.

11) Raghavan, V. 1999. Developmental Biology of Flowering Plants.Springer -Verlag, New York.

12) Raven, P.H., Evert, R.F. and Eichhorn, S.E. 1992. Biology of Plants (5th Edition).worth, New York.

13) Steeves, T.A. and Sussex, I.M. 1989. Patterns in Plant Development (2nd edition). Cambridge University Press, Cambridge.

14) Sedgely, M. and Griffin, A.R. 1989. Sexual Reproduction of Tree Crops, Academic Press, London.

15) Waisel, Y., Eshel, A. and Kafkaki, U. (eds) 1996. Plant Roots: The Hidden Hall (2nd edition.) Marcel Dekker, New York.

16) Shivanna, K.R. and Sawhney, V.K. (eds) 1997. Pollen Biotechnology for Crop Production and Improvement, Cambridge University Press, Cambridge.

17) Shivana, K.R. and Rangaswamy, N.S. 1992. Pollen Biology: A Laboratory Manual. Springer-Verlag, Berlin.

18) Shivana, K.R. and Johri, B.M. 1985. The Angiosperm Pollen: Structure and Function. Wiley Eastern Ltd., New York.

19) The Plant Cell. Special issue on Reproductive Biology of Plants, Vol. 5(10) 1993.The American Society of Plant Physiologists, Rockville, Maryland, USA.

20) On line Journals available on UGC -VSAT

Suggested Laboratory / Field Exercises (Any 12)

1. Tissue systems, meristem, vascular and cork cambium.

2. Internal structure of root, stem and leaf (dicot and monocot), advanced secondary growth in dicot stem and root.

3. Anomalies in primary and secondary structure of stem.

4. Study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum* and *Hydrilla*.

5. Study of cytohistological zonation in the shoot apical meristem (SAM) in sectioned and double-stained permanent slides of a suitable plant such as *Coleus, Kalanchoe*, Tobacco.

6. Examination of shoot apices in a monocotyledon in both T.S. and L.S. to show the origin and arrangement of leaf primordia.

7. Study of alternate and distichous, alternate and superposed, opposite and superposed; opposite and decussate leaf arrangement.

8. Examination of rosette plants (*Launaea, Mollugo, Raphanus, Hyoscyamus* etc.) and induction of bolting under natural conditions as well as by GA treatment.

9. Microscopic examination of vertical sections of leaves such as *Cleome, Nerium*, Maize and Wheat to understand the internal structure of leaf tissues and trichomes, glands etc. Also study the C3 and C4 leaf anatomy of plant.

10. Study of epidermal peels of leaves such as *Coccinia, Gaillardia, Tradescantia, Thunbergia*, etc. to study the development and finalstructure of stomata and prepare stomatal index. Demonstration ofthe effect of ABA on stomatal closure.

11. Study of whole roots in monocots and dicots. Examination of L.S. of root from permanent preparation to understand the organization of root apical meriste m and its derivatives. (use maize, aerial roots of banyan, *Pistia*, *Jussieua* etc.).

12. Origin of lateral roots.

13. Study of leguminous roots with different types of nodules.

14. Study of microsporogenesis and gametogenesis in sections of anthers.

15. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (Maize, Grasses, *Crotolaria, Tradescantia, Brassica, Petunia, Solanum melongena*, etc.)

13. Tests for pollen viability using stains and in vitro germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.

14. Estimating percentage and average pollen tube length *in vitro*.

15. Role of transcription and translation inhibitors on pollen germination and pollen tube growth.

16. Pollen-pistil interaction, self-incompatibility, *in vitro* pollination.

17. Study of ovules in cleared preparations; study of monosporic, bisporic and tetrasporic types of embryo sac development through examination of permanent stained serial sections.

18. Field study of several types of flower with different pollination mechanisms (wind pollination, thrips pollination, bee/butterfly pollination, bird pollination).

19. Emasculation, bagging and hand pollination to study pollen germination, seed set and fruit development using self compatible and obligate outcrossing systems.

20. Study of cleistogamous flowers and their adaptations.

21. Study of nuclear and cellular endosperm through dissections and staining.

22. Isolation of zygotic globular, heart-shaped, torpedo stage and mature embryos from suitable seeds and polyembryony in citrus, jamun (*Syzygium cumini*) etc. by dissections.

23. Study of seed dormancy and methods to break dormancy.

Semester II

MBFS23: Cell and Molecular Biology-I

Objectives:

- **Understanding the structures and functions of the cell wall, plasma membrane and plasmodesmata**
- **Understanding the structures and functions of cell organelles, cytoskeleton, nuclear envelope, and structure of DNA**
- **Understanding various types of stresses and defense mechanisms in plants and apply this knowledge.**

Outcomes:

After successful completion of the course the students will be able to

- **Know the cell wall & cellular organization of the eukaryotic and prokaryotic cells**
- **Learn the cell cytoskeleton and its role**
- **Learn and apply techniques of stress related problems in plants**

Module I: (12 Hrs.)

Cell wall: Structure; function; biogenesis and growth.

Plasma membrane: Membrane architecture (fluid mosaic model); sites for ATPases; membrane transport-ion carriers, channels, pumps and aquaporins; receptors.

Plasmodesmata: Structure, role in movement of molecules and macromolecules; comparison with gap junction.

Module II: (12 Hrs.)

Cellular organelles: Ultra-structure and function of golgi complex, lysosomes, peroxisomes, endoplasmic reticulum, mitochondria, chloroplast and plant vacuoles.

Cell shape and motility: The cytoskeleton; organization and role of microfilaments, intermediate filaments and microtubules; motor movements, implications in cell division, flagellar & other movements.

Module III : (12 Hrs.)

Nucleus: Ultrastructure, nuclear pores, nucleolus, DNA structure A, B and Z forms, replication in prokaryotic and eukaryotic cells, DNA replication proteins, damage and repair.

Module IV : (12 Hrs.)

Stress biology: Definition and classification of stress.

Biotic stress: Plant defence mechanism (passive and active); HR and SAR; modulation of plant metabolism in response to biotic stress: early and late response; production of ROS, induction of enzymes; PR proteins; R-genes.

Abiotic stress: Effect of water, temperature, salt and light stress on plants; developmental and physiological mechanisms protecting plants against environmental extremes.

Suggested readings

Atherly, A.G., Griton, J.R. and Mc Donald, J. F. 1999.The Science of Genetics.Saunders College Pub. Fort Worth, USA

Buchanan, B.B., Gruissem, W. and Jones, R. L. 2000 Biochemistry and Molecular Biology of Plants. American Soc. Of Plant Physiologists, Maryland, USA.

Bush, H. Rothblum, L. 1982. Vol. X. The Cell Nucleus RDNA part A. Academic Press.

Dc, D. N. 2000 Plant cell vacuoles: An introduction. CSIRO Publication, Collingwood, Australia.

De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology 8Ed. B. I. Waverly Pvt. Ltd., New Delhi.

Jones R, Ougham H, Thomas H and Waaland S 2013 The Molecular life of plants. Wiley-Blackwell Publ., USA

Karp, G. 1999 Cells and Molecular Biology; Concepts and Experiments. John Wiley & Sons, Inc., USA.

Kleinsmith, L.J. and Kish, V.M. 1995 Principles of Cell and Molecular Biology (2nd Edi.)Harper Collins Coll. Publisher, New York, USA.

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Russel, P. J. 1998 Genetics (5th Edi.) The Banjamin/ Cummings Publishing Com. Inc., USA

Wolf, S.L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA

Taiz, L. and Zeiger, E. 1998: Plant Physiology. Sinaucr Associates, Inc., Publishers, Massachus, USA

Practicals

1. To study salivary gland chromosomes of Chironomas and Drosophila.
2. To isolate mitochondria and determine the activity of its marker enzyme SDH.
3. To isolate bacterial and plant DNA and quantify them by spectrophotometric method.
4. To demonstrate the semi-permeability of the plasma membrane.
5. To study the activity of Na/K ATPase.
6. To demonstrate different components of cytoskeleton in the suitable material.

7. To perform flagellar staining.

8. Isolation of DNA and preparation of Cot-curve.

9. Demonstration of vital structure and functions of cell

10. To study the activity of PAL in the seedlings challenged with elicitors.

11. To study the induction of antioxidant enzymes in the seedlings challenged with elicitors.

12. To study the effect of water stress on the seedling growth and its chlorophyll content.

13. To study the effect of temperature stress on the seedling growth and its chlorophyll content.

14. To study the effect of salt stress on the seedling growth and its chlorophyll content.

Suggested readings (for laboratory exercises)

Fukui, K. and Nakayama, S. 1996. Plant Chromosomes: Laboratory Methods. CRS Press, Boca Raton, Florida.

Glick, B. R. and Thompson, J.E. 1993. Methods in Plant Molecular Biology and Biotechnology.CRC Press, Boca Raton, Florida USA.

Goswami, H. K. 1986. Practical cytology – Applied Genetics and Biostatistics Himalaya Pub. House, Bombay.

Gunning, B.E.S. and Steer, M.W. 1996. Plant Cell Biology: Structure and Function. Jones and Barlett Publishers, Boston, Massachusetts.

Hall, J.L. and Moore, A.L. 1983.Isolation of Membranes and Organelles from Plant Cells Academic Press, London, U.K.

Harris,N. and Oparka, K.J. 1994. Plant Cell Biology: A Practical Approach. IRL Press, at Oxford University Press, Oxford, U.K.

Sharma, A.K. and Sharma, A. 1999. Plant Chromosomes: Analysis, Manipulation and Engineering. Har Academic Publishers, Australia.

Shaw, C.H. (Ed.), 1988. Plant Molecular Biology: A Practical Approach. IRL Press, Oxford.Techniques, 2nd edition. PAS, IRL Press at Oxford University Press, Oxford.

References: Online journals available on UGC V-SAT programme.

Review Journals:

Annual Review of Plant Physiology and Molecular Biology

Biochemistry and Cell Biology

Cell Death and Differentiation

Cell Motility and the Cytoskeleton

Cellular Physiology and Biochemistry

Current Advances in Plant Sciences

European Journal of Cell Biology Journal of Cell Science

Nature Reviews: Molecular and Cell Biology

Protoplasma-An International Journal of Cell Biology

Trends in Cell Biology

Trends in Plant Sciences

Semester II

MBFS24 :Angiosperms-I and Ethnobotany

OBJECTIVES:-

- **Understanding the morphology of flowers of dicot and monocots for proper identification of angiospermplants**
- **Understanding plant taxonomy and modern trends in taxonomy and conservation methods of ethnobotanical plants**

OUTCOMES:

After successful completion of the course the students will be able to

- **Learn basic structure of flowers for identification and distinguishthem**
- **Apply taxonomic tools in taxonomic classification, modern and numerical taxonomy andphylogeny**

Module I: (12 Hrs.)

Angiosperm Morphology, structural units and floral symmetry, dicot and monocot flower; structure, diversity origin and evolution of stamen, carpels; placentation types.

Floral adaptation to different pollinators

Module II: (12 Hrs.)

Angiosperm Taxonomy: Scope, aims, principles of taxonomy, historical development of plant taxonomy, relative merits and demerits of major systems of classifications. Taxonomic structure: taxonomic hierarchy, concept of taxa, concept of species, concept of genus and family; Taxonomic character, Analytic versus synthetic character, qualitative versus quantitative characters.

Module III: **(12 Hrs.)**

Taxonomic evidence: Morphology, anatomy, embryology, palynology, cytology.

Taxonomic tools: herbarium, floras, monographs, botanical gardens, biochemical and molecular techniques, computers andGIS. Electronic Herbarium and digital database preparation, Important websites for taxonomic literature.

Module IV: **(12 Hrs.)**

Biosystematics: The population concept phenotypic plasticity, biosystematic categories, methods of biosystematics studies. Scope and limitations. Numerical taxonomy: principles, aims and objectives, cladistics in taxonomy, homology, homoplasy, monophyly, polyphily.

Ethnobotany:Definition; scope and significance; Sacred groves and their role in conservation.

Practicals

1. To study the floral symmetry in varioustaxa.
2. To study and work out the differences in dicot and monocotflower.
3. To study the variation in stamens andcarpels.
4. To study placentation types in varioustaxa.
5. To study the floral adaptations forpollination.
6. To study anatomical features of varioustaxa.
7. To study cytological features of varioustaxa.
8. To prepare a cladogram on the basis of various morphological features of the species belonging to agenus.

Suggested Readings

Devis, P.H. and Heywood, V. H. 1973.Principles of angiosperms taxonomy. Robert E. Kreiger Pub. Co. Newyork.

Grant, V. 1971.Plant Speciation, Columbia University press, London.

Grant W. F. 1984. Plant Biosystematics.Academic press, London.

Harisson, H.J. 1971. New concept in flowering plant Taxonomy. Hickman educational books Ltd.London.

Hislop-Harisson, J. 1967.Plant Taxonomy.English Language Book Sco.And Edward Arnold Pub.Ltd,UK.

Heywood, V. H. and Moore, D. M. 1984. Current concepts in Plant Taxonomy. Academic Press,London.

Joncs, A. D. and Wibins, A. D. 1971. Variation and adaptation in Plant species Hickman and Co. New York.

Jones, S. B., Jr.and Luchsinger, A. E. 1986. Plant Systematics (gd edition). McGraw -Hill Book Co., New York.

Nordentam, B., El Gazaly, G. and kassas, M. 2000.Plant systematic for 21st century.Portland press.Ltd, London.

Radford, A. E. 1986. Fundamentals of plant systematic.Harper and Raw publication, USA.

Solbrig, O.T. 1970. Principles and methods of plant Sytematics. The Macmillan Co. Publication Co. Inc., USA.

Woodland, D. W. 1991. Contemporary Plant Syatematics, Pentice Hall, New Jersery.

Takhtajan, A. L. 1997. Diversity and classification of Flowering Plants. Columbia University

Press, New York.

Stebbins, G. L. 1974. Flowering Plants-evolution Above species Level. Edvard Arnold Ltd, London.

Joncs, A. D.; Wibins, A. D. 1971. Variation and adaptation in Plant species Hickman and Co.

Jones, S. B., Jr.and Luchsinger, A. E. 1986. Plant Systematics (gd edition). McGraw Hill Book Co., New Delhi.

Plant systematics An integrated approach (Third Edition), Gurucharan Singh, Science Publishers, 234 May street POB 699 Enfield, New Hampshire 03748 USA.

Systematic Botany (ANGIOSPERMS), Fourteenth Edition, Prof R. C.Mathur, Agra Book Store

Plant Systematics & Biosystematics Classical and Modern Methods, Rana, Nair, Upreti, New India Publishing Agency, New Delhi- 110034

Plant Taxonomy Saxena and Saxena, 7th revised edition, Pragati Prakashan Meerut.

Taxonomy of Angiosperms, AVSS sambamurty,I K International Pvt. Ltd, New Delhi.

Flowering plants, Armen Takhtajan, Second Edition, Springer.

Taxonomy of Angiosperms V.N. Naik - 1984

Taxonomy of Angiosperms V. S. S. Sambamurty - 2010

Taxonomy of Angiosperms Pandey&Misra - 2008

Taxonomy of Angiosperms V. Singh - 1981

Introduction to Taxonomy of Angiosperms Verma, Verma B. K. - 2011

Taxonomy of Angiosperms T. Pullaiah - 2007

Taxonomy of Angiosperms R. Nair - 2010

Taxonomy of Angiosperms B. P. Pandey - 2007 -

Taxonomy of Angiosperms ArunThuruthikkattil Ram, Mohammed Shareef K. -2015

PLANT TAXONOMY 2E SHARMA - 2011

Taxonomy of Angiosperms: Text Book for Univeristy StudentsV. Singh, D. K. Jain - 1985

Taxonomy of Angiosperms P. C. Vasishta - 1974

Taxonomy of Angiosperms (systematic Botany) for University Students

A Text Book of Practical Botany Vol II, Bendre, Kumar 7th Edition, Rastoi Publications, Meerut.

Semester III

MBSS31 : Plant Ecology and Conservation Biology

Objectives:

- **Understanding the concept of community, ecological succession trends and climax.**
- **Understanding the structures and functions of ecosystem**
- **Understanding and applying various methods of plant conservation; importace and maintenance of National parks, sanctuaries, Biospheres, botanical gardens etc.**

Outcomes:

After successful completion of the course the students will be able to

- **Learn structure and function of ecosystems and their succession and climax formation**
- **Learn and apply the knowledge of conservation methods.**

Learn and apply techniques of Botanical gardens etc.

Module I: **(12 Hrs.)**

Vegetation organization: Concepts of community and continuum, analysis of communities (analytical ad synthetic characters): interspecific associations, concept of ecological niche.

Vegetation development: Temporal changes (cyclic and non-cyclic); mechanism of ecological succession (relay floristics and initial floristic composition; facilitation, tolerance and inhibition models).

Community function- Dynamics and succession, laboratory model, trends in succession, climax concept, General introduction to autecology.

Module II: **(12 Hrs.)**

Ecosystem organization: Structure and functions; primary production (methods of measurement, global pattern, controlling factors); energy dynamics (trophic organization, energy flow pathways, ecological efficiencies); litter fall and decomposition (mechanism, substrate quality and climatic factors); global biogeochemical cycles of C, N, P and S. Nutrient budget in forest and aquatic ecosystem.

Module III: **(12 Hrs.)**

Ecosystem stability: Concept (resistance and resilence); Ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems; ecology of plant invasion; environmental impact assessment; ecosystem restoration.

Ecological management: Concepts; sustainable development; sustainability indicators.

Module IV: **(12 Hrs.)**

IUCN- General account, categories, Commissions, role in conservation; Red Data Book

Protected areas- Sanctuaries, National parks, Biosphere reserves.

Wetlands and Mangroves

Coral Reefs- Types, importance, artificial reefs, conservation measures

Botanical gardens, Seed Banks; *In-vitro* repositories; Cryobanks,

Practicals

Based on Biostatistics

1. Calculate mean, variance, standard deviation and coefficient of variation for comparing two means related to given ecological data.
2. Calculate mean, variance, and to use t-test for comparing two means related to given ecological data.
3. To find out association between important grassland species from the given data using chi-square test.
4. To find out relationship between two ecological variables using correlation analysis.
5. To perform the one-way ANOVA from the given data.

Based on Ecology

1. A trip to the grass land/ forest/ water body to get acquainted with their plant species.
2. Distribution pattern of different plant species determined by Quadrate/Transect/ Point centered Quarter methods.
3. To determine minimum size and number of quadrats required to study grassland.
4. Qualitative parameters of distribution of plant species, Frequency, Density, Basal cover, dominance, Abundance and IVI.
5. To determine diversity indices (Shanon-Weiner, species richness, B-diversity) from given data.
6. To estimate DO content in the eutrophic and oligotrophic water samples by azide modification of Winklers method.
7. To determine gross and net phytoplankton productivity by light and dark bottle method.
8. To estimate chlorophyll content in SO_2 fumigated and unfumigated leaves.
9. Analysis of soils of two different areas i.e. Cropland and forest/ grassland for certain nutrients, CO3, NO3, Base deffiency.
10. To study ecological adaptations of the given plants

Suggested readings

1. Ambasht R.S. 1968. Freshwater ecosystem-Manual of Ecology 123-137 (See Misra KC et al 1968)

2. Ambasht R.S. 1966 Conservation Ecology, Abs Proc School on Plant Ecol (Full paper in press Oxford and IBH Calcutta).

3. Ambasht R.S. 1995 A text book of plant ecology Student and co. Varanasi-5

4. Anderson JM Ecology for environmental sciences: biosphere ecosystems and man

5. Billings WB 1964 Plants and the ecosystem Macmillan & co, London.

6. Clements FE 1916 Plant succession, An analysis of the development of vegetation. Carnegie Institute of Washington.

7. Cragg JB 1968 The theory and practice of conservation, IUCN Publ, New Series No. 12, 25-35.

8. Dash MC 1993 Fundamentals of Ecology WB Saunders and co. Philadelphia USA.

9. Deangelis DL Energy flow, nutrient cycling and ecosystem resilience. Ecology 56, 23843.

10. Dwivedi Rama Shankar 1968. The decomposer system manual of ecology See Misra KC et al 1970)

11. Frankel OH, Soule ME, 1981, Conservation and Evolution, Cambridge Univ Press.

12. Grace J 1983, Plant atmosphere relationships. Champman & Hall.

13. Greig Smith P 1983, Quantitative plant ecology, Univ California Press, California.

14. Hutchings MJ (ed) 1988, Plant population biology, Blackwell.

15. Hutchinson GE 1978, An introduction to population ecology. Yale Univ. Press.

16. Kochhar PL 1986 Plant Ecology Ratan prakashan, Mandi, Agra.

17. Krebs GJ 1972 Ecology Harper and Row Publ, New York.

18. Kumar HD 1994 Modern concepts of ecology. Vikas publishing house pvt ltd, New Delhi.

19. May RM (ed) 1981 Theoretical Ecology, Blackwell.

20. Odum EP 1963 Ecology Holt Reinhart and Winston Inc.

21. Odum EP 1983 Basic Ecology, Saunders Publ Philadelphia.

22. Reynolds CS 1984 The ecology of phytoplankton, Cambridge Univ Press

23. Silverton JW 1982 Introduction to plant population ecology, Longman.

24. Southwick CH 1983 (ed) Global Ecology Sinauer.

25. Whittaker RH 1975 Communities and Ecosystems (2nded) MacMillan, New York.

SEMESTER III
MBSS32: Angiosperm II

Objectives:

- Understanding the morphology and descriptions of various dicot and monocots groups for proper identification of angiospermplants
- Understanding plant biodiversity concept, role**Outcomes:**

After successful completion of the course the students will be able to

- Learn and apply knowledge basic structure of flowers for identification and distinguish themfamily-wise.
- Training in usage of floras for identification of species, field trips for preparation of field notes and compilation of plantdata.

3T2 Core ANGIOSPERMS II (REVISED 2020 Onwards)

MODULE I (12 Hrs.)

Probable ancestors of angiosperms, primitive living angiosperms, speciation and extinction, abominable mystery, and fossil angiosperms, IUCN Categories of threat, distribution and global pattern of biodiversity.

MODULE II (12 Hrs.)

Plant Nomenclature: History of nomenclature, polynomial and binomial systems, salient features of ICBN, effective and valid publications, Rank of taxa, rule of priority and its limitations, typification, author citation, rejection of names and names of hybrids, A brief account of international code of nomenclature of cultivated plants.

MODULE III (12 Hrs.)

Biological diversity concept and levels, role of biodiversity in ecosystem functions and stability, endemism, hotspots and hottest hotspots, invasions and introductions, local plant diversities and its socioeconomic importance.

MODULE IV (12 Hrs.)

Families of angiosperms: Characteristic features, interrelationships, economic importance's and classification as per APG –IV of following group of families:

ANITA grade Amborellaceae, Hydatellaceae,

Magnoliids: Magnoliaceae, Monocots: Araceae, Commelinoids: Arecaceae

Eudicots: Papaveraceae, Eursidies I: Amaranthaceae, Eurocid II: Malvaceae, Asterids: Sapotaceae, Euasterids: Gentianaceae, Acanthaceae, Euasteries-II Apiaceae, Asteraceae

Practicals

1. Description of specimens from representative, locally availablefamilies.

2. Description of various species of a genus, location of key characters and preparation keys at genericlevel.

3. Location of key characters and use of keys at familylevel.

4. Field trips within and around the campus; compilation of field notes and preparation herbarium sheets of such plants, wild or cultivated as are abundant.

5. Comparison of different species of genus and different genera of family to calculate similarity coefficients and preparations of dendrograms.

6. Programming DELTA of at least 20 species with images.

Suggested readings

- Devis, P.H. and Heywood, V. H. 1973.Principles of angiosperms taxonomy. Robert E. Kreiger Pub. Co. Newyork.
- Grant, V. 1971.Plant Speciation, Columbia University press, London. Grant W. F. 1984. Plant Biosystematics.Academic press, London.
- Harisson, H.J. 1971. New concept in flowering plant Taxonomy. Hickman educational books Ltd.London.
- Hislop-Harisson, J. 1967.Plant Taxonomy.English Language Book Sco.And Edward Arnold Pub.Ltd,UK.
- Heywood, V. H. and Moore, D. M. 1984. Current concepts in Plant Taxonomy. Academic Press,London.
- Joncs, A. D. and Wibins, A. D. 1971. Variation and adaptation in Plant species Hickman and Co. NewYork.
- Jones, S. B., Jr.and Luchsinger, A. E. 1986. Plant Systematics (gd edition). McGraw -Hill Book Co., New York.
- Nordentam, B., El Gazaly, G. and kassas, M. 2000.Plant systematic for 2ft century.Portlant press.Ltd, London.
- Radford, A. E. 1986. Fundamentals of plant systematic.Harper and Raw publication, USA.
- Solbrig, O.T. 1970. Principles and methods of plant Sytematics. The Macmillan Co. Publication Co. Inc., USA.
- Woodland, D. W. 1991. Contemporary Plant Syatematics, Pentice Hall, New Jersery.
- Takhtajan, A. L. 1997. Diversity and classification of Flowering Plants. Columbia University Press, New York.
- Stebbins, G. L. 1974. Flowering Plants-evolution Above species Level. Edvard Arnold Ltd, London.
- Joncs, A. D. and Wibins, A. D. 1971. Variation and adaptation in Plant species Hickman and Co.
- Jones, S. B., Jr.and Luchsinger, A. E. 1986. Plant Systematics (gd edition). McGraw Hill

Book Co., New Delhi.

- Plant systematics An integrated approach (Third Edition), Gurucharan Singh, Science Publishers, 234 May street POB 699 Enfield, New Hampshire 03748 USA.
- Systematic Botany (ANGIOSPERMS), Fourteenth Edition, Prof R. C.Mathur, Agra Book Store
- Plant Systematics & Biosystematics Classical and Modern Methods, Rana, Nair, Upreti, New India Publishing Agency, New Delhi- 110034
- Plant Taxonomy Saxena and Saxena, 7th revised edition, Pragati Prakashan Meerut.
- Taxonomy of Angiosperms, AVSS sambamurty,I K International Pvt. Ltd, New Delhi.
- Flowering plants, Armen Takhtajan, Second Edition, Springer.
- Taxonomy of Angiosperms V.N. Naik - 1984
- Taxonomy of Angiosperms V. S. S. Sambamurty - 2010
- Taxonomy of Angiosperms Pandey&Misra - 2008
- Taxonomy of Angiosperms V. Singh - 1981
- Introduction to Taxonomy of Angiosperms Verma, Verma B. K. - 2011
- Taxonomy of Angiosperms T. Pullaiah - 2007
- Taxonomy of Angiosperms R. Nair - 2010
- Taxonomy of Angiosperms B. P. Pandey - 2007 -
- Taxonomy of Angiosperms ArunThuruthikkattil Ram, Mohammed Shareef K. -2015
- PLANT TAXONOMY 2E SHARMA - 2011
- Taxonomy of Angiosperms: Text Book for Univeristy StudentsV. Singh, D. K. Jain - 1985
- Taxonomy of Angiosperms P. C. Vasishta - 1974
- Taxonomy of Angiosperms (systematic Botany) for University Students
- A Text Book of Practical Botany Vol II, Bendre, Kumar 7th Edition, Rastoi Publications, Meerut.

Semester III
MBSS33PN- Elective I: (Palynology I)

Objectives:

- **Know the history, palynological centres in India**
- **Understanding the structure of pollen & pistil and their importance.**
- **To Study pollen morphology, pollination, floral adaptations to diff. Pollinators, applications ofpollen biology.**
- **Knowledge on different types of honeys, methods of analysis uses of honey in medicine, cosmetics etc.**

Outcomes:

- **After successful completion of the course the students will be able to**
- **Understand the different aspects of pollen, pistil and pollination Applying knowledge with reference to agriculture, horticulture, medicine.**
- **To get acquainted with reproductive plant organs as stamen & Pistil**
- **To know the various pollination methods, plant-pollinator interactions, various pollinating agents useful for plant breeding experiments.**
- **To identify and classify palynomorphs and use palynofacies to reconstruct sedimentary environments and evaluate their oil/ petroleum, coal potential**
- **To apply the knowledge gained in checking adulteration of honeys, identification of poisonous honeys, and use in curing human ailment, its different uses in agriculture and medicine.**

Module I (12 Hrs.)

General aspects of Palynology: -Historical background, Definition, basic concepts, scope,inter-relationship with other branches of Botany, Applications, Indian work on Palynology,Palynological centres in India.

Microsporogenesis : Stamen initiation, anther differentiation- anther initiation, anther wall,Tapetum, structure and functions, its role in pollen development, pollen/microspore and wall development, production and deposition of sporopollenin.

Pistil : Structure and function of stigma and style, stigma receptivity and its importance.

Module II **(12 Hrs.)**

Pollination Biology -Origin of pollination biology/anthecology, Spore and pollen dispersal in lower plants and gymnosperms, Pollination in angiosperms- types of pollination, floral adaptation to different pollinators(mode, style) flowers pollinated biotically (Hymenoptera, Diptera, Coleoptera, Lepidoptera,birds, bats) and abiotically (wind, water), pollination-plant interactions, special devices associated with pollinator attraction - pollen, nectar, Elaiophores, resin glands, osmophores, floral scent and perfume flowers.

Palaeopalynology:- Palynomorphs, their preservation in diverse lithic types, techniques involved in the recovery and concentration of spores and pollen from clays, shales, coals and lignites. Maceration techniques, Application of Palynology in relation to oil and coal exploration. Role of spores and pollen in stratigraphy, index spores.

Module III (12 Hrs.)

Phylogeny of Pollen and spores, Systematic palynology-monocotyledoneae and dicotyledoneae, evolutionary trends among pollen grains based on palynotaxonomical works, Palynology of spores / pollen- Algae, Fungi, Bryophytes, Pteridophytes and pollen types of Gymnosperms.

Pollen morphology of Angiosperms.: Introduction- Pollen units, polarity, symmetry, Shape, size, Apertures size, shape of thepollen grain, sporoderm stratification, Apertures-NPC System of classification, Apertural types, Exine ornamentation, LO analysis, evolutionary trends in exine structure, trends of evolution in apertural pattern, Techniques for the preparation of pollen slides, LM, SEM and TEM studies of pollen and its significance.

Module IV **(12 Hrs.)**

Melittopalynology- Pollen analysis of honey-methods, qualitative and quantitative, social organization of honey bees, foraging behavior, geographical and floral origin of honey, its chemical analysis, adulteration of honeys, physical characteristics of honey, deterioration of honey, heavy metal contamination in honey, honey as environmental monitors, unifloral and multifloral honey, Applied Melissopalynology - Bees as pollinators, role of apiaries in crop production , Role in Agriculture/ Horticulture, Use of honey in medicine, cosmetics, confectionary and other applications, Pollen loads, analysis, Bee pollen, chemical composition, utility, and its role in curing various human ailments.

List of practicals:

Section A. Basic aspects / Pollen Morphology (At least any FIVE expts.)

1. To study structure ofstamen
2. Study of permanent slides ofmicrosporogenesis
3. Field study on different pollinationmechanism
4. To study structure ofpistil
5. Preparation of glycerinjelly
6. Preparation of pollen- Acetolysistechnique
7. Preparation of pollen – Wodehousetechnique.
8. Study of pollen types using acetolysed and non-acetolysed pollen.Pollen
9. morphology polarity, symmetry, shape, size, sporoderm stratification aperture NPC(To study the pollen types from at least 30 different species, Angiosperms preparation of permanent slides.)
10. Preparation and palynological description in technical language (at least 10 speciesof Angiosperms).
11. Interpretation of selected electron micrographs (SEM, TEM) ofpollen.
12. Preparation, description and identification of spores of Algae, Fungi, Bryophytes, Pteridophytes and pollen types ofGymnosperms.

Section B. Aeropalynology/Melittopalynology/Palaeopalynology (At least two expts.)

13. Use of pollen traps to study local air-spora.
14. Analysis of aerospora slides.
15. Preparation of reference slides by different techniques, culture method (culture of fungi/Algae)
16. Preparation of slides honeysamples
17. Analysis of honey samples for qualitative and quantitative study of pollen contents.
18. Estimation of pollen load from bee hive or bees/pollinator
19. Analysis of coal samples for microfossils with special reference to pollen and spores.
20. Preparation of allergenic extract of pollen.

Section C Pollen Physiology/ecology/biochemistry/ecology. (At least three expts)

21. To study pollen production of the given flowers.

22. To study pollen viability of the given flowers.
23. To study percentage of pollen germination & rate of pollen tube growth.
24. To study different techniques of pollen storage

25. Effect of temperature and relative humidity on viability of stored pollen
26. Effect on Boron and Calcium on pollen germination and tube growth.
27. Semi-vivo technique to study pollen germination and pollen tube growth.
28. Multiple staining for localizing pollen tubes in thepistil
29. To study pollen germination and pollen tube growth in the pistil by employing aniline-blue fluorescence method
30. Cytochemical localization of esterase on stigmasurfaces
31. Cytochemical analysis of pollen and pollen tube for various metabolites like proteins, amino acids, carbohydrates, starch, ascorbic acid, DNA, RNA, lipids, lignin, pectin, cellulose, etc (at least five metabolites)
32. Study of pollen contents by paper chromatography/TLC.
33. Colorimetric estimation of proteins/carbohydrates of pollen grains
34. To separate pollen proteins by SDS-PAGE electrophoresis
35. Enzyme bioassay in pollen grains.

Recommended reading

Agashe S. N. – Paleobotany (1997) – Plants of the past their evolution paleoenvironment and applications inexploration ofFossil.

Agashe S. N. – Palynology and its Applications – Oxford and IBH Publishing Co. Pvt. Ltd. NewDelhi.

Alexander M.P. (1969). Differential staining of aborted and non-aborted pollen Stain Technol44:117-122.

Alexander, M.P. (1987). A method for staining pollen tubes in pistil. Stain Technol 62, 107- 112.

Alexander, M.P., Ganeshan S. (1990).An improved cellophane method for in vitro germination of recalcitrant pollen. Stain Technol 64:225-227. Archaeology, *Rev. Palaeobot. Palynol*21:171-185,

Baker, H.G. 1954. Aperture membranes in Studies of Pollen Morphology and Taxonomy. *Newphytologist*,54(3),

Banerjee, U.C. 1965,et al.Exine plasticity during pollen grain maturation. *J.palynol.*:70-89,

Banerjee, U.C.1967.U!trastructureof the tapetal membranes in grasses. *Grana palynologia*: 7,2-3,

Bhattacharya K., Majumdar M. and Gupta Bhattacharya S. (2006). A text book of Palynology.New Central Book Agency(P)Ltd.,Kolkata

Bhojwani, S .S. and S.P. Bhatnagar. 1978. The Embryology of Angiosperms. Vikas Publishing House, NewDelhi,

Bir Bahadur 1998. Nectary biology. Datt sons publications, NagpurBombay,

Bradley, D. E. 1958. The study of pollen grain surfaces in the electron microscope

New Phytologist Volume57, Issue2 : 226-229

Brooks. J. and G. Sha'w. 1978. Sporopollenin: A review of its chemistry, palaeochemistry and Geochemistry. Grana.17(2) :91-98.

Caulton Eric, Agashe S. N. -Pollen and Spores applications with special emphasis on Aerobiology andAllergy15.

Hague Joel P. , Stephen L. Dellaporta , Maria A. Moreno , Chip Longo 1 , Kimberly Nelson 1 and Albert P. Kausch Pollen Sterility—A Promising Approach to Gene Confinement and Breeding for Genetically Modified Bioenergy Crops Agriculture 2012, 2, 295-315; doi:10.3390/agriculture204029

Cresti, M., Gori P., Pacini E. (eds.) (1988) Sexual reproduction in higher plants. Springer, Berlin Heidelberg New YorkTokyo.

Cronquist, A. 1968. The evolution and classification of flowering plants, Nelson,London

Dafni Amots, Hesser Michel, Paeini Ettore – Pollen and Pollination-Springer Wien New York

Davis. P.H. and V.H. Heywood. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd,London,

Doyle James A(2005) Early evolution of angiosperm pollen as inferred from molecular and morphological phylogenetic analyses, Grana, 44:4, 227-251, DOI: 10.1080/00173130500424557

EI-Gazzar and M.K. Hamza. 1973. Morphology of the twin Pollinia of Asclepiadaceae. Pollen et spores XV(3-4)

Erdtman, G. 1945. Pollen Morphology and Plant Taxonomy IV Labiatae, Verbenaceae, Avicenniaceae. Svensk Botanisk Tidskrift.39(3),

Erdtman, G. (1966). Pollen morphology and plant taxonomy angiosperms hafner. New York.

Erdtman, G. (1969). Handbook of Palynology. Hafner, NewYork

Erdtman, G. 1943. An Introduction to Pollen Analysis. Chronica Botanica Co., Waltham, Mass. pp.239,

Erdtman, G. 1952. Pollen Morphology and Plant Taxonomy (An Introduction to Palynology-1, Angiosperms). Aimqvist, and Wicksell,Stockholm,

Erdtman, G. 1956. Current Trends in Palynological Research Work Grana Palynologica (N.S.)1:2,

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Semester III

MBSS33PP- Elective I:(Plant Physiology - I)

Objectives:

- **Understanding Plant growth and Development.**
- **Understanding the function of different growth regulators.**
- **Understanding seed physiology**
- **Understanding stress physiology**

Outcomes:

After successful completion of the course the students will be able to

- **Understand the aspects of plant growth and development**

Understand the aspects of seed physiology and stress physiology

Module:-I **(12 Hrs.)**

Plant Growth and Development: - Growth, Differentiation and development. Control of growth and development, genetic control of development, hormonalControl of development. Pattern of growth and development, Plant growth Kinetics- Growth through time, Plant organs- How they grow? Morphogenesis.

Nitrogen: Importance of nitrogen for growth and development,nitrogen cycle, biological nitrogen fixation, symbiotic nitrogen fixation in legumes

Module-II **(12 Hrs.)**

Growth Regulators (Plant Hormones): -Biosynthesis, Storage, breakdown and transport, physiological effects and movement of action., ABA, ethylene And nontraditional growth hormones, Jasmonate, Brassinosteriods, oligosachharins, polyamines, salisalate, nitric oxide, commercial application of plant growth regulators,

A brief idea about role of plant growth retardants: - a) CCC b) maleic hydrazide c) Trizoles a) TIBA

Module-III **(12 Hrs.)**

Seed physiology:-

Structure of monocot and dicot seed

Latent life -Seed dormancy: Importance and types of dormancy, overcoming seeddormancy, bud dormancy. Factors responsible for dormancy, mechanism of dormancy, methods of breaking the seed dormancy.

Germination of seed: types of germination, chemical Changes duringgermination, mobilization of reserve Food during germination, hormonalControl seed Germination

Post Harvest Physiology: Ripening of fruit and its regulation, metabolismof leafy vegetables during storage.

Seed development: Biochemical changes during development of seeds.

Module-IV **(12 Hrs.)**

Stress physiology: Response of plants to biotic(pathogen and insect) and abioticStress (water, temperature and salt)

a) Biotic Stress: - mechanism of resistance to biotic stress (HR, SAR) and tolerance to abiotic stress

b) Abiotic Stress:-

Water stress: - causes of water stress, drought effect On physiological processesin plants,various mechanism of drought resistance in plants.

Flooding stress: - nature of water logging stress. Effect of flooding onphysiological processes in plants. Mechanism of water logging tolerance

Salt stress :- definition of saline soil, physiological responses ofplants to salinitystress, halophytes and glycophytes mechanism of salinity tolerance in higherplants, genetic engineering for salt tolerance.

Thermal stresses: - Effect of high and low temperatures on plant metabolism,mechanism of high and low temperatures tolerance, cold hardening, role of HSP.

Oxidative stress: - Generation of reactive oxygen species, effect ofROS onmetabolism, ROX detoxification mechanisms in plants.

Suggested Readings (For theory):

Asana, R.D. and Sarin M.N. (1968): Crop Physiology in India IARI Publ.

Abdelhamid Elaissari, (2008). Colloidal Nanoparticles in Biotechnology, John Wiley

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Lodish, H., Berk, A., Zipursky S.L., Matsudaira, P., Baltimore, D and Darnell, J. 2000. Molecular Cell Biology (4thed). W. H. Freeman and Company. New York ,USA.

Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones (2nded). Springer- Verlag, New York, USA.

Mansfield, C.A. (1976): Effect of air pollutant on plants.

Marschner, H. W. (1986): Mineral nutrition of Higher Plants.

McLaren, J.S. (1985): Chemical manipulation of crop growth and Development.

Mehrotra, R.S. (1980): Plant Pathology.

Mahadevan ,A and Sridhar R.(1986) Methods in Physiological plant Pathology, Sivakami Publications, Madras

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Upeke, L. K. (1982): Tropical tree crops.

Westhoff, P.1998: Molecular Plant Development: From gene to plant. Oxford University Press, Oxford, UK.

Zuley G.L., (1998). Biochemistry, Wm.C .Brown Publishers USA.

Journals

- Annual reviews of Plant Physiology and Molecular Biology.
- Indian Journal of Plant Physiology.
- Journal of Experimental Botany.

Suggested Laboratory Exercises

1. Estimation of phenols from given plant material.
2. Estimation of proline from plant tissues under different environmental and physiologicalconditions.
3. Study the effects of red and infrared radiation on seed germination as affected.
4. Determination of gibberellic acid by half seed (cereal) method.
5. Demonstration of effects of auxin on abscission.
6. Demonstration of effects of cytokinin on senescence.
7. Demonstration of effects of abscission acid on stomatal regulation.
8. Preparation of cytoplasmic and chloroplastic LPC.
9. Estimation of Vitamin „C" from suitable plant material.
10. Estimation of alkaloids from medicinal plants.
11. Study of changes in starch / protein content during seed development.
12. Study of lipid accumulation during development of oil seeds.
13. Study of effect of PEG induced water stress on seed germination.
14. Study the effect of ZnSO4 (800ppm) solution on (paddy) seed germination
15. study the physical and chemical methods for breaking the seed dormancy .

Suggested Readings (for laboratory exercises):

Bajracharya, D. 1999. Experiments in Plant Physiology: A Laboratory Manual. Narosa Publishing House, New Delhi.

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Sadasivam and Manikum: Biochemical Methos , New Age International (p) Limited Publishers 4835/24, Ansari Road, Daryaganj, New Delhi- 110002

Semester III

MBSS33RB- Elective I: (Reproductive Biology of Angiosperms - I)

Objectives:

- **Understanding of need of reproductive system as experimental material.**
- **Understanding of structure of male and female reproductive parts and thei developmentin Angiosperms.**
- **Understanding & Application of knowledge of male sterility.**
- **Understanding of pollen mechanism, pollen-pistil interaction and incompatability.**

Outcomes: After completion of the course, the student will be able to

- **Learning the structure, and developmental variation in the sexual organs in Angiosperms.**
- **Analysis of causes for male sterility.**
- **Understanding and application of knowledge of reproduction for human welfare**

Module I **(12 Hrs.)**

General: Need for reproductive system as experimental material, Interdisciplinary approaches: genetic and molecular perspective,

Anther: Structure, anther wall; endothecium, middle layer, tapetum-Structure, typesstructure-function relationship, role of tapetum, microsporogenesis-sporogenous cells cytoplasmic reorganization during sporogenesis (Ultrastructural changes), molecular biology of meiosis, DNA and RNA synthesis, Protein synthesis, meiosis specific genes. Pollen tetrad development, pollen wall proteins, adaptive significance of pollen wall.

Module II **(12 Hrs.)**

Male gametophyte development: formation of vegetative and generative cells, differential behaviour of sperms, gene expression during pollen development.

Pollen: Physiological and biochemical aspects, pollen storage, viability, causes for loss of viability. Pollen abortion and male sterility: structural, developmental and functional aspects of male sterility environmental factors, role of mitochondrial genome in male sterility, gametocides.

Module III **(12 Hrs.)**

Pistil: Carpel determination, ovule and its structural details.

Megasporogenesis: Meiosis, functional megaspores, organization of female gametophyte structure of the embryo sac, egg, synergid-ultrastructure, role central cell, antipodal cell, haustoria, cytoskeleton of the embryo sac, enzymatic isolation of embryo sac, types of embryo sac, nutrition of embryo sac.

Module IV **(12 Hrs.)**

Pollination: pollination mechanism, biotic and abiotic pollination, floral attractants and rewards,

Pollen-pistil interaction: The stigma-Types and structure, stigmatic exudates, style-transmitting

tissue, canal cell, post pollination events (stigma receptivity, pollen adhesion, pollen hydration, pollen germination and pollen tube growth, biochemistry of pollen germination, RNA and protein metabolism during pollen tube, calcium gradient in the pollen tube (Chemotropism) pollen allelopathy.

Incompatibility: General concept, self incompatibility (Intraspecific type) heteromorphic, homomorphic types, mechanism of self compatibility, importance of self compatibility, methods of overcoming self incompatibility, Parasexual hybridization,

Suggested readings

1. Asker S. 1979, Progress in apomixis research. Hereditas 91, 231-240.

2. Barnier, G. 1986, The flowering process as an example of plastic development. Soc. Expt.. Biol. 40: 257-286.

3. Barth, F.G. 1991, insects and flowers, Princeton Univ. Press. Princeton.

4. Battaglia, E. 1963. Apomixis In recent advances in the embryology of angiosperms (ed P. Maheshwari), pp-264, Intt. Soc. Plant Morphologists, Univ. Delhi.

5. Bhandari N. N. 1984, The microsporangium in embryology of angiosperms (ed B.M. Johri) Springer-Verlag, Berlin, pp. 53-121.

6. Bhandari N.N., M. Bhargava and P. Chitralekha 1986, Cellularization of free nuclear endosperm of Pappaver somniferum L. Phytomorphology, 36, 357-366.

7. Bhojwani S.S. and M.K. Rajdan 1983, Plant tissue culture Theory and Practice Elsevier, Amsterdam.

8. Boesewinkel F.D. and Boman F. 1984, The seed structure in embryology of angiosperms (ed B.M.Johri), Springer-Verlag, Berlin, pp. 567-610.

9. Bouman F. 1984 The ovule in embryology of angiosperms (ed B.M.Johri), Springer-Verlag, Berlin, pp. 123-157.

10. Cartson P.S., Smith N.H., Dearing R.D. (1972) Parasexual interspecific plant hybridization. Proc. Nat. Acad. Sci. USA, 69, 2292-2294.

11. Cartson P.S. (1973) The use of protoplasts of genetic research. Proc. Nat. Acad. Sci. USA, 70, 598-602.

12. Chitralekha P. and N.N. Bhandari 1991, Post fertilization development of antipodal cells in Ranunculus scferatus. Phytomorphology 41, 200-212.

13. Ciampolini F.M., Nepi and E. Pacini 1993, tapetum development in Cucurbita pepo (Cucurbitaceae) Pt. Syst. Evol. (Suppl) 7-13-22.

14. Cocking E.C. 1960, A method for the isolation of plant protoplasts and vacuoles. Nature (London) 187-927-929.

15. Cocking E.C. 1970, Virus uptake, cell wall regeneration and virus multiplication in isolated plant protoplasts. Int. Rev. Cytol 28-89-124.

Practicals

1) Study from the permanent preparations.

a) Development and structures of anther pollen.

b) Structure of ovule, types, megasporogenesis, embryo sac types.

c) Development of endosperm, types.

d) Structure and development of embryo-types

e) Pericarp and seed coat structure from sections and macerations.

f) Sketching of ovular structure, embryo sac, anther wall, embryo with the help of camera lucida.

2) Techniques, Familiarity with phase contrast, polarizing, fluroscence and electron microscopy, wholemounts, fissection and macerations, permanent double stained microtome sections, photo microscopy.

3) Preparation of dissected wholemounts of endothecium, tapetum, endosperm and embryo, squash preparations of tapetum, microspore mother cells, dyads, tetrads pollinia and massulae. Study of mitosis and meiosis and identification of various stages.

4) Study of different pollen using acetolysed and non acetolysed pollen, preparation of permanent slides for morphological study. (polarity, symmetry, shape, size, aperture, sporoderm stratification: minimum 15 slides to prepare).

5) Interpretation of electron micrographs (SEM, TEM) of pollen.

6) Short term exercises on pollen production, viability and their percentage of germination. Rate of growth of germ tube to be studied in a given period.

7) Viability of seed through germination, biochemical and excised embryo methods.

8) Cytology of pollen inhibition in self and interspecific incompatibility, application of some technique to overcome incompatibility.

9) Experiments on intra-ovarian pollination.

10) Experiments on plant tissue culture. Technique-washing.Sterilization, preparation of media, storage of media, inoculation, callus initiation, proliferation.

11) Responses of calli to stress condition viz. temp, (low, high), moisture, salinity.

12) Induction of androgenesis through anther culture.

13) Physiology of embryo development, using electropheratic and histochemical methods embryo culture.

14) Somatic embryogenesis

15) Protoplast culture.

Semester III

MBSS34 : Aesthetic Botany

Objectives:

- **Knowledge on floristic regions of the world and India, endemism, hotspots etc.**
- **Understanding the scope, components of the garden and features of the garden**
- **Knowledge on scope of floriculture, methods of propagation and its importance in designs**
- **Understanding the scope of landscape, elements of landscape, importance of polyhouses, designing of lawns and cactus garden.**

Outcomes:

After successful completion of the course the students will be able to

- **Learn phytogeographical regions of India, world, scope of gardening, landscaping.**
- **Learn designing of lawns and cactus, ornamental gardens.**

Module I – Phytogeography (12 Hrs.)

Climate and Vegetation of the world

Floristic regions of the world. Phytogeographical regions of India; Endemism; Concept of hotspots, hot spots of the world. Forest types of India

Module II – Gardening (12 Hrs.)

Garden Design: Scope and objectives of gardening; Style of gardens (Formal, Informal); Types of gardens (English, Mughal and Japanese)

Components of garden; Planning of outdoor gardens- Small, Residential, Larger Home Garden, Roof Garden, Terrace Garden, Industrial garden, Housing complex, Indoor gardening

Garden Features and Ornamentation: Water, Garden pool, Stream, Waterfall, Fountain, Rocks, Roads, Walks, Pavements and Steps, Walls fences and Gates, Hedges, Edges, Arches, Statues, Towers.

Module III– Floriculture (12 Hrs.)

Nursery production and management: Scope, Site, Soil, Environment, Layout, Manure, Fertilizers, Maintenance, Garden tools, Culture and Garden calendar, Types, Nursery beds, Pest & Disease management.

Propagation of ornamental plants by seeds, bulbs, layering, cuttings, grafting, budding & tissue culture.

Plant disorders including nutrition, pests and diseases, and chimaeras

Ornamental ferns and their propagation; herbaceous perennials, Annuals & Biennials: Important Genera and Species, their importance in garden designs.

Module IV – Landscaping (12 Hrs.)

Landscape Design: Definition, objectives and scope, Landscape elements of construction and designing of Residential, Commercial, Bungalow, Public area, Hotel, Educational Institute and religious places Palms and Cycas: Characteristics, propagation, culture, pest and disease,

importance and uses, genera and species of palms and Cycads. Bamboo and conifers: Genera, species and varieties
Lawns & Grasses: Planting methods, maintenance, pest management
Ornamental succulents, Cacti
Polyhouse technology: Scope and objectives of floriculture.

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Randhawa GS and Mukhopadhyay A. 2004.Floriculture in India.Allied Publishers Pvt. Limited.

Swarup Vishnu. 2003. Garden Flowers. National Book Trust

Hartmann HT, Kester DE, Davies FT and Geneve RL. 2002. Plant Propagation – Principles and Practices. Prentice Hall India Ltd.

Royal Horticultural Society"s Encyclopedia of Gardening.

Semester IV

MBSS41 : Cell and Molecular Biology-II

Objectives:

- **Knowledge on structure and functions of ribosomes, mechanism of transcription and translation in pro- and eukaryotes.**
- **Understanding the gene structure and regulation of gene expression**
- **Knowledge on genome organization and recombination mechanisms**
- **Understanding the mechanism of cell cycle, apoptosis, techniques in cell biology**

Outcomes:

After successful completion of the course the students will be able to

- **Learn structure and functions of ribosomes, mechanism of transcription and translation.**
- **Learn gene structure and regulation of gene expression**
- **Learn mechanism of cell cycle, apoptosis, application of cell biology techniques.**

Module I: (12 Hrs.)

Ribosomes: Structure and function

Transcription: Transcription in prokaryotic and eukaryotic cells, plant promoters, transcription factors, types of RNA and their function, RNA splicing, mRNA transport

Translation:In prokaryotic and eukaryotic cells, structural levels of proteins, post-translational modification; structure and role of rRNA and tRNA.

Module II: **(12 Hrs.)**

Protein sorting: Protein glycosylation; vesicles involved in protein transport; protein targeting to plastids, mitochondria, peroxisomes, nucleus, vacuoles; modification during transport.

Gene structure: Chemical nature of gene; Fine structure of gene: Classical and modern concept of gene, Cis-trans test; fine structure analysis in eukaryotes; introns and their significance, RNA splicing

Regulation of gene expression:Prokaryotes- Positive and negative control, inducible and repressible operons, lac operon, trp operon, attenutation, riboswitch; Eukaryotes- Regulation at DNA, transcription, translation and post translational level, Epigenetic regulation

Module III: **(12 Hrs.)**

Genome organization in prokaryotes and eukaryotic organelles: Phage genome, genetic recombination in phage and mapping phage genes; mapping of bacterial genes through transformation, conjugation and transduction; genome of mitochondria and chloroplast.

Genetic recombination and genetic mapping: Recombination; independent assortment and crossing over; molecular mechanism of recombination; role of RecA and RecBCD enzymes; homologous, non-homologous and site-specific recombination; chromosome mapping- linkage

group, genetic markers, types of maps, construction of molecular maps, correlation of genetic and physical maps; Somatic cell genetics -an alternative approach to gene mapping.

Module IV: **(12 Hrs.)**

Cell cycle and apoptosis: Control mechanismsof bacterial and eukaryotic cell cycle, check point control, presence of regulators of cell cycle, G1 – S progression, G2 – M progression, role of cyclins and cyclin dependent kinases; retinoblastoma and E2F proteins; cytokinesis and cell plate formation; Apoptosis and its pathway.

Signal transduction:Overview, receptors and G-proteins, phospholipid signaling, role of cyclic nucleotides, calcium-calmodulin cascades, diversity in protein kinases and phosphatases, specific signaling mechanisms e.g. two-component sensor-regulator system in bacteria and plants, sucrose sensing mechanism

Techniques in cell biology: Electrophoresis, immunotechniques(Western blotting and ELISA), FISH, GISH, confocal microscopy

Suggested readings

Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999.

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Buchanan, B.B., Gruissem, W. and Jones, R. L. 2000 Biochemistry and Molecular Biology of Plants. American Soc. Of Plant Physiologists, Maryland, USA.

De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology 8th Ed. B. I. Waverly Pvt. Ltd., New Delhi.

Jones R, Ougham H, Thomas H, Waaland S 2013 The Molecular life of plants. Wiley-Blackwell, USA

Karp, G. 1999 Cells and Molecular Biology; Concepts and Experiments. John Wiley & Sons, Inc., USA.

Khush, G.s. 1973 Cytogenetics of Aneuploids, Academic Press, New York, London Kleinsmith, L.J. and Kish, V.M. 1995 Principles of Cell and Molecular Biology (2 nd Edi.) Harper Collins Coll. Publisher, New York, USA.

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Lodish, H., Berk, A. Zipursky, S. L. Matsudaira, P., Baltimore, D. and Darnell, J. 2000 Molecular Cell Biology Edi.W.H. Freeman and Co., New York, USA.

Malacinski, G. M. and Freifelder, D. 1998 Essentials of Molecular Biology (3rd Edi.)Jones and Bartiet Pub. Inc., London.

Russel, P. J. 1998 Genetics (5th Edi.) The Banjamin/ Cummings Publishing Com. Inc., USA

Sunstad, D. P. and Simmons, M. J. 2000 Principles of Genetics (2nd Edi.) John Wiley & Sons Inc., USA.

Tamarin, R. H. 2001 Principles of Genetics 7th Edi.The McGraw-Hill Companies.

Wolf, S.L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA.

References: Online journals available on UGC V-SAT programme

Practicals

1. Isolation of nuclei and identification of histones by SDS-PAGE.
2. Isolation of chloroplast and demonstration of two subunits of RUBISCO by SDS-PAGE
3. To perform the restriction digestion of the DNA and analyse the digest over agarose gel.
4. To study *in vitro* transcription.
5. To study *in vitro* translation.
6. To study conjugation in bacterial cells.
7. To detect the presence of specific antigen by ELISA
8. Isolation of RNA and quantification by spectrophotometric method.
9. To map the genes on the basis of given cross-over data.
10. Separation of amino acids by paper electrophoresis, TLC method.
11. Separation of carbohydrates by paper electrophoresis, TLC method.

Semester IV

MBSS42 : Plant Biotechnology and Plant Breeding

Objectives:

- **Understanding the principles and techniques of gene cloning, types of vectors**
- **Knowledge on recombinant DNA technology & its tools, microbial genetic manipulations.**
- **Understanding the basic concepts of tissue culture and knowledge on transgenics.**
- **Practical knowledge and analysis skills in usage of various bioinformatic tools.**

Outcomes:

After successful completion of the course the students will be able to

- **Learn gene cloning, recombinant DNA technology etc.**
- **Learn ttissue culture methods.**
- **Learn and apply bioinformatic tools for analysis of bioinformation data.**

Module I

(12 Hrs.)

a. Recombinant DNA technology: Gene cloning- Principles and technique; vectors- types (cloning & expression; plasmid & viral) and their properties; construction of DNA libraries (gDNA and cDNA); splicing of insert into the vector; screening of DNA libraries and introduction of the recombinant DNA into the host cells.

b. Genetic engineering of plants: Aims, strategies for development of transgenics (with suitable examples); Agrobacterium-the natural genetic engineer; T-DNA and transposon mediated gene tagging.

Module II

(12 Hrs.)

a. Microbial genetic manipulation: Bacterial transformation, selection of recombinants and transformants, genetic improvement of industrial microbes and nitrogen fixers, fermentation technology.

b. Genomics and proteomics: Molecular markers for introgression of useful traits; high throughput sequencing; functional genomics; Protein profiling and its significance.

c. DNA synthesis; DNA sequencing; basic polymerase chain reaction and applications of PCR; DNA fingerprinting

Module III

(12 Hrs.)

Plant tissue culture: Basic concepts; Principles and scope; tissue culture media; callus induction and cell suspension; aspects of morphogenesis; haploid and triploid production; production of somatic embryos; applications of plant tissue culture; protoplast isolation and culture; production of cybrids

Transgenic production: Methods to introduce gene in plants; selection of transformed plants/explants; salient achievements in crop biotechnology.

Module IV **(12 Hrs.)**

Bioinformatics: Introduction, History, Definition and applications of bioinformatics; Database: Sequences (nucleotide and amino acid); nomenclature- IUPAC symbols, nomenclature of DNA & protein sequences, directionality of sequences, types of sequences used in bioinformatics; Definitions, types and classification of databases- Primary Databases, Secondary databases, Literature database and Taxonomy database.

Plant breeding: Methods of breeding sexually (self and cross pollinated) and vegetatively propagated crops; heterosis and inbreeding depression and their genetic basis; use of male sterility in hybrid production.

Suggested readings

Baxevanis, A. D., Davison, D. B.; Page, R. D. M.; Petsko, G. A.; Stein, L. D. and Stormo, G. D. 2008 Current Protocols in Bioinformatics, John-Wiley and Sons Publications, New York.

Baxevanis, A. D. and Ouellate, B. F. F. 2009 Bioinformatics: A Practical Guide to the analysis of genes and proteins. John-Wiley and Sons Publications, New York.

Brown, T. A. 1999. Genomes, John Wiley &Sons(Asia) Pvt. Ltd., Singapore.

Callow, J. A., Ford-Lloyed, B. V. and Newbury, H. J. 1997. Biotechnology and Plant Genetic Resources: Conservation and Use, CAB International, Oxon UK.

Chrispeeels, M. J. and Sadava, D. E. 1994, Plants, Genes and Agriculture.Jones & Barlett Publishers, Boston, USA.

Dubey, R. C. 2014 Advanced Biotechnology. S. Chand & Co. Pvt. Ltd., New Delhi.

Glazer, A. N. and Nikaido, H. 1995.Microbial Biotechnology. W. H. Freeman & Company, New York, USA.

Gustafson, R. J. 2000. Genomes.Kluwer Academic Plenum Publishers, New York, USA.

Henry, R. J. 1997. Practical Applications of Plant Molecular Biology.Chapman & Hall, London, UK.

Jain, S. M., Sopory, S. K. and Veilleux, R.E. 1996. In vitro Haploid Production in Higher Plants, Vols. 1-5, Fundamental Aspects and Methods. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Jolles, O. and Jornvall, H. (eds) 2000. Proteomics in Functional Genomics.Birkhauser Verlag, Basel, Switzerland.

Kartha, K. K. 1985. Cryopreservation of Plant Cells and Organs.CRC Press, Boca Raton, Florida USA.

Kingsman, S. M. Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eukaryotes, Blackwell Scientific Publications, Oxford, 1998

Mount W. 2004 Bioinformatics and sequence genome analysis 2nd Edi. CBS Pub. New Delhi

Old, R. W. and Primrose, S. B. 1989.Principles of Genome Analysis.Blackwell Scientific Publications. Oxford, UK.

Primrose, S. B.1995. Principles of Genome Analysis.Blackwell Scientific Ltd., Oxford, UK.

Raghavan, V. 1997.Molecular Biology of Flowering Plants. Cambridge University Press, New York, USA.

Practicals

1. To study the growth characteristics of *E. coli* using plating and turbidimetric methods.

2. To isolate the plasmid from *E. coli* and quantify it with suitable method.

3. To perform restriction digestion of the given plasmid DNA and to estimate of the size of various DNA fragments.

4. To Clone the given DNA fragment in a plasmid vector.

5. To prepare competent cells from the given bacterial culture.

6. To transform the competent bacterial cells with the given vector and perform blue-whit selection.

7. To prepare the media for plant tissue culture.

8. To surface sterilize the given seeds/explant for tissue cultural manipulation.

9. To isolate protoplast and determine its viability.

10. To fuse the protoplast for production somatic hybrid.

11. To workout the DNA sequence from the given autoradiogram and identify the gene using online tools.

12. To search literature database of different organisms.

13. To search the genes in the Genebank.

14. To use the various tools to retrieve information available from NCBI

15. To locate gene(s) on chromosomes for a given disease/disorder.

Suggested Readings(for laboratory exrcises)

Baxevanis, A. D. and Ouellate, B. F. F. 2009 Bioinformatics: A Practical Guide to the analysis of genes and proteins. John-Wiley and Sons Publications, New York.

Glover, D. M. and Hames, B. D.(Eds) 1995. DNA Cloning 1: A Practical Approach: Core Techniques, 2nd edition PAS, IRL Press at Oxford University Press, Oxford.

Hackett, P. B. Fuchs, J. A. and Messing, J. W. 1988. An Introduction to Recombinant DNA Techniques.Basic Experiments in Gene Manipulation. The Benjamin/cummings Publishing Co., Inc. Menlo Park, California.

Maniatis et al. Molecular cloning Vol.I, II and III.Cold-Spring Harbor Lab Press.

Shaw, C. H. (Ed.) 1988, Plant Molecular Biology : A Practical Approach. IRl Press, Oxford.

References: Online journals available on UGC V-SAT programme.

Semester IV

MBSS43PN Elective II:(Palynology - II)

Objectives:

To study various aspects of pollen physiology and biochemistry
To study and understand the various aspects of pollen biotechnology, genetics and forensic palynology.

To get the knowledge on aerobiology history and various methods applied for collection and data analysis.
To study the different airborne microbiodata particularly pollen & spores, monitoring techniques, analysis
To gain the knowledge on pollen allergy, causes, symptoms, prevention and cure.

Outcomes:
After successful completion of the course the students will be able to
Understand the different aspects of pollen physiology, biochemistry, genetics, biotechnology and forensic palynology in order to understand the role of pollen in plant breeding experiments for developing new variety, germplasm conservation, disease resistant variety, increasing crop yield, production of haploids, use of recombinant DNA technology for crop improvement.
To study different aeroallergens, immunoglobulins, testing and treatment of allergies and Preparing a basis for standardization of allergens.
To apply the knowledge of aerobiology in enlisting airborne allergens, helping allergologists / physicians in proper diagnosis and treatment of allergies, in developing disease forecasting method of fungal crop pathogens and prevention of allergies in allergy patients

Module I: Pollen physiology and biochemistry- (12 Hrs.)
Pollen production, Pollen viability, techniques involved, , Pollen germination -in *vivo* and in *vitro*, germination requirements, Role of boron and calcium in pollen germination, Factors affecting pollen germination. Chemical composition of pollen wall and pollen contents (amino acids, proteins, carbohydrates, lipids, vitamins, pectin, DNA, RNA, ascorbic acid, flavones, pigments etc.). Fine structure inside the tube, pollen culture movements of nuclei-and formation of callose plug, promotion and inhibition of pollen tube, elongation, pollen enzymes andisozymes.

Module II: Pollen biotechnology and genetics, forensic palynology (12 Hrs.)
Pollen storage-Factors affecting viability in storage, freeze-drying of pollen, storage of pollen inorganic solvents, causes of decreased viability in storage and pollengermination.
Pollen-pistil interaction- significance, self-incompatibility (regulation of fertilization) Pollen biotechnology & crop production- Anther / pollen culture, production of haploids
Genetics of pollen: Genetic segregation of pollen, pollen sterility- genic and cytoplasmic male sterility, factors involved in male sterility. Male sterility through recombinant DNA technology.
Forensic palynology- Introduction, methodology, role in criminology, examples

Module III: (12 Hrs.)
Aerobiology-Introduction, Historical background, applications of Aeropalynology, Aeromycology,Aerophycology. Importance in medical and Agricultural field, disease forecasting of crop plants, aerobiological work in India and abroad.

Intramural and extramural studies- Different devices to collect spores, pollen grains such as kite, balloons, trap air strips and slides, volumetric samplers, culturing techniques, analysis of data and their processing, Outdoor & Indoor airspora - identification &characteristics, seasonal changes of air-spora.

Module IV: **(12 Hrs.)**

Airborne allergens- Introduction, allergens and their types, Impact of airborne materials onhuman system, Lung as particulate sampler, Source, causes, symptoms of Pollen allergy, fungal spore allergy, dust mite allergy, algal allergy other allergies, pollinosis, nasobroncheal allergy, Prevention and cure, Human immunoglobulins- types, and significance in diagnosis of allergy, diagnosing allergic diseases, Testing and treatment standardization, pollen calendar, Correlation between aerobiological, clinical and meteorological data.

Recommended reading

Agashe S. N. – Paleobotany (1997) – Plants of the past their evolution paleoenvironment and applications inexploration ofFossil.

Agashe S. N. – Palynology and its Applications – Oxford and IBH Publishing Co. Pvt. Ltd. NewDelhi.

Alexander M.P. (1969). Differential staining of aborted and non-aborted pollen Stain Technol44:117-122.

Alexander, M.P. (1987). A method for staining pollen tubes in pistil. Stain Technol 62, 107- 112.

Alexander, M.P., Ganeshan S. (1990).An improved cellophane method for in vitro germination of recalcitrant pollen. Stain Technol 64:225-227. Archaeology, *Rev. Palaeobot. Palynol*21:171-185,

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Hague Joel P. , Stephen L. Dellaporta , Maria A. Moreno , Chip Longo 1 , Kimberly Nelson 1 and Albert P. Kausch Pollen Sterility—A Promising Approach to Gene Confinement and Breeding for Genetically Modified Bioenergy Crops Agriculture 2012, 2, 295-315; doi:10.3390/agriculture204029

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Cronquist, A. 1968. The evolution and classification of flowering plants, Nelson,London

Dafni Amots, Hesser Michel, Paeini Ettore – Pollen and Pollination-Springer Wien New York

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Doyle James A(2005) Early evolution of angiosperm pollen as inferred from molecular and morphological phylogenetic analyses, Grana, 44:4, 227-251, DOI: 10.1080/00173130500424557

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Erdtman, G. (1969). Handbook of Palynology. Hafner, NewYork

Erdtman, G. 1943. An Introduction to Pollen Analysis. Chronica Botanica Co., Waltham, Mass. pp.239,

Erdtman, G. 1952. Pollen Morphology and Plant Taxonomy (An Introduction to Palynology-1, Angiosperms). Aimqvist, and Wicksell,Stockholm,

Erdtman, G. 1956. Current Trends in Palynological Research Work Grana Palynologica (N.S.)1:2,

Erdtman, G. 1960. The Acetolysis method revised description Su. Bot. Tidskr.54(4).

Erdtman, G. 1964. Palynology. In: W.B. Turrill (Editor) Vistas in Botany. Macmillan Go., New York, Vol.4:23-54.

Erdtman. G.1945.Pollen Morphology and Plant Taxonomy V on the occurrence of tetrads and dyads.Su. Bot. Tidsker.39(3),

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Heslop-Harrison, J. (1987). Pollen germination and pollen tube growth. Int. Rev. Cytol. 107:1-78.

Heslop-Harrison, J. 1962.Origin of Exine. Nature, 195 (4846):1069-1071

Heslop-Harrison, J. 1971. (Editor). Pollen: Development & Physiology. Butterworths, London,

Heslop-Harrison, J. 1976. The adaptive significance of the exine.Academic Press. London, Linn. Soc. Symp. Ser1:27-37,

Shivanna K.R. (1984). The evaluation of pollen quality and a further appraisal of the fluorochromatic (FCR) test procedure. Theor. Appl. Genet 67:367-375.

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Iwanami, Y,, Sasakuma, T., Yamada, Y. (1988). Pollen: illustrations and scanning electron micrographs. Kodansha (Tokyo) and Springer, Berlin Heidelberg New YorkTokyo

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Knox. R.B., Williams, E.G., Dumas, C. (1986). Pollen, pistil and reproductive function in crop plants.Plant Breed.Rev.4:9-79.

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Nair. P.K.K. 1965.Pollen Grains of Western Himalayan Plants.Asia Publ. House.of pollen vedamse Book (P) Ltd. NewDelhi.

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Rangaswamy, N.S. (1977). Applications of in vitro pollination and in vitro fertilization. In.. Reinert J., Bajaj. YPS (eds.). Applied and fundamental aspects of plant cell tissue and organ culture. Springer, Berling, Heidelberg. New York, pp.412425.

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ShiD.-Q. and W.-C. Yang 2010. Pollen Germination and Tube Growth Plant Developmental Biology - Biotechnological Perspectives: Volume 1, Page 245-282 Pua, Eng Chong; Davey, Michael R. (Eds.) Springer-Verlag Berlin Heidelberg

Shivanna, K, R. (1982,). Pollen-pistil-interaction and control of fertilization. In: Johri B.M. (ed.). Experimental embryology of vascular plants. Springer, Berlin Heidelberg New York, pp, 131-174.

Shivanna, K.R. and Johri, B M 1989. The Angiosperm Pollen:Structureand Function. Wiley Eastern Ltd., NewDelhi

Shivanna, K.R. and Rangaswami, N.S. 1992. Pollen Biology: A laboratory manual. Narosa Publishing House, NewDelhi..

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Stanley, R.G., Linskens, H.F. (1974). Pollen: biology. Biochemistry and management.Springer, Berlin Heidelberg NewYork.

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Tilak S.T. 1987 "Air monitoring practical Manual", Vaijanti Prakashan,Aurangabad.

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Walton, John. 1940. An Introduction to the Study of Fossil Plants. Adam and Charles Black,London

Wodehouse,R.P.1935.PollenGrains.McGrawHillandCo.NewYork.

Semester IV

MBSS43PP - Elective II:(Plant Physiology - II)

Objectives:

- **Understanding the role of secondary metabolites in plants.**
- **Understanding various industrial applicable concepts and nanobiotechnology**
- **Understanding neuro and electro physiology**
- **Understanding the signal transduction in plant cells.**

Outcomes:

After successful completion of the course the students will be able to

- **Understand the importance of secondary metabolites and their medicinal importance**
- **Understand the applicability of learnt concepts at industrial level.**
- **Understand the pathways and proteins involved for different signaling response at cellular level.**

Module-I **(12 Hrs.)**

Secondary metabolites :-Introductionand classification, Secondary metabolitesand ecological functions in plants , secondary metabolites defend plants against herbivoresand pathogens

a. Alkaloids:- alkaloid biosynthesis, Biotechnological application of alkaloidsBiosynthesis, plant defense against pathogens

b. Terpenoids:- terpenoids and herbivory, steroids and sterols, polyterpens,prenyltrasferase and terpene synthase reactions, modifications of terpeniod skeletons toward transgenic production

c. Phenolic compounds:- medicinal properties of phenolic compounds, types- simple phenolics, coumarins, lignin, flavonoids, tannins

d. Glycosides:-saponins, cardiac glycosides, cyanogenics glycoside,glucosinolates

Module-II **(12 Hrs.)**

Leaf protein: - Green crop fractionation (GCF), Leaf Protein Concentrate (LPC), Chloroplastic LPC, Cytoplasmic LPC, Deproteinised Leaf Juice (DPJ), Uses of DPJ.Importance of leaf protein

Industrial fermentation:-importance of fermentation, type of fermentation, alcoholic fermentation, enzyme production , antibiotic production

Biodiesel production:- introduction and historical account of biodiesel,methods of preparation biodiesel from vegetable oil, biochemical properties of biodiesel Importance of biodiesel.

Module-III **(12 Hrs.)**

Plant Neuro/electro physiology:- introduction and historical account of plantelectrophysiology, Factor affecting electrical potential, electrodes and methods usedfor Measuring the Electrical potential energy of plants and fruits

Signal Perception and Transduction:-Introduction, overview of signal transduction pathway, receptors, specific examples of plant receptors, signal transduction in Prokaryotes, signal transduction in eukaryotes, G-proteins and phospholipids signaling, cyclic nucleotides, secondary messengers (Calcium, calcium-calmodulin complexes, Protein kinases particular pathways of signal transduction Associated with plant growth regulators

Module-IV **(12 Hrs.)**

Vitamins:- water and fat- soluble vitamins, biochemical function of thiamine, riboflavin, nicotinic acid, pantothenic acid, pyridoxin, biotin, folic acid, vitamin B12, ascorbic acid, vitamin A and vitamin D

Antioxidants:-what are antioxidants, types of antioxidants, role of antioxidants in medicine and in disease control, cure and prevention, antioxidant rich foods

Nanobiotechnology:-Application of nano-biotechnology in medicine and food, synthetic and natural bionanomaterials. Implications of nanoscience and nanotechnology on society.

Issues- biosensors and their applications, biological nanostructures.Applications of bionanoscience to materials research.

Suggested Readings (For theory):

Asana, R.D. and Sarin M.N. (1968): Crop Physiology in India IARI Publ.

Abdelhamid Elaissari, (2008). Colloidal Nanoparticles in Biotechnology, John Wiley

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Fageria, N. K. 1992. Maximizing crop yield.

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Fitter, A. H. and Hay, R. K. M. S. (1987): Environmental Plant Physiology.

Gupta, U. S. (1972): Crop Physiology.

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Journals

- Annual reviews of Plant Physiology and Molecular Biology.
- Indian Journal of Plant Physiology.
- Journal of Experimental Botany.

Semeste Semester IV

MBSS43RB Elective II:(Reproductive Biology of Angiosperms - II)

- **Understanding of mechanism of fertilization. Formation of endosperm, nutritive part of the seeds.**
- **Understanding of development of embryo, variation in types of embryo formation,**
- **Understanding of use of biotechnology in solving plants reproductive problems and metabolite production and its uses.**

Outcomes: After completion of the course, the student will be able to

- **Learning of problems in fertilization and fruit froduction.**
- **Analysis of type of reproduction, production of seedless fruits and role of insects in the fruit formation/pollination**
- **Understanding and application of knowledge of role of biotechnology in the reproduction and their uses for human welfare.**

Module I: (12 Hrs.)

Fertilization: Cellular nature of sperm, the sperm cytoskeleton, the male germ unit, isolation and characterization of sperm, growth of the pollen tube through the style, passage of sperm into the embryo sac, fussion of nuclei, double fertilization, triple fussion, unusual features. In-vitro approaches to the study of fertilization-Intra-ovarian pollination, test tube fertilization, in-vitro fertilization, placental pollination, Gynogenesis.

Endosperm: types of endosperms, ruminate endosperm, cytological status. endosperm haustoria, chemical composition of endosperm, food reserve in endosperm, role of endosperm in embryo development, endosperm mutants.

Module II: **(12 Hrs.)**

Embryogenesis: Zygote and its ultra-structure, Johanssen"s system of embryo development, symmetry and polarity, rest period in zygote embryonic formulae, embryonomic law. Suspensor-Ultra structure of suspensor cells, cytology of suspensor cell, physiology and biochemistry of suspensor; Nutrition of embryo-nutrient supply of the zygote, embryo-endosperm relation.

Polyembryony: Defination, causes, classification, induction of polyembryony, practical importance of polyembryony.

Module III: **(12 Hrs.)**

Apomixis: Defination, causes, classification, -Diplospory, Apospory, pseudogamy, autogamous development of endosperm, causes of apomixes, significance.

Parthenocarpy:Defination, causes, practical importance

Mellitopalynology: Pollen analysis of honey, Role of apiary in crop production.

Biotechnology: Concept and scope of biotechnology; Cell structure, cellular totipotency

a) Anther and pollen culture,

b) Ovule and nucellus culture

c) Endosperm culture and its practical applications

Module IV: **(12 Hrs.)**

d) Embryo culture: Techniques, nutritional aspects of embryo culture morphological and physiological considerations, culture of mature embryo and proembryo.

e) Somatic embryogenesis: historical background, embryogenesis from callus, direct embryogenesis-recurrent embryogenesis; cytology of somatic embryogenesis, nutritional factors, hormonal factors.

f) Protoplast culture and somatic hybridization-isolation of protoplast, culture methods, fussion of protoplast, selection of fussion products, consequences of fussion, production of Cybrids and hybrids.

g) Biotransformation and production of useful compounds through cell culture, factor affecting yield, biotransformation, bioreactors, perspective.

Suggested readings

16. Asker S. 1979, Progress in apomixis research. Hereditas 91, 231-240.

17. Barnier, G. 1986, The flowering process as an example of plastic development. Soc. Expt..Biol. 40: 257-286.

18. Barth, F.G. 1991, insects and flowers, Princeton Univ. Press. Princeton.

19. Battaglia, E. 1963. Apomixis In recent advances in the embryology of angiosperms (ed P.Maheshwari), pp-264, Intt. Soc. Plant Morphologists, Univ. Delhi.

20. Bhandari N. N. 1984, The microsporangium in embryology of angiosperms (ed B.M. Johri)Springer-Verlag, Berlin, pp. 53-121.

21.Bhandari N.N., M. Bhargava and P. Chitralekha 1986, Cellularization of free nuclear endosperm of Pappaver somniferum L. Phytomorphology, 36, 357-366.

22. Bhojwani S.S. and M.K. Rajdan 1983, Plant tissue culture Theory and Practice Elsevier,Amsterdam.

23. Boesewinkel F.D. and Boman F. 1984, The seed structure in embryology of angiosperms (edB.M.Johri), Springer-Verlag, Berlin, pp. 567-610.

24. Bouman F. 1984 The ovule in embryology of angiosperms (ed B.M.Johri), Springer-Verlag,Berlin, pp. 123-157.

25. Cartson P.S., Smith N.H., Dearing R.D. (1972) Parasexual interspecific plant hybridization. Proc. Nat. Acad. Sci. USA, 69, 2292-2294.

26. Cartson P.S. (1973) The use of protoplasts of genetic research. Proc. Nat. Acad. Sci. USA, 70, 598-602.

27. Chitralekha P. and N.N. Bhandari 1991, Post fertilization development of antipodal cells in Ranunculus scferatus. Phytomorphology 41, 200-212.

28. Ciampolini F.M., Nepi and E. Pacini 1993, tapetum development in Cucurbita pepo (Cucurbitaceae) Pt. Syst. Evol. (Suppl) 7-13-22.

29. Cocking E.C. 1960, A method for the isolation of plant protoplasts and vacuoles. Nature (London) 187-927-929.

30. Cocking E.C. 1970, Virus uptake, cell wall regeneration and virus multiplication in isolated plant protoplasts. Int. Rev. Cytol 28-89-124.

MBSS44: PLANT RESOURCES

Module 1: Economic Botany (12 Hrs.)

Food plants: History, origin, distribution and nature Morphology and anatomy of selected: Fiber yielding plants (Cotton, Jute), forest resources (timber and non-timber plants), gum and resin yielding plants, fumitories and masticatories, spices and condiments. Food adulteration.

Module 2: Pharmacognosy (12 Hrs.)

Introduction, classification of crude drugs, plant anatomy (stomata, trichomes, xylem, phloem, ergastic substances) Morphology of Different parts of Medicinal plant, Evaluation of drugs: organoleptic, microscopic, chemical, physical and biological Drug adulteration

Module 3: Phytochemistry (12 Hrs.)

Structure, classification, properties, importance and plant sources of: alkaloids, terpenoids, steroids, glycosides.

Module 4: Industrial Botany (12 Hrs.)

Paper and pulp industry: Paper making, raw materials, manufacture of wood pulp, paper manufacture, kinds of paper and paper products. Beverages: Source, plant description, cultivation, manufacturing, chemical composition- Tea Coffee and Cocoa.

Dyes: Plant sources (Description, chemical nature, extraction of dyes). Essential oil: Occurrence, extraction, essential oils used in perfumery and other industries. Rubber and latex: Classification of rubber, Natural rubber- source, cultivation, collection of latex, processing, uses of rubber

References-

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Ali Mohammed 1998 Textbook of Pharmacognosy. CBS Publi., New Delhi.

Sabnis S D and Daniel M 1990 A Phytochemical approach to Economic Botany. Kalyani Publi., New Delhi.

Text Book of Phaermacognocy & Phytochemistry, Biren Shah Ghosh A K, Elseiver, First Edition 2010.