

APPENDIX – 1

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

Sr. No.	Semester	Course code / Paper	Course / paper	Title of course/ paper	Teaching Scheme		
					Theory (Hrs.)	Practical (Hrs.)	No. of Credits
1	One	BOT T I	I	Microbiology Algae & Fungi	5	4	4
2	One	BOT T II	II	Bryophytes & pteridophytes	5	4	4
3	One	BOT T III	III	Gymnosperms and Paleobotany	5	4	4
4	One	BOT T IV	IV	Cytology & Genetics	5	4	4
6	One	BOT P I	PRACT. I	Algae, fungi, Bryo.,	--	-	4
7	One	BOT P II	PRACT. II	Pterido, Gymno- Paleo, Cytology, Genetics	--	-	4
8	One	Seminar –I					1
8	Two	BOT T V	I	Plant Physiology and Biochemistry	5	4	4
9	Two	BOT T VI	II	Plant development and Reproduction	5	4	4
10	Two	BOT T VII	III	Cell & Molecular biology- I	5	4	4
11	Two	BOT T VIII	IV	Angiosperms - I	5	4	4
13	Two	BOT P III	PRACT. III	Pl Physiology and Biochemistry, and Growth & Dev.	--	-	4
14	Two	BOT P IV	PRACT. IV	Cell & Mol. Bio. I and Angio I	--	-	4
	Two	Seminar –II					1
15	Three	BOT T IX	I	Plant ecology	5	4	4
16	Three	BOT T X	II	Cell and Molecular Biology - II	5	4	4
17	Three	BOT T XI	III	Plant Biotechnology	5	4	4

18	Three	BOT T XII	IV	Angiosperms - II	5	4	4
20	Three	BOT P V	PRACT. V	Ecology, Cell and Mol. Bio. II	--	-	4
21	Three	BOT P VI	PRACT. VI	Pl. Biotech., Angiosperms II	--	-	4
	Three	Seminar – III					1
22	Four	BOT T XIII	I	Plant Conservation, IPR& Ethnobotany	5	4	4
23	Four	BOT T XIV	II	PRU, Biosafety, Bioethics, Biostat. & Pl. Breed.	5	4	4
24	Four	BOT T XV	III	Special paper-I	5	4	4
25	Four	BOT T XVI	IV	Special paper-II	5	4	4
27	Four	BOT P VII	PRACT. VII	Special I & II	--	--	4
28	Four	BOT P VIII	Project		--	-	4
		Seminar IV					1

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 on the hour duration 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 at the end of 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 under credit based semester system for M. Sc. Program in  
BOTANY.

SN	Semester	Course / Paper	Title of paper	Duration of paper / hrs.		Maxi- mum marks	Total grade
				T	P		
1	One	I	Microbiology, Algae and Fungi	3		100	4
2	One	II	Bryophytes and Pteridophytes	3		100	4
3	One	III	Gymnosperms and Paleobotany	3		100	4
4	One	IV	Cytology and Genetics	3		100	4
5	One	Pract. I	Microbiology, Algae and Fungi and Bryophytes		6	80+20	4
6	One	Pract. II	Pteridophytes, Gymnosperms, Paleobotany, Cytology and Genetics		6	80+20	4
7	One		Seminar		1	25	1
8	Two	V	Plant physiology and Biochemistry	3		100	4
9	Two	VI	Plant Development and Reproduction	3		100	4
10	Two	VII	Cell and Molecular Biology- I	3		100	4
11	Two	VIII	Angiosperms- I	3		100	4
12	Two	Prac. III	Plant physiology, Biochemistry, Plant Development and Reproduction		6	80+20	4
13	Two	Prac. IV	Cell and Molecular Biology- I and Angiosperms- I		6	80+20	4
14	Two		Seminar		1	25	1
15	Three	IX	Plant Ecology	3		100	4
16	Three	X	Cell and Molecular Biology- II	3		100	4
17	Three	XI	Plant Biotechnology	3		100	4
18	Three	XII	Angiosperms- II	3		100	4
19	Three	Pract. V	Plant ecology, Cell and Molecular Biology- II		6	80+20	4

20	Three	Pract. VI	Plant Biotechnology and Angiosperms- II		6	80+20	4
21	Three		Seminar		1	25	1
22	Four	XIII	Plant conservation, IPR and Ethnobotany	3		100	4
23	Four	XIV	Pl. Res. Uti., Bioethics, Biosafety, Pl. Breed. & Biostat.	3		100	4
24	Four	XVIII	Special Paper I	3		100	4
25	Four	XIX	Special Paper II	3		100	4
26	Four	Pract. VII	Special I & II		6	80+20	4
27	Four		Project		1	100	4
28	Four		Seminar		1	25	1

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 on the hour duration 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 at the end of 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 .

## APPENDIX – 3

Rules and Regulations for the Credit and Semester system in Post Graduate Teaching Department Botany of University.

### I. General Administration of the Credit and Semester system.

1. There shall be a Coordinator committee for Credit and Semester system, with Head of the Department as its chairperson, consisting of not less than three teachers of the department. The committee will be nominated by Vice Chancellor. This committee will, from time to time take appropriate decisions. This committee will forward these recommendations to appropriate authority, in case such approvals are essential.
2. Any issue not covered by this set of Rules and Regulations, but covered by the Rules previously existing shall be governed by the rules existing before the commencement of these Rules.
3. Any issue arising out of the implementation of the Credit and Semester system which are of the specific nature, which do not need the approval of any authority and Vice Chancellor shall be resolved by the departmental coordination committee.
4. The coordination committee shall from time to time consider suggestions received from Faculty, Student and Examination Section and wherever the matter pertains to the overall functioning of the Credit and Semester system, shall recommend new rules, modification in existing rules or clarification thereof.

### II. Admission and Conduction of the credit system.

1. The M. Sc. Degree of Botany will be awarded who complete the total of 100 credits (sciences) in the minimum of two years.
2. Each credit will be equivalent to (i.e. 15 hrs.).
3. The department can announce the seminar courses to introduce students to research done by the faculty. Seminar credits are to be conducted through discussion and presentation by the students and the personal guidance of the teacher. Seminar shall not exceed a maximum of 2 credits. These credits will be evaluated as internal assessment.
4. The Departmental Coordination Committee-
  - a. Will nominate the faculty of each course to be taught in the department.
  - b. Will approve a plan for evaluation prepared by the faculty for the credits concerned as an internal continuous assessment of 50% from among the 12 given in the III below. Ordinarily the teacher may opt for an internal assessment procedure other than the written exams;
  - c. Will evolve the norms of evaluating oral examination whenever necessary in relation to term paper assignment;
  - d. Will take appropriate decisions in the cases of readmissions of students during the transition from old to revised syllabus by deciding which credit from the revised syllabus was equivalent to credit from the old syllabus;
  - e. Will revise the syllabus at least five years.
5. There will be no mid-way change to over to credit system to noncredit or external examination or vice versa.

### III. EXAMINATION RULES

1. Each course will have
  - a. 50 % of marks as a semester end examination of three hours.
  - b. 50 % marks for internal (i.e. in- semester) assessment .
- 2 .the student has to obtain forty percent marks in the combined examination of in- Semester assessment and semester – End assessment with a minimum passing of 30 % in both these separately .
3. To pass, a student shall have to get minimum aggregate 40% marks (E and above on grade point scale ) in each course.
4. If a student misses an internal assessment examination he/ she will have a second chance with the permission of the teacher concerned. Such a second chance with the permission of the teacher concerned .such a second chance shall not be the right of the student ; it will be the discretion of the teacher concerned to give or not give second chance to a student to appear for internal assessment .
5. Students who have failed semester –End exam may reappear for the semester end exam only twice in subsequent period . the student will be finally declared as failed if he/she does not pass in all credits with in a total period of four years . After that such students will have to seek fresh admission as per admission rules prevailing at that time .
6. A student cant not register for the third semester, if he/ she fails to complete all credits of the total credits expected to be ordinarily completed with in two semesters.
7. Internal marks will not change. A student can not repeat internal assessment .
8. There shall be revaluation of the answer script of semester end theory examination only as per the excixting ordinance in force. There shall not be revaluation of the internal assessment papers and practical examination.
9. While marks will be given for all examination, they will be converted into grades. The semester end and final grade sheets and transcripts will have only grades and grade point average.
10. The project will consist of not more than ten percent of the total credits for the Degree course .
11. Each credit will have an internal (continuous) assessment of 50% of marks and a teacher must select a variety of procedures for examination such as:
  - i. Written test and / or Mid term test (not more than one for each course );
  - ii. Term paper ;
  - iii. Journal / lecture / library notes ;
  - iv. Seminar presentation ;
  - v. Short quizzes ;
  - vi. Assignments ;
  - vii. Extension work;
  - viii. Research projects by individual student or group of students;
  - ix. An open book test (with the concern teacher deciding what books are to be allowed for this purpose).
12. The system for evaluation will be as follows: Each assignment will be evaluated in terms of grades. The grades for separate assignments and the final semester end examination

## SEMESTER I

### PRACTICAL I

Time : 6 Hours	Full marks : 80
Q. 1 To identify the given Cyanobacterial material A.	6
Q.2 To identify two algal forms B, C, from the given mixture.	12
Q.3 To identify the given fungal culture D	6
Q. 4 To identify the given pathogen in the given material E.	8
Q. 5 To prepare a double stained micropreparation of the given Bryophytic F material and identify it.	10
Q. 6 Comment on the given spot G (Cyanobacteria/Bacteria), H (Algae), I (Fungi), J (Bryophyte)	20
Q.7Viva-voce	8
Q. 8 Practical Recordand tour report	10

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## SEMESTER I

### PRACTICAL II

Time : 6 Hours	Full marks : 80
Q. 1 To prepare a double stained micropreparation of the given Pteridophytic A material and identify it.	08
Q.2 Write a monograph on the given gymnospermic material B	12
Q.3 Comment on the given fossil specimen C	08
Q. 4 One experiment from Cytology and Genetics D	12
Q. 5 Comment on the given spot E (Pteridophyte), F (Gymnosperm), G (fossils), H (Ecology)	20
Q.6Viva-voce	08
Q. 7 Practical Recordand tour report	10

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## SEMESTER II

### PRACTICAL III

Time : 6 Hours	Full marks : 80
Q. 1 To perform the given physiological experiment A and report The findings	15
Q.2 To quantify the given metabolite in the given sample B	08
Q.3 To study the cytohistological zonation in SAM of given material C	08
Q. 4 To perform the given exercise based on plant development D	10
Q. 5 Write a note on given stage of micro- or megasporogenesis E	06
Q. 6 Spotting: F (Physiology), G (Plant development), H (Reproduction)	15
Q. 7 Viva-voce	08
Q. 8 Practical Record	10

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## SEMESTER II

### PRACTICAL IV

Time : 6 Hours	Full marks : 80
Q. 1 One experiment from paper VII A	12
Q.2 One experiment from paper VII B	08
Q.3 One experiment from paper VIII C	12
Q. 4 One experiment from paper VIII D	10
Q. 5 Spotting: E (Paper VII), F (Paper VII), G (Paper VII), H (Paper VII)	20
Q. 6 Viva-voce	08
Q. 7 Practical Record and field diary	10

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### SEMESTER III

#### PRACTICAL V

Time : 6 Hours	Full marks : 80
Q. 1 To perform the given ecological exercise A	12
Q.2 Soil analysis/Ecological adaptation B	08
Q.3 One experiment from paper X C	12
Q. 4 One experiment from paper X D	10
Q. 5 Spotting: E (Paper IX), F (Paper IX), G (Paper X), H (Paper X)	20
Q. 6 Viva-voce	08
Q. 7 Practical Record	10

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### SEMESTER III

#### PRACTICAL VI

Time : 6 Hours	Full marks : 80
Q. 1 One experiment from paper XI A	12
Q.2 One experiment from paper XI B	08
Q.3 To describe the given plant in technical language with floral formula and floral diagram C	12
Q. 4 To prepare the generic/family key D	10
Q. 5 To identify the species of the given plant using the standard flora	5
Q. 6 Spotting: E (Plant biotechnology), F (Plant biotechnology), G (Angiosperms)	15
Q. 7 Viva-voce	08
Q. 8 Practical Record and tour report	10

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## SEMESTER IV

### PRACTICAL VI

Time : 6 Hours

Full marks : 80

Q. 1	One experiment from paper XIII A	08
Q.2	One experiment from paper XIV B	08
Q.3	One experiment from paper XV C	08
Q. 4	One experiment from paper XVI D	08
Q. 5	Spotting: E (paper XIII), F (paper XIV), G (paper XV), H (paper XVI)	20
Q. 6	Viva-voce	13
Q. 7	Practical Record	15

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## M. Sc. Botany Syllabus

### Semester I

Course code/name: PAPER –I: Microbiology, Algae and Fungi

#### MODULE-I:

##### General Microbiology :

History – Contributions made by Leeuwenhoek, Pasteur, Robert Hook, Jenner, Waksman, Iwanowsky. Koch's Postulate.

Bacteria – Structure, morphology, reproduction.

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

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

#### MODULE-II

##### Phycology:

**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, algal biofertilizers; algae as a food, feed and uses in industry.

#### MODULE-III

**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*, *Rhizopus*, *Syncephalastrum*, *Cunninghamella*

#### MODULE- IV:

**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*, *Phoma*

**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.)

## **PRACTICAL**

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*, *Phytophthora*, *Albugo*, *Mucor*, *Rhizopus*, *Yeast*, *Aspergillus*, *Penicillium*, *Chaetomium*, *Taphrina*, *Peziza*, *Erysiphe*, *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*, *Penicillium*, *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

## M. Sc. Botany Syllabus

### Semester I

#### Course code/name: PAPER –II: Bryophytes& Pteridophytes

##### **Module I:**

General characters, distribution, classification, ecology of Bryophytes, Bryophytes as ecological indicators, morphogenesis in bryophytes, fossil history of bryophytes, cytology of bryophytes, regeneration in bryophytes, modern trends in taxonomy.

##### **Module II:**

General account in-

Hepaticopsida: Sphaerocarpales, Takakiales

Anthocerotopsida: Anthocerotales,

Bryopsida: Sphagnales, Polytrichales..

##### **Module III:**

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

##### **Module IV:**

General account of Sphenopsida [Hyeniales, Equisetales], Filicopsida [Ophioglossales, Filicales, Salviniaceae, Marsileales], Tracheophyta [Progymnospermosida].

##### **BRYOPHYTES:**

###### **Practicals:-**

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:**

###### **Practicals: 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.

###### **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. 9
10. Cavers, F. (1911). The interrelationship of Bryophyta VII-IX. New Phytologist. 10.
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 Embriyophyta, 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) (4<sup>th</sup> 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.)
32. Sharma O.P (1996) Textbook of pteridophyta (Mac Millan India Ltd, New Delhi)
33. Smith A. J. E. (1986). Bryophyte phylogeny fact or Fiction? Journal of Bryology, 14,83-89.

34. Smith G. M. (1955). Cryptogamic Botany-vol. 2 Bryophyta and Pteridophyta (McGraw Hill Book company, Newyork)
35. Smith W. N. and G. W. Rothwell (1993). Paleobotany and the evolution of plants (Cambridge Univ. press)
36. Sporne K.R. (1962) The morphology of pteridophyta (Hutchinson Univ. Library, London)
37. Steil W.N. (1939) Apogamy, Apospory and Parthenogenesis in the pteridophyta, Bot. rev, 5, 433-453.
38. Steward W.N. (1983) Paleobotany and the evolution of plants. 1<sup>st</sup>ed. New York, (Cambridge Univ. press)
39. Surange K.R and S. Chandra (1972) Fructification of Glossipteridae from India, Paleobotanist 21, 1-17.
40. Taylor T.N. (1988) the origin of land plants- Some answers more questions, Taxon, 37, 805-33.
41. Udar ram (1970) An introduction to bryophyte (Shashidhar malviya Prakashan, Lucknow)
42. Udar Ram, Srivastava S.C. and Kumar Dinesh (1970) Genus *Buxbaumia* in India, Curr. Sci. (India) 39, 14-15.
43. Walton J. (1925) Carboniferous Bryophyta I. Hepaticae. Annals of Botany, 39, 563-72.
44. Walton J. (1928) Carboniferous Bryophyta II. Hepaticae & Musci. Annals of Botany, 42, 707-16.
45. Walton J. (1940) An introduction to the study of fossil plants. A& C Black, London.
46. Watson E.V. (1967) The structure and life of Bryophytes, 2<sup>nd</sup> ed, London, Hutchinson.
47. Wilson C.W. (1942) The telome theory and the origin of the stamen. Am. J Bot., 29, 759-764.
48. Zimmermann W. (1952) Main results of the "Telome theory". The Paleobotanist, Birbal Sahni Memorial Volume, 456-70.



## M. Sc. Botany Syllabus

### Semester I

#### Course code/name: PAPER –III: Gymnosperms and Paleobotany

#### Module I – Paleobotany

**Introduction :** Plant fossils – Preservation, preparation, age determination, geological time scale; Fossil record – systematic, reconstruction and nomenclature; Applied aspects of paleobotany.

#### Module II – Gymnosperms

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

#### Comparative morphology and evolutionary tendencies of

1. Pteridospermales – Lyginopteridaceae (*Calymotheca hoeninghausii*, *Heterangium*, *Spherostoma*) Medullosaceae (*Medullosa*, *Trignocarpus*)
2. Cycadales – Cycadaceae; Fossil history (*Baenia*, *Nilssonia*, *Androstrobus*)
3. Cycadeoidales – Williamsoniaceae, Cycadoeoidaceae

#### Module III

4. Cordaitales (General account and relationships)
5. Caytoniales (General account and relationships)
6. Glossopteridales (General account and relationships)
7. Pentoxylales (General account and relationships)
8. Gnetales (General account and relationships)

#### Module IV

9. Ginkgoales – *Ginkgo*, *Baiera*, *Trichopitys*
10. Coniferales – (Morphology, reproductive organs, gametophytes, embryo)
11. Taxales – *Taxus*

#### 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 micropreparations 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 Readings:

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, Freeman Publishers, 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 and distributors, New Delhi. On line Journals available on UGC -VSAT

**M.Sc. Botany Syllabus**  
**Semester I**  
**Course code/name: Paper- IV Cytology and Genetics**

**Module I**

Mendel's laws of inheritance; chromosome theory of inheritance; deviations from Mendel's findings; Penetrance and expressivity; Modifiers, suppressors and pleiotropic genes; multiple alleles and isoalleles (example Corn, *Drosophila* and *Nicotiana*); multigene families (globin and immunoglobulin genes); sex determination and dosage compensation in plants, *Drosophila*, *C. elegans*.

**Module II**

**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; specialized types of chromosomes: polytene, lampbrush, B-chromosome, sex chromosome; molecular basis of chromosome pairing, C- value paradox, Cot curve and its significance.

**Module III**

Structural and numerical changes in chromosomes; origin, breeding behavior 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.

**Module IV**

**Mutations:** Spontaneous and induced; physical and chemical mutagens; molecular basis; transposable genetic elements; site directed mutagenesis; role of mutations in crop improvement; induction of polyploidy

**Epigenetics:** Introduction; paramutations in maize; Callipygh sheep; role of histones; DNA methylation; Epigenetics and Lamarckism; Epigenome and epigenomics.

**Practicals**

1. To study the effect of mutagen treatment on germination, seedling height and cell division.
2. To study the spontaneous and induced chromosomal aberrations in pollen mother cells.
3. To study the effect of mutagen treatment on pollen fertility.
4. To study the karyotype of given organism.
5. To study the chiasma frequency in the given material.
6. To study linear differentiation of chromosomes by chromosome banding.
7. To perform the site directed mutagenesis in the given system.

**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 (4<sup>th</sup>ed.). Jones and Barflett Publishers, USA.

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

Snustad D P and Simmons M J 2000 Principles of Genetics (2<sup>nd</sup>ed.) John Wiley and Son Inc., USA.

**M. Sc. Botany Syllabus**  
**Semester II**  
**Paper-V Plant Physiology and Biochemistry**

**Module-I:-**

**1) The Scope of plant physiology**

**2) Photosynthesis:** Evolution of photosynthetic apparatus, pigments, Light, light harvesting complex, Mechanism of electron transport, Photo protective mechanism, CO<sub>2</sub> fixation, C<sub>3</sub>, C<sub>4</sub> and CAM pathway, Photorespiration, photosynthesis Physiological and ecological consideration (photosynthetic responses to light by the intact leaf, photosynthetic responses to carbon dioxide and temperature) coupled reaction and ATP Synthesis, the chemiosmotic-coupling hypothesis, ATP Synthesis in chloroplast and in mitochondria

**Module-II**

**Respiration:-** introduction, the respiratory substrate, fermentation, anaerobic and aerobic respiration, mechanism of respiration ,Glycolysis, Citric acid cycle, oxidative pentose phosphate pathway, Plant mitochondrial electron transport, alternative pathway of electron transport chain, cyanide resistant chain, metabolic pool, respiratory ratio, measurement of R.Q., Regulation of respiration ,respiratory enzymes, the non oxidative enzymes, the oxidative enzymes, factor affecting the rate of respiration

**Module-III**

**1) Carbohydrates Metabolism**

General classification and properties of carbohydrates, synthesis of starch and Sucrose, catabolism (degradation) of starch and sucrose

**2) Lipids Metabolism**

General classification and properties of lipids, fatty acid biosynthesis, synthesis of membrane lipids, synthesis of structural lipids, synthesis and catabolism of storage lipids.

**3) Metabolism of amino acids**

General classification and properties of amino acids, amino acid biosynthesis in plants, assimilation of inorganic nitrogen into n-transport amino acids, GS/GOGAT Cycle

**4) Nitrogen metabolism**

Nitrogen cycles, Biological Nitrogen fixation by free-living and symbiotic bacteria, nif genes

**5) Sulfur and Phosphate assimilation by the plants**

**Module-IV**

**Enzymes:-** nomenclature and classification of Enzymes, Isoenzymes, Allosteric Enzymes, Multienzymes, Ribozymes, Lysozymes, Ribozymes & Abzymes and Coenzymesenzyme kinetics, mode and mechanism of Enzyme action (Regulation of Enzyme activity), Activators & Inhibitors,properties of Enzymes, factors affecting Enzyme activitypH, Buffer, reaction kinetics, colligative properties

**Solute transport and photo-assimilate translocation:-**Mechanism of water transport through xylem; Pathway of translocation patterns of Translocation through phloem;

Source and sink, Materials Translocated in the Phloem i.e. Sucrose, Amino acids, Hormones and some inorganic ions, Rate of Movement, Phloem loading: from chloroplast to sieve elements, Phloem Unloading: sink-to-source Transition, mechanism of translocation in the phloem

### **Suggested Laboratory Exercises:**

To study the effect of time and enzyme concentration on the rate of reaction of enzyme (e.g. phosphatase, nitrate reductase).

To study the effect of substrate concentration on activity of enzyme and determination of its  $K_m$  value.

Demonstration of the substrate inducibility of the enzyme nitrate reductase.

Determination of succinate dehydrogenase activity, its kinetics and sensitivity to inhibitors.

To determine the total carbohydrate content in the given sample

Estimation of Pectic Substances-gravimetric method

To prove Berr-Lambert's law using a suitable solution.

Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophyll and carotenoids.

To determine the chlorophyll a/ chlorophyll b ratio in C<sub>3</sub> and C<sub>4</sub> plants.

Isolation of intact chloroplasts and estimation of chloroplast proteins by spot protein assay.

Preparation of standard curve of protein (BSA) and estimation of protein content in extracts of plant material by Lowry's or Bradford's method.

Preparation of Leaf Protein Concentrates from green vegetables.

Determination of reducing sugars by Nelson – Somogyi Method

### **Suggested Readings (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.

- 3 **Copeland, R.A. 1996.** Enzymes: A Practical Introduction to Structure, Mechanism and Data Analysis. VCH Publishers, New York.
- 4 **Dennison C. 1999.** A guide to Protein Isolation. Kluwer Academic Publishers, Dordrecht, The Netherland.
- 5 **Devi, 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 University Press, New York.
- 7 **Hames, B.D.(Ed.).1998.** Gel Electrophoresis of Proteins: A Practical Approach, 8<sup>th</sup> edition. PAS, Oxford University Press, Oxford, UK.
- 8 **Harborne, T.C. 1981.** Phytochemical Methods: A Guide to Modern Techniques of Plants Analysis. Chapman& Hall, London.
- 9 **Moore, T.C. 1974.** Research Experiences in Plant Physiology: A Laboratory Manual. Springer-Verlag, Berlin.
- 10 **Ninfa, A. J. and Ballou, D. P. 1998.** Fundamental Laboratory Approaches for Biochemistry 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.
- 12 **Scott, R.P.W. 1995.** Techniques and Practice of Chromatography. Marcel Dekker, Inc., New York.
- 13 **Wilson, K. and Goulding, K.H.(Eds), 1986.** A Biologists Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold, London,UK.
- 14 **Wilson, K. and Walker, J. 1994.** Practical Biochemistry: Principles and Techniques, 4<sup>th</sup> 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.

- 2 **Dennis, D.T., Turpin, D. H., Lefebvre, D.D. and Layzell, D.B. (eds).1997.** Plant Metabolism (2<sup>nd</sup> 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 **Lodish, H., Berk, A., Zipursky S.L., Matsudaira, P., Baltimore, D and Darnell, J. 2000.** Molecular Cell Biology (4<sup>th</sup>ed). W. H. Freeman and Company. New York ,USA.
- 7 **Moore, T.C. 1989.** Biochemistry and Physiology of Plant Hormones (2<sup>nd</sup>ed). Springer-Verlag, New York, USA.
- 8 **Nobel, P.S.1999.** Physicochemical and Environmental Plant Physiology (2<sup>nd</sup> ed). Academic Press, Diego, USA.
- 9 **Salisbury, F.B. and Ross, C.W.1992:** Plant Physiology (4<sup>th</sup>ed). Wadsworth Publishing Co., California, USA.
- 10 **Singhal G.S., Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee.1999:** Concepts in Photobiology Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
- 11 **Taiz, L. and Zeiger, E. 1998:** Plant Physiology. Sinauer Associates, Inc., Publishers, Massachusetts, USA.
- 12 **Thomas,B. and Vince-Prue,D.1997:** Photoperiodism in Plants (2<sup>nd</sup> 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-238884
- 15 **Ranjan, purohit, Prasad 2003:** Plant Hormones Action and Application, Agrobios(India), agro house, behind Nasrani cinema Chopasani Road, Jodhpur -34



**M. Sc. Botany Syllabus**  
**Semester -II**  
**Paper- VI: Plant Development and Reproduction**

**Module I:**

**Plant growth**

**Kinetics and pattern of growth**

**Shoot Development** – Organization of shoot apical meristem (SAM); cytological and molecular analysis of SAM; control of cell division and cell communication; control of tissue differentiation.

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

**Module II :**

**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 :**

**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 and fertilization;** Structure of the pistil; pollen – stigma interactions, double fertilization; *in vitro* fertilization.

**Module IV :**

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

**Germination of seed:** Biochemical and hormonal control.

**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. Unwin Hyman, London.
- 8) Murphy, T.M. and Thompson, W.F. 1988. Molecular Plant Development. 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*. Examination of shoot apices in a monocotyledon in both T.S. and L.S. to show the origin and arrangement of leaf primordia.
6. Study of alternate and distichous, alternate and superposed, opposite and superposed; opposite and decussate leaf arrangement.
7. Examination of rosette plants (*Launaea*, *Mollugo*, *Raphanus*, *Hyoscyamus* etc) and induction of bolting under natural conditions as well as by GA treatment.
8. 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.
9. Study of epidermal peels of leaves such as *Coccinia*, *Gaillardia*, *Tradescantia*, *Thunbergia*, etc. to study the development and final structure of stomata and prepare stomatal index. Demonstration of the effect of ABA on stomatal closure.
10. Study of whole roots in monocots and dicots. Examination of L.S. of root. from permanent preparation to understand the organization of root apical meristem and its derivatives. (use maize, aerial roots of banyan, *Pistia*, *Jussieua* etc.). Origin of lateral roots. Study of leguminous roots with different types of nodules.
11. Study of microsporogenesis and gametogenesis in sections of anthers.
12. 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. Study of cleistogamous flowers and their adaptations.
20. Study of nuclear and cellular endosperm through dissections and staining.
21. Isolation of zygotic globular, heart-shaped, torpedo stage and mature embryos from suitable seeds and polyembryony in citrus, jamun (*Syzygium cumini*) etc. by dissections.
22. Study of seed dormancy and methods to break dormancy.

## M. Sc. Botany Syllabus

### Semester II

Course code/name: Paper- VII Cell and Molecular Biology Biology- I

#### Module I:

**Cell wall:** Structure; function; biogenesis and growth; cell differentiation

**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:

**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 microtubules and microfilaments; motor movements, implications in flagellar & other movements, cell division.

#### Module III:

**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:

**Molecular biology of stress responses:** Definition and classification of 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, induction of genes involved in phenylpropanoid metabolism; PR proteins and R- genes

#### 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 8<sup>th</sup> Ed. B. I. Waverly Pvt. Ltd., New Delhi.
- 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 (2<sup>nd</sup> Edi.) Harper Collins Coll. Publisher, New York, USA.
- Krishnamurthy, K.V. 2000 Methods in Cell wall Cyto-chemistry. CRC Press, Boca Raton, Florida
- 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
- Russel, P. J. 1998 Genetics (5<sup>th</sup> Edi.) The Benjamin/ Cummings Publishing Com. Inc., USA
- Wolf, S.L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA

### **Practicals**

- Orcein staining of the salivary gland chromosomes of *Chironomus* and *Drosophila*.
- Cell fractionation & isolation of Chloroplast and mitochondria.
- Isolation of plant DNA and its quantification by spectrophotometric method.
- To perform flagellary staining.
- Isolation of DNA and preparation of Cot-curve.
- Demonstration of vital structure and functions of cell
- To study the induction of defence genes by elicitors.

### **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, 2<sup>nd</sup> 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

- Cell Biology International -
- Cell Death and Differentiation -
- Cell Motility and the Cytoskeleton -
- Cellular Physiology and Biochemistry
- Current Advances in Plant Sciences
- Cytokine -
- 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

## M. Sc. Botany Syllabus

### Semester II

#### Course code/name: Paper- VIII Angiosperms- I

##### Module I:

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

##### Module II:

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: HETEROBATHMY, ANALYTIC Vs. synthetic character, qualitative Vs quantitative characters.

##### Module III:

Taxonomic evidence: Morphology, anatomy, embryology, palynology, cytology, phytochemistry, genome analysis.

Taxonomic tools: herbarium, floras, monographs, botanical gardens, biochemical and molecular techniques, computers and GIS.

##### Module IV:

Biosystematics: The population concept phenotypic plasticity, biosystematic categories, methods of biosystematics studies. Numerical taxonomy: principles, aims and objectives, cladistics in taxonomy, polarity of characters, homology, homoplasy, monophyly, polyphyly. Plant nomenclature: Salient features of ICBN

##### Practicals

1. To study the floral symmetry in various taxa.
2. To study and work out the differences in dicot and monocot flower.
3. To study the variation in stamens and carpels.
4. To study placentation types in various taxa.
5. To study the floral adaptations for pollination.
6. To study anatomical features of various taxa.
7. To study embryological features of various taxa.
8. To study palynological features of various taxa.
9. To study cytological features of various taxa.
10. To prepare a cladogram on the basis of various morphological features of the species belonging to a genus.

##### 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.
- Harrison, H.J. 1971. New concept in flowering plant Taxonomy. Hickman educational books Ltd. London.
- Hislop-Harrison, 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.
- Jones, A. D. and Wiggins, 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 (2nd edition). McGraw-Hill Book Co., New York.
- Nordstrom, B., El Gazaly, G. and Kassas, M. 2000. Plant systematics for the 21st century. Portland press. Ltd, London.
- Radford, A. E. 1986. Fundamentals of plant systematics. Harper and Row publication, USA.
- Solbrig, O.T. 1970. Principles and methods of plant Systematics. The Macmillan Co. Publication Co. Inc., USA.
- Woodland, D. W. 1991. Contemporary Plant Systematics, Pentice Hall, New Jersey.
- 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. Edward Arnold Ltd, London.
- Jones, A. D. and Wiggins, A. D. 1971. Variation and adaptation in Plant species Hickman and Co.
- Jones, S. B., Jr. and Luchsinger, A. E. 1986. Plant Systematics (2nd edition). McGraw Hill Book Co., New

## M. Sc. Botany Syllabus

### Semester III

#### Course code/name: PAPER –IX: Plant ecology

##### Module I:

Vegetation organization: Concepts of community and continuum, analysis of communities (analytical and 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); changes in ecosystem properties during succession, Autecology.

##### Module II:

**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; mineral cycles (pathways, processes, budgets) in terrestrial and aquatic ecosystems.

##### Module III:

**Air, Water and Soil pollution:** Kinds; sources; quality parameters; effects on plant and ecosystems.

Climate change: Greenhouse gases (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, CFCs; sources, trends and role); ozone layer and ozone hole; consequences of climate change (Global warming, sea level rise, UV radiation).

##### Module IV:

**Ecosystem stability:** Concept (resistance and resilience); 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.

##### Plant Ecology- Practicals:

- 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 Quadrat/ Transat/ Point centered Quarter methods.
- 3) Qualitative parameters of distribution of plant species, Frequency, Density, Basal cover, dominance, Abundance and IVI.
- 4) Analysis of soils of two different areas i.e. Cropland and forest/ grassland for certain nutrients, CO<sub>3</sub>, NO<sub>3</sub>, Base deficiency.
- 5) Analysis of water quality for physical properties like colour BOD, COD, O<sub>2</sub>, CO<sub>2</sub> contents etc.
- 6) Study of adaptations in plants of hydrophytic, Xerophytic and halophytic zones.

##### Suggested Readings:

1. Ambast R.S. 1968. Freshwater ecosystem- Manual of Ecology 123-137 (See Misra KC et al 1968)
2. Ambast R.S. 1966 Conservation Ecology, Abs Proc School on Plant Ecol (Full paper in press Oxford and IBH Calcutta).
3. Ambast 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, 238-43.
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. Chapman & 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. Silvertown JW 1982 Introduction to plant population ecology, Longman.
24. Southwick CH 1983 (ed) Global Ecology Sinauer.
25. Whittaker RH 1975 Communities and Ecosystems (2<sup>nd</sup>ed) MacMillan, New York.

## M. Sc. Botany Syllabus

### Semester III

Course code/name: Paper- X Cell and Molecular Biology- II

#### Module I:

**Ribosomes:** Structure and function

**Transcription & Translation:** Transcription in prokaryotic and eukaryotic cells, plant promoters, transcription factors, types of RNA and their function, splicing, mRNA transport, rRNA biosynthesis; translation in prokaryotic and eukaryotic cells, structural levels of proteins, post-translational modification; structure and role of tRNA.

#### Module II:

**Gene structure and expression:** Fine structure of gene, Cis-trans test; fine structure analysis in eukaryotes; introns and their significance, RNA splicing; regulation of gene expression in pro- and eukaryotes.

**Protein sorting:** Machinery involved, vesicles, coat proteins; protein targeting to plastids, mitochondria, peroxisomes, nucleus, vacuoles; modification during transport.

#### Module III:

**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; genetics 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; site-specific recombination; chromosome mapping, linkage group, genetic markers, construction of molecular maps, correlation of genetic and physical maps; Somatic cell genetics - an alternative approach to gene mapping.

#### Module IV:

- a. **Cell cycle and apoptosis:** Control mechanisms, role of cyclins and cyclin dependent kinases; retinoblastoma and E2F proteins; cytokinesis and cell plate formation; programmed cell death in plants; regulation in plant growth and development.
- b. **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
- c. **Techniques in cell biology:** Electrophoresis, immunotechniques, FISH, GISH, confocal microscopy

**Suggested readings:**

- Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular Biology of Cell, Garland Publishing, Inc., New York.
- 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 8<sup>th</sup> Ed. B. I. Waverly Pvt. Ltd., New Delhi.
- 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<sup>nd</sup> Edi.) Harper Collins Coll. Publisher, New York, USA.
- Lewin, B. 2000 Gene VII Oxford Univ. press, New York.
- 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 (3<sup>rd</sup> Edi.) Jones and Bartiet Pub. Inc., London.
- Russel, P. J. 1998 Genetics (5<sup>th</sup> Edi.) The Benjamin/ Cummings Publishing Com. Inc., USA
- Sunstad, D. P. and Simmons, M. J. 2000 Principles of Genetics (2<sup>nd</sup> Edi.) John Wiley & Sons Inc., USA.
- Tamarin, R. H. 2001 Principles of Genetics 7<sup>th</sup> Edi. The McGraw–Hill Companies.
- Wolf, S.L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA.

### **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. Restriction digestion of plant DNA, its separation by agarose gel electrophoresis, visualization by ethidium bromide staining.
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.

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

**M. Sc. Botany Syllabus**  
**Semester III**  
**Course code/name: Paper- XI Plant Biotechnology**

**Module I:**

- a. **Recombinant DNA technology:** Gene cloning and principles and technique; vectors-types and their properties; construction of DNA libraries; 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:**

- 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; polymerase chain reaction; DNA fingerprinting

**Module III:**

**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:**

- a. **Bioinformatics:** Introduction, History, Definition and applications of bioinformatics.
- b. **Database:** Types and classification of databases – Primary Databases (Nucleic acid sequence, protein sequence, protein structure), Secondary databases (Genomic, cDNA, Organellar, gene expression), special databases (Human, *Escherichia coli*, *Saccharomyces cerevesaie* and *Arabidopsis thaliana*), Literature database (PubMed, OMIM), Information Retrieval system (Entrez). Other databases: GeneBank, KEGG, Taxonomy databases
- c. **Data analysis, prediction and submission tools and their uses:** ORFfinder, Blasts, FASTA, RASMOL, Prediction of pro- and eukaryotic genes and promoters (Genscan); protein structure (SWISS-Prot, pfam, PDB, PIR); **sequin**, webin, AutoDep tools.

**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.
- Chrispeels, M. J. and Sadava, D. E. 1994, Plants, Genes and Agriculture. Jones & Barlett Publishers, Boston, USA.
- 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 2<sup>nd</sup> 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.
- Watson, J. , Tooze and Kurtz Recombinant DNA: A short course

### **Practicals:**

1. Growth characteristics of *E.coli* using plating and turbidimetric methods.
2. Isolation of plasmid from *E.coli* and its quantification.
3. Restriction digestion of the plasmid and estimation of the size of various DNA fragments.
4. Cloning of a DNA fragment in a plasmid vector, transformation of the given bacterial population and selection of recombinants.

5. Co-cultivation of the plant material (e.g. leaf discs) with *Agrobacterium* and study GUS activity histochemically.
6. Preparation of media for plant tissue culture.
7. To surface sterilize the given seeds/explant for tissue cultural manipulation.
8. To isolate protoplast and determine its viability.
9. To fuse the protoplast for production somatic hybrid.
10. Demonstration of DNA sequencing by Sanger's dideoxy method.
11. To search literature of different organisms and genes from NCBI.
12. Use of various tools to retrieve information available from NCBI
13. To retrieve gene and protein sequences of various organisms from NCBI.
14. To locate gene(s) on chromosomes for a given disease/disorder.

### **Suggested Readings(for laboratory excrises)**

- 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.
- Gelvin, S. B. and Schilperoort, R. A (eds) 1994. Plant Molecular Biology Manual, 2<sup>nd</sup> edition. Kluwer Academic Publishers, Dordrecht, The Netherlands,
- Glover, D. M. and Hames, B. D.(Eds) 1995. DNA Cloning 1: A Practical Approach: Core Techniques, 2<sup>nd</sup> 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. IRI Press,
- Oxford.

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



**M. Sc. Botany Syllabus**  
**Semester III**  
**Course code/name: Paper- XII Angiosperms- II**

**Module I:**

General account, distinguished characters, floral variation and evolution, affinities of :- Magnoliidae, Hamamelidae, Dilleniidae, Rosidae, Asteridae, circumscription as per Cronquist, 1968

**Module II:**

Alismatidae, commelinidae, Aracidae, Lilidae; Interesting features and systematic position of Cucurbitaceae, Cactaceae, Asteraceae, Amentiferae, Lemnaceae, Palmae, Orchidaceae.

**Module III:**

Probable ancestors of angiosperms, primitive living angiosperms, speciation and extinction, IUCN categories of threat, distribution and global pattern of biodiversity.

**Module IV:**

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.

**Practicals:**

Angiosperms

1. Description of a specimen from representative, locally available families.
2. Description of a species based on various specimens to study intra specific variation: collective exercise.
- 3.
4. Description of various species of a genus, location of key characters and preparation keys at generic level.
5. Location of key characters and use of keys at family level.
6. Field trips within and around the campus; compilation of field notes and preparation herbarium sheets of such plants, wild or cultivated as are abundant.
7. Training in using floras herbaria for identification of specimens described in the class.
8. Demonstration of the utility of secondary metabolites in the taxonomy of some appropriate genera.
9. Comparison of different species of a genus and different genera of a family to calculate similarity coefficients and preparation of dendrograms.

**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.

Jones, 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 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.

Jones, 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.

## M. Sc. Botany Syllabus

### Semester IV

Course code/name: Paper- XIII Plant conservation, IPR and Ethnobotany

#### Module I

**Plant biodiversity** – Concept of Biodiversity; Types (Species, Genetic, Ecosystem diversity. Present status in India  
Origin of Biodiversity; values of Biodiversity; loss of Biodiversity.  
Megabiodiversity Centers with special emphasis on Western Ghats and Indo-Burma region  
Biodiversity and agriculture; Bioprospecting; commercial values of Biodiversity.  
CBD – General account

#### Module II

IUCN – General account, categories, Commissions, role in conservation; Red Data Book  
CITES – General account, CITES & International trade  
Strategies for conservation  
Protected areas concept: Sanctuaries, National parks, Man and Biosphere programme, Biosphere reserves  
Tiger reserves with reference to Melghat Tiger Project, Tadoba Andhari Tiger Reserve and Pench)  
Wetlands – Types, Importance, Measures taken for conservation at National and International levels, Ramsar Convention  
Mangroves – Types, Zonations, Importance, Measures taken for conservation at National and International levels

#### Module III

Coral Reefs – Types, importance, artificial reefs, conservation measures  
Legislative framework for protection  
Principles and practices for *Ex-situ* conservation, Botanical gardens, Field Gene Banks, Seed Banks.  
*In-vitro* repositories, Cryobanks,  
General accounts and activities of national institutes like Botanical Survey of India (BSI), National Bureau of Plant Genetic Resources (NBPGR), Indian Council of Agricultural Research (ICAR), Department of Biotechnology (DBT) and their role in plant conservation

#### Module IV

Intellectual property right; patenting: basic requirement, novelty, public domain; plant variety protection act; farmers right protection act; WTO with reference to biotechnological affairs  
**Ethnobotany:** Definition, scope and significance. Status in India Major tribes of Maharashtra – Madia, Korku, Gond, Bhil, Varli (information on customs, traditions, plants used as medicines, scarcity food); Important medicinal plants used by tribals in Vidarbha; Sacred groves and their role in conservation.

**M. Sc. Botany Syllabus**  
**Semester IV**

**Course code/name: Paper- XIV Plant resource utilization, Bioethics, Biosafety, Plant breeding and Biostatistics**

**Module 1:**

Centres of diversity of domesticated plants; Green revolution.

Important fire wood and timber yielding plants; qualities of timber plant, Non-wood forest products (NWFPs) such as Bamboos and rattans

Origin, evolution, botany and uses of food crop (rice and pigeonpea), Fibre crop (Cotton, jute), Vegetable oil yielding crop (Safflower, Sunflower ) Sugar and biomass crop (Sugarcane, Beet)

Source, types and uses of – gums, resins, tannins and dyes

A brief account of major spices, condiments, narcotics, mastigatories and fumitories and beverages

Fodder and forage plants

Medicinal and aromatic plants

General account of petrocrops

**Module 2:**

**Sampling**-Sampling procedure, homogenization of samples, samples size, Selection of random sample, Limitation of analytical methods

Types of data, Frequency distribution, Measure of central values - Mean, median and mode,

**Measures of dispersion** - range , mean deviation , standard deviation, coefficient of variation, moment, Statistical Inference of Qualitative & Quantitative Variables, level of significance, Chi square test & its applications, One-Way ANOVA, Two way ANOVA, t-test

**Module 3:**

**Population genetics:** Hardy-Weinberg equilibrium and deviations from it; quantitative trait loci (Kernel colour in wheat, corolla length in *Nicotiana longifera*).

**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.

**Bioethics:** Professional ethics, ethical decision making and ethical dilemmas

**Module 4:**

Biosafety in the laboratory institution: Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory/ institution

Biosafety regulations in the handling of recombinant DNA processes and products in institutions and industries, biosafety assessment procedures in India and abroad

Biotechnology and food safety: The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance.

Ecological safety assessment of recombinant organisms and transgenic crops, case studies of relevance (Eg. Bt cotton).

Biosafety assessment of biotech pharmaceutical products such as drugs/vaccines etc.

International dimensions in biosafety: Cartagena protocol on biosafety, bioterrorism and convention on biological weapons

### **Recommended Books :**

- Arora, P. N. & Malhon, P. K., 1996 Biostatistics. Himalaya Publishing House, Mumbai.
- Bliss, C. I. K. 1967 Statistics in Biology. Vol. 1 Mc Graw Hill, New York.
- Campbell, R. C. 1974 Statistics for Biologists. Cambridge University Press, Cambridge.
- Cochran, W. G. Sampling Techniques, Wiley eastern Ltd, New Delhi.
- Daniel, W.W. 2004, Biostatistics. 8th Edn. Wiley
- Donald T. Haynie, Biological thermodynamics. Cambridge University Press, 1st edition.
- Feller, W. Introduction to probability theory and its applications, Asia Publ. House, Mumbai.
- Glover, T. and Mitchell, K. 2002, An introduction to Biostatistics. McGraw-Hill, N.Y.
- Intellectual Property Rights - Brigitte Anderson, Edward Elgar Publishing
- Intellectual Property Rights and the Life Sciences Industries - Graham Dutfield, Ashgate Pub.
- WIPO Intellectual Property Handbook
- Intellectual Property Rights - William Rodelph Cornish, David Clewelyn
- Biotechnology-The science and the business Mosses V, Cape RE, 2<sup>nd</sup> edn., CRC press 2000.
- Patterns of Entrepreneurship - Jack M. Kaplan
- Indian Patents Law, Mittal, D.P. (1999) Taxmann, Allied Services (p) Ltd.
- Handbook of Indian Patent Law and Practice - Subbaram, N. R., S. Viswanathan (Printers and Publishers) Pvt. Ltd., 1998.

**Websites:** 1) Intellectual Property Today : Volume 8, No. 5, May 2001, [www.iptoday.com](http://www.iptoday.com)

2) Using the Internet for non-patent prior art searches, Derwent IP Matters, July 2000. [www.ipmatters.net/features/000707\\_gibbs.html](http://www.ipmatters.net/features/000707_gibbs.html)

## M. Sc. Botany Syllabus

### Semester IV

Course code/name: Paper-XV (Molecular Biology and Plant Biotechnology –special I)

#### Module I:

- a. **DNA replication:** DNA replication in prokaryotic organism – Initiation, elongation, and termination, DNA replication in eukaryotes – origin, replication form, replication proteins, Comparative account of DNA replication in prokaryotes and eukaryotes, DNA replication proteins
- b. **DNA damage and repair:** Types of DNA damage, factors for DNA damage, **Repair system:** Single base change, direct repair, mismatch repair, SOS response.

#### Module II:

- a. **Isolation of gene and nucleotide sequence:** DNA manipulation enzymes; General methods of gene isolation.
- b. **Molecular probing:** Recombinant DNA libraries (gDNA and cDNA, oligonucleotide probes); nucleic acid hybridization (southern, northern, dot-blot and slot-blot); antibodies as probe for proteins (immunoblotting or western blotting, immunoprecipitation, southwestern screening).

#### Module III:

- a. **Splicing of foreign DNA into cloning vector:** Vectors for prokaryotes; ligation.
- b. **Introduction of foreign DNA into host cell:** Transformation; transfection; transgenesis
- c. **Isolation of genes or protein products from clones:** Expression vectors- Characteristics; vectors producing fusion proteins
- d. **Polymerase chain reaction:** Types of PCR's and their applications in molecular biology

#### Module IV:

- a. **Sequence alignment and phylogenetic trees:** Dot plots, sequence similarity, pairwise and multiple alignment, significance of alignment, phylogeny and phylogenetic trees and evolution.
- b. **Genomics:** Definition; genome analysis (genetic polymorphisms, genetic mutations); microarray technology and applications (gene expression and diseases).
- c. **Proteomics:** Protein stability and folding; application of hydrophobicity; DALI (Distance-matrix alignment); Protein structure- evolution, classification, prediction and modeling, prediction of function. DNA microarrays, mass spectrometry, network and graphs, protein complexes and aggregates, protein interaction networks, regulatory networks.

#### Suggested Readings:

- Alberts, Bruce; Johnson Alexander; Lewis, Julian; Raff, Martin; Roberts, Keith; Walter,
- Peter, C. 2002 Molecular Biology of the Cell, Garland Science, New York and London.
- 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.
- 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
- Bergman, N.H 2007 Comparative Genomics Humana Press Inc., Part of Springer Science+ Business Media
- Brown, T. A. 1999. Genomes, John Wiley & Sons(Asia) Pvt. Ltd., Singapore
- De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology 8<sup>th</sup> Ed. B. I. Waverly Pvt. Ltd., New Delhi.
- Glover, D.M. and Hames, D.B 1995 DNA Cloning : A practical approach, R.L. 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.
- Jolles, O. and Jornvall, H. (eds) 2000. Proteomics in Functional Genomics. Birkhauser Verlag, Basel, Switzerland.
- Karp, G. 1999 Cells and Molecular Biology; Concepts and Experiments. John Wiley & Sons, Inc., USA.
- Lehninger' Principles of biochemistry-Nelson, Cox, 4th Edn., W.H.Freeman and Co.,2005.
- Lewin, B. 2000 Gene VII Oxford Univ. press, New York.
- Lewin, B. 2010 Gene X Oxford Univ. press, New York.
- 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
- Mount W. 2004 Bioinformatics and sequence genome analysis 2<sup>nd</sup> Edi. CBS Pub. New Delhi
- Old and Primrose , 1994, Principles of gene manipulation. Blackwell Scientific Publ.
- Raymond Schuler and Zielinski, E. 2005, Methods in plants Molecular biology - Acad. Press.
- Russel, P. J. 1998 Genetics (5<sup>th</sup> Edi.) The Benjamin/ Cummings Publishing Com. Inc., USA
- Sambrook and Russel. 2001. Molecular cloning Vol. 1-3 CSH press.
- Shaw, C.H. 2006, Plant Molecular Biology: A practical approach. Panima Pub. Corp.
- Stryer, Berg, Biochemistry- 6th Edition, W. H. Freeman and Co.,2007.
- Voet, D.; Voet, J.; Biochemistry – 3rd Edn. John Wiley and sonsInc., 2004.
- Wilson Keith and Walker John 2005 Principles and techniques of biochemistry and molecular biology, 6th Ed. Cambridge University Press, New York.

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

**Practicals:**

1. Detection of DNA damage by mutagens
2. Bacterial transformation and selection of transformed cells.
3. To detect molecular polymorphism of different species
4. To demonstrate the presence of particular polypeptide by Western blotting.
5. To design PCR primers for isolation of given gene and to clone it in the given vector.
6. Amplification and sequencing of nr DNA by PCR
7. To find the sequences of a given protein in SWISS-Prot, Uni-Prot
8. To work out the sequence from given autoradiogram and to identify it from GeneBank by BLAST method.
9. To generate Pairwise and multiple sequence alignment of a given organisms
10. To generate phylogenetic tree using given sequences.
11. To predict a protein from given sequence by using online tools from NCBI.

**Suggested Readings(for laboratory excrcises)**

- 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.
- 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.
- McEntyre, J.; Ostell, J., editors Bethesda (MD) The NCBI Handbook: National Library of
- Medicine (US), NCBI; 2002-2005
- Sambrook and Russel. 2001. Molecular cloning Vol. 1-3 CSH press.
- Tools & updated literature available at [www.ncbi.com](http://www.ncbi.com)

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



**M. Sc. Botany Syllabus**  
**Semester IV**

**Course code/name: Paper XV- Reproductive Biology of Angiosperms (Special) I**

**Module I:**

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

**Anther:** Structure, anther wall;: endothecium, middle layer, tapetum-Structure, types-structure-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:**

**Male gametophyte development:** formation of vegetative and generative cells, differential behavior 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:**

**Pistill:** 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:**

**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. Chitralkha 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. Chitralkha 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.

**M. Sc. Botany Syllabus**  
**Semester IV**

**Course code/name: Paper XV- ADVANCED PHYCOLOGY PAPER- I (Special)**

**MODULE 1:**

- 1 Prokaryotic characters , ultra structure of cell, reproduction and affinities.
- 2 Sources of Nitrogen and its assimilation, importance and activity of biofertilizers , biotechnological implication and Biological Nitrogen fixation.
- 3 Biotechnology and international market, Nif gene transformation and present status of genetic engineering
- 4 Toxic algae: Phycotoxins, characteristics and their effects on human beings.
- 5 Algae cytology and genetics
- 6 Calcification, extracellular products of algae and fossil algae.()

**MODULE 2:**

**Bacteria:** Strain selection, sterilization, growth, fermentation production, application technology for major biofertilizers, viz. *Rhizobium* , *Azotobacter*, *Azospirillum*, *Bacillus megaterium* (PSB), *Pseudomonas fluorescens*.

**Cyanobacteria:** *Phormidium*, *Aulosira*, *Cylindrospermum*, *Rivularia*, Symbiotic algae and their role in other plan.

**MODULE 3:**

- 1 Algae as a food feed and medicine.
- 2 Eukaryotic characters (morphology) reproduction, life cycle patterns, taxonomy, Phylogeny , and interrelationship of Protochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Pheophyta and Rhodophyta;
- 3 Prochlorophyta :** *Prochloron*.
- 4 Chlorophyta:** *Microspora*, *Draparnaldia*, *Trentopholia*, *Fritschiella*, *Cosmarium*, *Codium*, *Bryopsis* . .

**MODULE 4:**

Industrial product from algae of marine and freshwater

**Phaeophyta :** Thallus range, cell structure, alternation of generation, *Cutleria*, *Padina*, *Laminaria*, *Turbinaria*.

**Rhodophyta :** *Nemalion*, *Gelidium*, *Gracilaria*, *Corallina*, *Polysiphonia*.

**Euglenophyta :** *Euglena*, *Phacus*.

**Bacillariophyta :** *Cyclotella*, *Synedra*, *Cymbella*, *Navicula*, *Gomphonem*

**Chrysophyta:** *Synura* and *Dinobryon*.

## M. Sc. Botany Syllabus

### Semester IV

Course code/name: Paper- XV (Mycology and Plant pathology- special I)

#### MODULE I: General Microbiology –

**Bacteria** – Morphology, size, shape, structure, Characters of Eubacteria, Actinomycetes, Archaeobacteria, Bacterial nutrition, reproduction.

**Viruses** – General Characteristics, structure, classification (LHI System), replication (lytic cycle & lysogeny)

**Rickettsia** – General characters

#### MODULE II: Mycorrhiza :

1. Kinds of mycorrhizae. Ectotrophic and endotrophic mycorrhizae, their morphology and anatomy. V A - mycorrhiza. Importance of mycorrhiza in Agriculture.
2. Rhizosphere and phyllosphere - General concept and importance.
3. Medical Mycology - Dermatophytic fungi - Knowledge of common dermatophytes and human diseases caused by them viz. *Tinea pedis*. *Tinea capitis*, *Tinea barbae*. *Tinea corporis* and *Tinea manuum*, Non-dermatophytes.

#### MODULE III: Production of Metabolites By Fungi:

##### A) Industrial Fungal Metabolites:

- i) Antibiotics - Penicillin, Cephalosporin, Griseofulvin, Industrial production. of Penicillin
- ii) Enzymes -. Amylase, proteases, Lipases, Pectinases, Cellular and xylanases.
- iii) Organic acids - Citric acid, Gluconic acid, lactic acid, kojic acid. Itaconic acid.

##### B) Non Industrial Fungal Metabolites :

- i) Phytoalexins , ii) Mycotoxins , "

#### MODULE IV :Fungi as welfare to human beings:

- i) Fungi in food processing
  - ii) Fungi in Medicine
  - iv) Fungi as food - edible mushrooms, methods of their cultivation
  - v) and economic importance.
  - vi) Concept of biodeterioration and Biodegradation
- a) Biodeterioration of noncellulosic materials.
  - b) Biodeterioration of cellulosic materials.
  - c) Role of microorganisms in Biodegradation of organic wastes. Factors affecting the process of Biodegradation.

#### Suggested Readings .

1. Agrios, G.N. (1980) Plant Pathology, Academic Press, INC, New York.
2. Ainsworth, G.C. and A.S.Sussman (eds). The Fungi, An advance Treatise Vol.I, II, III & IV Academic Press, New York.

3. Alexopoulos, C.J. (1962). *Introductory Mycology* John Wiley Eastern Pvt.Ltd.
4. Alexopoulos, C.J. and Mims C.W. (1979). *Introductory Mycology* 3rd Edition, John Wiley and Sons, Inc. Wiley, New York.
5. Alexopoulos, C.J., Mims and Black well (1996) 4th ed. John Wiley and Sons, Inc. Wiley, New York
6. Aneja, K.R. (1993) *Experimental in Microbiology, Plant Pathology & Tissue Culture*, Wiswa Prakashan, New Delhi.
7. Bessey, E.A. (1950) *Morphology and Taxonomy of Fungi*. The Blakiston co. Philadelphia.
8. Bilgrami, K.S. and H.C.Dube (1985) *A text Book of Modern Plant Pathology*, Vikas Publication House, New Delhi.
9. Barnett, J.H. (1968) *Fundamentals of Mycology*. The English Language Book Society and Edward Arnold Publication, Limited.
10. Dube, R.C. and D.K.Maheshwari (1999) *A.Text Book of microbiology*, S.Chand & Co. Ltd.
11. Dube, R.C. and D.K.Maheshwari (2000) *Practical Microbiology - S.Chand & Co. Ltd.*
12. Gupta, V.K. and M.K.Behl (1994) *Indian Plant Viruses and Mycoplasma* Kalyani Publishers, 1/1, Rejinder Nagar, Ludhiana.
13. Jha, D.K. (1993) *A Text Book of Seed Pathology*, Vikas Publication House.
14. Mehrotra, R.S. (1989) *Plant Pathology*, Tata McGraw Hill.
15. Mehrotra, R.S. and K.R.Aneja (1998) *An Introduction to Mycology*, New Age Intermediate Press.
16. Pelzer, M.J. , Jr.Cahn, E.C.S. and N.R.Krieg (1993) *Microbiology*, Tata McGraw Hill.
17. Preece and Dickeson. *Ecology of leaf surface microorganism* Academic Press, New York.
18. Rangaswamy, G. and A.Mahadevan (1999) *Diseases of Crop Plant in India*, Prentice Hall of India.
19. Raychoudhari, S.P. and Nariani, T.K. (1977) *Virus and Mycoplasma Diseases of Plant in India*, Oxford and IBH Publication Co.
20. Schlegel, H.G. (1996) *General Microbiology*, 7th Edition, Cambridge University Press.
21. Snowdon, A.L. (1991) *A colour Atlas of Post harvest diseases & disorders of fruits & vegetables Vol.I & II* Wolfe Scientific, London.
22. Sunder Rajan, S. (2001) *Tools and Techniques of Microbiology*, Anmol Publ.New Delhi.
23. Thind, T.S. (1998) *Diseases of field crops and their management*, National Agricultural Technology, Information Centre, Ludhiana.
24. Vaidya, J.G. (1995) *Biology of the fungi*, Satyajeet Prakashan, Pune.
25. Walker, J.G. (1952) *Diseases of Vegetables Crops*. McGraw Hill, New York.
26. Walker, J.C. (1968) *Plant Pathology*, McGraw Hill, New York.
27. Eggins, H.O.W. and Allsop (1975) *The Filamentous Fungi Vol. I Industrial Mycology (Biodeterioration and Biodegradation by Fungi)* Eds. J.E. Smith and D.R. Berry Edward Arnold, London.

28. Emmons, C. W., C. H. Binford, J.P. Utz and Knowlton Chung (1977) Medical Mycology, Lea and Febiger, Philadelphia.

29. Holliday, P. Fungus disease of tropical plants (1980), Cambridge University Press, Cambridge.

On line Journals available on UGC -VSAT

**M. Sc. Botany Syllabus**  
**Semester IV**  
**Course code/name: Paper- XV (Palaeobotany - special I)**

**MODULE – I:**

Introduction to the science of Petrology- The earth zones, chemical composition of earth crust. The classification of rocks i.e. Endogenetic and Exogenetic (igneous, metamorphic and sedimentary) and their brief account. Glaciations, volcanic eruption and earthquake.

**MODULE –II**

Geological column and time scale. Physiography of India. Fossilisation, modes of preservation, preparation and age determination and techniques. Systematics, reconstruction and nomenclature. Life in Precambrian, greening of earth –speculation.

**MODULE –III:**

Study of Rhyniopsida (primitive vascular plants) Cooksonia, Steganotheca, Uskiella, Renalia, Horniophyton, Aglophyton, Zosterophylopsida (ancestors of microphyllous plants) Zosterophyllum, Sawadonia, Asteroxylon. Prelycopods and Lycopsidea-Hebaceous Lycopods of Devonian –Baragwanthia, Protolpidodendron, and Miadessmia, Arborescent Lycopods of Carboniferous-study of Lepidodendrales members.

**MODULE –IV:**

Sphenopsida-Its origin and evolutionary consideration .Study of Hyeniales and Sphenophyllales .Horsetails and their relatives-Calamitales members. Filicopsida-Study of primitive ferns and their relatives-Cladoxylales, Stauropteridales, Zygopteridales. Filicales-classification and study of its members, Coenopteridales-Ankyropteris. Marratiales - - Psaronius.

**Suggested Laboratory and Field Exercises for Paper I**

- Stratigraphy Maps of the India and World
- Geological Maps of India
- Geological column and time scale.
- Study of different rocks.
- Different techniques to study fossils. (Ground sectioning, peel technique) Study different types of fossils
- Study of plant fossils as per syllabus based on specimens and slides.
- Study of Rhyniopsida (primitive vascular plants)
- Arborescent Lycopods of Carboniferous-study of Lepidodendrales members
- Sphenophyllales, Calamitales members.
- Study of primitive ferns and their relatives Cladoxylales, Stauropteridales, Zygopteridales. Filicales-Coenopteridales-Ankyropteris. Marratiales - -Psaronius
- Preparation of practical record.

## M. Sc. Botany Syllabus

### Semester IV

#### Course code/name: Paper- XV (PALYNOLOGY - special I)

##### MODULE -I: -

**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, Functions of callose wall, 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: -

**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 and evolution of breeding systems, 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: -

**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 the pollen grain, saccate pollen grain, sporoderm stratification, Apertures-NPC System of classification, Apertural types, Exine ornamentation, LO analysis

Pollen wall morphogenesis, evolutionary trends in exine structure, trends of evolution in apertural pattern,

Techniques for the preparation of pollen slides, Light and scanning electron microscopic studies of pollen, significance of SEM and TEM studies.

##### MODULE -IV:

**Melittopalynology**- pollen analysis of honey-methods, qualitative and quantitative, social behaviour of honey bees, floral fidelity, foraging behavior, geographical and floral origin of honey, its' chemical analysis, adulteration of honeys, physical characteristics of honey, honey



quality standard, deterioration of honey, heavy metal contamination in honey, honey as environmental monitors, honey and allergy, unifloral and multifloral honey, pollen toxicity, Applied Palynology with special reference to Agriculture and Horticulture - Bees as pollinators, role of apiaries in crop production. Bee keeping and enhanced honey production, recognition of areas suitable for honey production, 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.

## M. Sc. Botany Syllabus

### Semester IV

Course code/name: Paper- XVI (Molecular Biology and Plant Biotechnology- Special II)

#### Module I:

- a. **Transgenics** : Cloning vectors for higher plants; Methods for gene transfer, *Agrobacterium tumefaciens* mediated-Basis of tumor formation, features of Ti and Ri plasmids, mechanisms of DNA transfer, role of virulence genes, use of Ti and Ri genetic markers, use of reporter genes and introns; Direct DNA transfer; particle bombardment; electroporation; microinjection; macroinjection; liposomes; electrophoretic; pollen tube method; pollen transformation; PEG method; transformation of monocots; transgene stability and gene silencing; chloroplast transformation.

#### Module II:

- a. **Applications of transformation:** Herbicide resistance; insect resistance; Bt genes, disease resistance; Nutritional quality; biopesticides and biofertilizers; hazards and safety regulations for transgenic plants.
- b. **Metabolic engineering through transgenic plants:** Production of secondary metabolites; industrial enzymes; biodegradable plastics (PHB and any other); edible vaccines; antibody production and other important drugs.

#### Module III:

**Plant tissue culture:** History, Culture types: Callus culture, organ culture, suspension culture for production of secondary metabolites, protoplast culture, fusion and somatic hybrids, Somatic embryogenesis, anther and pollen culture, haploid plants, somaclonal variations, organogenesis (direct and indirect).

**Gene expression:** Gene expression in Mitochondria, chloroplast, yeast

**Regulation of gene expression:** Regulation of gene expression in translation and post-translation level

#### Module III:

- a. **Nitrogen fixing genes:** Organization, function and regulation of nitrogen fixing genes in *Klebsiella*, *hup* genes.
- b. **DNA fingerprinting and marker assisted breeding:** RFLP maps; linkage analysis; RAPD markers; STS; SSR (microsatellites); ISSR; SCAR (sequence characterized amplified regions); SSCP (single strand conformational polymorphism); AFLP; QTL: map based cloning; molecular marker assisted selection
- a. **Cleaner Biotechnology:** Pollution control through genetically modified organisms.

### **Suggested Readings:**

- Alberts, Bruce; Johnson, Alexander; Lewis, Julian; Raff, Martin; Roberts, Keith; Walter,
- Bhojwani SS and Rajdhan MK 1996 Plant tissue culture: Theory and Practice. Elsevier Sci. Publ., New York
- Peter c2002 Molecular Biology of the Cell, New York and London: Garland Science.
- Callow, J. A., Ford-Lloyed, B. V. and Newbury, H. J. 1997. Biotechnology and Plant Genetic Resources: Conservation and Use, CAB International, Oxon UK.
- Charlwood, B. Y. and Rhodes, M.V. 1999 Secondary products from plant tissue culture, Clarendon Press. Oxford.
- Chrispeels, M. J. and Sadava, D. E. 1994, Plants, Genes and Agriculture. Jones & Barlett Publishers, Boston, USA.
- Collins HA and Edwards S 1998 Plant cell culture. BIOS Sci. Publ., Oxford UK
- Dicosmo F and Misawa, M. 1996 Plant Cell culture: Secondary metabolism towards industrial application, CRC press, Boca Raton, NewYork.
- 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 SM, Sopory SK and Veilleux RE 1996 In vitro haploid production in higher plants. Vols. 1-5. Kluwer Acad. Publ., The Netherlands
- Kurz, W.G.W 1989 Primary and Secondary metabolism of plant and Cell cultures, Springer Verlag, Berlin.
- 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.
- Shantharam, S. and Montgomery, J. F. 1999. Biotechnology, Biosafety, and Biodiversity. Oxford & IBH Publication Co., Pvt., Ltd., New Delhi.

### **Practicals:**

1. Agrobacterium *tumefaciens* mediating gene transfer in a suitable plant
2. Elisa testing of Bt gene in cotton
3. Induction of secondary metabolite synthesis in suspension culture.
4. Isolation of secondary metabolites by gel filtration.
5. Purification of plant metabolite/ protein by column chromatography.
6. Use of RAPD/RFLP/SSCP etc. markers to detect molecular polymorphism of different species.

7. Isolation and protein profiling in different plant species by SDS-PAGE.
8. Raising of suspension culture and plotting of growth curve.
9. Bacterial transformation and selection of transformed cells.
10. DNA ligation and analysis of ligated DNA on agarose gel (cloning and analysis using GUS gene).
11. Study of expression of inducible genes at biochemical level.
12. Organogenesis and somatic embryogenesis using appropriate explants and preparation of artificial seeds.
13. Demonstration of anther culture.

**Suggested Readings(for laboratory exercises)**

- Gelvin, S. B. and Schilperoort, R. A (eds) 1994. Plant Molecular Biology Manual, 2<sup>nd</sup> edition. Kluwer Academic Publishers, Dordrecht, The Netherlands.
- Glick, B. R. and Thompson, J. E. 1993, Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida.
- Glover, D. M. and Hames, B. D.(Eds) 1995. DNA Cloning 1: A Practical Approach: Core Techniques, 2<sup>nd</sup> 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.
- Hall, R. D. (Ed.), 1999. Plant Cell Culture Protocols. Humana Press. Inc. New Jersey, USA.
- Maniatis et al. Molecular cloning Vol. I, II and III. Cold-Spring Harbor Lab Press.
- Sambrook and Russel. 2001. Molecular cloning Vol. 1-3 CSH press.
- Shaw, C. H. (Ed.) 1988, Plant Molecular Biology : A Practical Approach. IRL Press, Oxford.
- Smith, R. H. 2000. Plant Tissue Culture : Tecniques and Experiments. Academic Press, New York.

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

**M. Sc. Botany Syllabus**  
**Semester IV**

**Course code/name: Paper Xvi- Reproductive Biology of Angiosperms (Special) II**

**Module I:**

**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, fusion of nuclei, double fertilization, triple fusion, 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, ruminant endosperm, cytological status. endosperm haustoria, chemical composition of endosperm, food reserve in endosperm, role of endosperm in embryo development, endosperm mutants.

**Module II:**

**Embryogenesis:** Zygote and its ultra-structure, milieu of the developing embryo, symmetry and polarity, rest period in zygote embryonic formulae, embryonic 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:** Definition, causes, classification, induction of polyembryony, practical importance of polyembryony.

**Module III:**

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

**Parthenocarpy:** Definition, causes, practical importance

**Mellitopalynology :** Pollen analysis of honey, Role of apiculture 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
- 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.

**Module IV:**

- f) **Protoplast culture and somatic hybridization-** isolation of protoplast, culture methods, fusion of protoplast, selection of fusion products, consequences of fusion, production of Cybrids and hybrids.
- g) Biotransformation and production of useful compounds through cell culture, factors affecting yield, biotransformation, bioreactors, perspective.

## 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, fluorescence and electron microscopy, wholemounts, dissection 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 electrophoretic and histochemical methods embryo culture.
- 14) Somatic embryogenesis
- 15) Protoplast culture.

## 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. Chitralkha 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. Chitralkha 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.

**M. Sc. Botany Syllabus**  
**Semester IV**

**Course code/name: Paper XVI- ADVANCED PHYCOLOGY PAPER- II (Special)**

**MODULE 1:**

Algae Physiology, and Cultivation;-

- 1 Cyanide resistance, respiration in algae, heavy metal pollution and their role in Biotechnology.
- 2 Intracellular substance of *Spirulina*, *Scenedesmus*, *Chlorella* and marine algae.
- 3 Algae cultures & continuous and mass cultivation in laboratory and their field applications.

**MODULE 2: Hydrobiology / Limnology**

1. Lentic environment: General consideration, physico-chemical factors, and their influence, Phytoplankton nature and adaptation of plankters, periodicity and succession, vertical distribution, productivity and factors influencing it.
2. Lotic environment: General consideration, physico-chemical factors, and their influence.
3. Marine benthic: General Principal, shore types, zonation patterns and factors governing them, Life forms, Geographical distribution, Marine Algae in India.

Eutrophication and algal blooms: Definition factor: responsible for water quality, use of algal blooms and their control measures.

**MODULE 3 : Study of phytoplanktons**

Terminology, population, adaptations

Distribution, productivity and succession

Primary productivity and measurement of growth rate and natural mortality.

Chemical features and chemical cycles in epilimnion and hypolimnion.

**MODULE 4 : Ecology and environmental Biotechnology:**

1. Distribution, community structure in fresh and marine water. Role of algae as indicators of pollution and its concept.
2. Algae in waste water treatment, use of algal bacterial system in sewage and other waste effluents, Biomonitoring of water quality. Algae stabilization pond.
3. Ecobiotechnology for the remediation of eutrophic lentic and lotic waterbodies.



**M. Sc. Botany Syllabus**  
**Semester IV**

**Course code/name: Paper- XVI (Mycology and Plant Pathology - special II)**

**Module 1:**

**History :** Milestones in phytopathology with particular reference to India. Major epidemics and their social impacts. Historical developments of chemicals, legislative, cultural and biological protection measures including classification of plant diseases.

**Physiological and Molecular Plant Pathology**

Altered metabolism of plants under biotic and abiotic stresses. Molecular mechanisms of pathogenesis: recognition phenomenon, penetration, invasion, primary disease determinant.

**Module II: Principles of Plant pathology**

- i. Principles of plant pathology- Importance, nature, classification and general symptoms of plant diseases.
- ii. Koch's Postulates: Pathogenicity of microorganisms and pathogenesis.
- iii. Host parasite relationship and Interaction, mechanism of infection, path of infection. .
- iv. Defence mechanism in host plants against pathogens - morphological or structural defence mechanism, Biochemical defence mechanisms, defence, role of phenolic compounds, enzymes and toxins,
- v. Epidemiology and forecasting of plant diseases- the form of epidemic conditions for decline of epidemic, methods used in forecasting. .
- vi. Principles and methods of plant disease control - cultural methods, chemical methods, Biological control , integrated pest management (IPM), Biopesticides.

**Module III :**

**A Detailed study of the Diseases of the following crops caused by fungal pathogens with effective control measures.**

**Diseases of Cereals :**

Seedling blight of cereals, Smut of wheat, Foot rot of wheat, Loose smut, Covered smut of Barley, False smut of rice, Leaf spot of rice, Downey mildew of jowar, Green ear disease of Bajra, Ergot of Bajra, Downey mildew of maize.

**Diseases of Vegetable crops with special reference to the important diseases of the following:**

Chilli, Brinjal, Tomato, Potato, Coriander, Ginger, Onion, Bhindi.

General knowledge of post harvest diseases of fruits and vegetables and their control.

Diseases of Oil Seed Crops: Viz. - Linum, Sesamum, Groundnut, Mustard and Sunflower

**Diseases of Fruit Trees-**

With special reference to important diseases of the following Citrus, Apple, Mango, Papaya., Banana and Grapes.

**Module- IV :Bacterial Diseases of Plants:**

Important Pathological aspects of the following bacterial diseases.

Bacterial blight of rice, Tundu disease of wheat, Angular leaf spot of cotton, stalk rot of maize, Fire blight of Apple, Bacterial soft rot of fruits and Vegetables. .

**Viral Diseases of Plant :**

Bunchy top of Banana, Leaf curl of Papaya, Yellow vein mosaic of Bhindi. Mosaic of .Cucurbits, Viral diseases of Tobacco, Potato and Tomato.

**Mycoplasma Diseases of Plants :**

Citrus greening, Rice yellow dwarf: Little leaf of Brinjal, Sandal Spike.

**Nematode Diseases of Plants :**

General knowledge of plant parasitic nematodes and Important nematode diseases viz.Root knot of Vegetables, Ear cockle of wheat. .

**Suggested Readings .**

1. Agrios, G.N. (1980) Plant Pathology, academic Press, INC, New York.
2. Ainsworth, G.C. and A.S.Sussman (eds). The Fungi, An advance Treatise Vol.I, II, III & IV Academic Press, New York.
3. Alexopoulos, C.J. (1962). Introductory Mycology John Wiley Eastern Pvt.Ltd.
4. Alexopoulos, C.J. and Mims C.W. (1979). Introductory Mycology 3rd Edition, John Wiley and Sons, Inc. Wiley, New York.
5. Alexopoulos, C.J., Mims and Black well (1996) 4th ed. John Wiley and Sons, Inc. Wiley, New York
6. Aneja, K.R. (1993) Experimental in Microbiology, Plant Pathology & Tissue Culture, Wiswa Prakashan, New Delhi.
7. Bessey, E.A. (1950) Morphology and Taxonomy of Fungi. The Blakiston co. Philadelphia.
8. Bilgrami, K.S. and H.C.Dube (1985) A text Book of Modern Plant Pathology, Vikas Publication House, New Delhi.
9. Barnett, J.H. (1968) Fundamentals of Mycology. The English Language Book Society and Edward Arnold Publication, Limited.
10. Dube, R.C. and D.K.Maheshwari (1999) A.Text Book of microbiology, S.Chand & Co. Ltd.
11. Dube, R.C. and D.K.Maheshwari (2000) Practical Microbiology - S.Chand & Co. Ltd.
12. Gupta, V.K. and M.K.Behl (1994) Indian Plant Viruses and Mycoplasma Kalyani Publishers, 1/1, Rejinder Nagar, Ludhiana.
13. Jha, D.K. (1993) A Text Book of Seed Pathology, Vikas Publication House.
14. Mehrotra, R.S. (1989) Plant Pathology, Tata McGraw Hill.
15. Mehrotra, R.S. and K.R.Aneja (1998) An Introduction to Mycology, New Age Intermediate Press.
16. Pelzer, M.J. , Jr.Cahn, E.C.S. and N.R.Krieg (1993) Microbiology, Tata McGraw Hill.
17. Preece and Dickeson. Ecology of leaf surface microorganism Academic Press, New York.
18. Rangaswamy, G. and A.Mahadevan (1999) Diseases of Crop Plant in India, Prentice Hall of India.
19. Raychoudhari, S.P. and Nariani, T.K. (1977) Virus and Mycoplasma Diseases of Plant in India, Oxford and IBH Publication Co.

20. Schlegel, H.G. (1996) General Microbiology, 7th Edition, Cambridge University Press.
21. Snowdon, A.L. (1991) A colour Atlas of Post harvest diseases & disorders of fruits & vegetables Vol.I & II Wolfe Scientific, London.
22. Sunder Rajan, S. (2001) Tools and Techniques of Microbiology, Anmol Publ.New Delhi.
23. Thind, T.S. (1998) Diseases of field crops and their management, National Agricultural Technology, Information Centre, Ludhiana.
24. Vaidya, J.G. (1995) Biology of the fungi, Satyajeet Prakashan, Pune.
25. Walker, J.G. (1952) Diseases of Vegetables Crops. McGraw Hill, New York.
26. Walker, J.C. (1968) Plant Pathology, McGraw Hill, New York.
27. Eggins, H.O.W. and Allsop (1975) The Filamentous Fungi Vol. I Industrial Mycology (Biodeterioration and Biodegradation by Fungi) Eds. J.E. Smith and D.R. Berry Edward Arnold, London.
28. Emmons, C. W., C. H. Bin ford, J.P. Utz and Know Chung (1977) Medical Mycology, Lea and Febigo, Philadelphia.
29. Holliday, P. Fungus disease of tropical plants (1980), Cambridge University Press, Cambridge.
30. On line Journals available on UGC -VSAT

### **Laboratory Exercises:**

1. Principles & working of tools, equipments and other requirements in the Mycology & Plant Pathology laboratory.
2. Micrometry and measurement of organisms.
3. Sterilization Processes viz. moist heat, dry heat, chemical and radiation.
4. Drawing of Camera Lucida diagrams and knowledge of computer based photomicrography and image processing
5. Preparation of different cultural media for cultivation of Fungi and Bacteria.
6. Monitoring and analysis of Aeromycoflora.
7. Isolation & identification of Phyllosphere mycoflora.
8. Demonstrate antifungal activities of different antibiotics and leaf, flower and root extract.
9. Study of toxicity of fungi in relation to seed germination, and seedling abnormality.
10. Cultivation of Mushrooms.
11. Demonstration on biodegradation of organic waste.
12. Isolation of Soil fungi by soil plate (War cup) and serial dilution (Walksman) method.
13. Isolation and identification of Rizosphere mycoflora.
14. Isolation of external and internal seed borne mycoflora by blotter and Agar Plate method. Cereals, pulses, oil seeds, fruit seeds.
15. Demonstration of Koch's Postulate.
16. Monographic study of locally available plant diseases caused by fungi (atleast 10).
17. Study of locally available crop plant diseases caused by Bacteria (Five)
18. Study of locally available plant diseases caused by viruses & Phytoplasma (Five)
19. Demonstration of morphological & physiological changes in disease plants.

20. Preparation and presentation of herbarium of pathological specimens available in the region (Atleast 20)

21. Field visit to different localities

Visit to Agriculture University, Plant Pathological research centers

## M. Sc. Botany Syllabus

### Semester IV

#### Course code/name: Paper- XVI (Palaeobotany - special II)

##### MODULE –I:

Gymnospermopsida-- Study of Aneurophytales and Archaeopteridales. Gymnosperm and early evolution (Archeosperma, Elkinsia, and Morentia) of seed habit stages in evolution. Study of Pteridosprmales-Lyginopteridaceae, Medullosaceae, Cycadeoidales-Cycadeoidaceae, Williamsoniaceae, Wielandiellaceae. and Fossil Cycads ( Nilssonina, Baenia, Androstrobus).

##### MODULE -II:

Gymnosper- Caytoniales, Glossopteridales, Penntoxylales. fossil Cordaitales, Voltziales and phylogenetic consideration of all the orders.

##### MODULE –III:

Study of Deccan Intertrappean flora of India. Formation of Deccan traps and Intertraps, age and its floristic composition in relation to Pteridophytes, Gymnosperms and Angiosperms. Paleocene and Paleogeography of Deccan Intertraps.

##### MODULE – IV

Paleopalynology-Important features of spores and pollen morphology, their role in stratigraphy and in exploration of coal and oil. Palaeopalynological studies, microfossils and its application. Paleocology and paleogeography.

Indian Gonwana-Its stratigraphy and classification (Two fold and three fold). Index fossil.

##### Suggested Laboratory and Field Exercises for Paper II

- Study different types of fossils
- Study of plant fossils as per syllabus based on specimens and slides.
- Gymnosperm- Caytoniales, Glossopteridales, Penntoxylales. fossil Cordaitales.
- Lyginopteridaceae, Medullosaceae, Cycadeoidales-Cycadeoidaceae, Williamsoniaceae, Wielandiellaceae. and Fossil Cycads (Nilssonina, Baenia, Androstrobus).
- Study of Deccan Intertrappean flora of India. Pteridophytes, Gymnosperms and Angiosperms-flowers and fruits.
- Important features of spores and pollen morphology and technique to study them (Maceration)
- Study of wood anatomy of fossils.
- Exploration and excursion to different fossiliferous localities.
- Preparation of practical record/submission of collection and tour report of excursion.

## SPECIAL PRACTICAL-II

**Time: 5 hours)**

**(Full marks: 70**

Preparation of slide by maceration technique of a given material

10

Write the monograph on given specimens

20

Comment on the spots (five spots)

15

Practical record, Viva-voce and Field report

20

(10+05+05)

Project

05

**M. Sc. Botany Syllabus**  
**Semester IV**  
**Course code/name: Paper- XVI (Palynology - Special II)**

**UNIT-I. Pollen physiology and biochemistry-**

**Pollen production,**

**Pollenviability**, tests for pollen viability,

**Pollengermination** of pollen in *vivo* and in *vitro*, germination requirements, germination of 3-nucleated pollen grain, effect of pH and light, effects of hormones and other substances radiation effect, release of metabolites in germination and tube growth, Role of boron and calcium in pollen germination,

**Chemical composition** of pollen wall and pollen contents (amino acids, proteins, carbohydrates, lipids, vitamins, pectin, DNA, RNA, ascorbic acid, flavones, pigments etc.) in pollen and pollen tube at different steps in germination & their significance, pattern of pollen tube elongation,

Fine structure inside the tube, pollen culture movements of nuclei-and formation of callose plug, promotion and inhibition of pollen tube, elongation, pollen enzymes and isozymes,

**UNIT II- Pollen biotechnology and genetics**

**Pollenstorage**-Factors affecting viability in storage, freeze-drying of pollen, storage of pollen in organic solvents, causes of decreased viability in storage and pollen germination.

**Pollen - pistil interaction** - significance, self incompatibility (regulation of fertilization).Pollen allelopathy, chemotropism, Pollen herbarium,

**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, problems

**UNIT III :-**

Aerobiology-Introduction, Historical background, applications of Aeropalynology  
Aeromycology Aerophycology. Importance in medical field, importance of aero mycological studies in various types of crop infection by spores, disease forecasting , 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, seasonal changes of air-spora

Indoor environments, Sick buildings & hazards, occupational environment and immunology

Outdoor airspora, characteristics, identification,

**UNIT IV :-**

Airborne allergens- Introduction, allergens and their types, Impact of airborne materials on human system, Lung as particulate sampler,

Source, causes, symptoms of Pollen allergy, fungal spore allergy, dust mite allergy, algal allergy other allergies, Prevention and cure, isolation & culturing of spores, mites, algae. antibodies to human immunoglobulin, types, and significance in diagnosis of allergy, diagnosing allergic diseases based on total and specific IgE determinations, radio immunoassay, (RAST, PRIST, ECP-immunoassay technique), ELISA (competitive, Double-antibody sandwich, indirect ELISA), Western blotting, allergen standardization, Testing and treatment, pollinosis, nasobroncheal allergy, Immunotherapy and prevention of allergy, pollen calendar and daily census of airborne pollen, circadian periodicities of pollen, Correlation between aerobiological, clinical and meteorological data.

## **LIST OF PRACTICALS: -**

### **Section A. Basic aspects / Pollen Morphology**

1. To study structure of stamen
2. Study of permanent slides of microsporogenesis
3. Field study on different pollination mechanism
4. To study structure of pistil
5. Preparation of glycerin jelly
6. Preparation of pollen- Acetolysis technique
7. Preparation of pollen – Wodehouse technique.
8. Study of pollen types using acetolysed and non-acetolysed pollen. Pollen 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.)
9. Preparation and palynological description in technical language (at least 10 species of Angiosperms).
10. Interpretation of selected electron micrographs (SEM, TEM) of pollen.
11. Preparation, description and identification of spores of Algae, Fungi, Bryophytes, Pteridophytes and pollen types of Gymnosperms.

### **Section B. Aeropalynology/Melittopalynology/Palaeopalynology**

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

### **Section C Pollen Physiology/ecology/biochemistry/ecology. ( Expt. No.29 is compulsory)**

20. To study pollen production and pollen viability of the given flowers.
21. To study percentage of pollen germination & rate of pollen tube growth.
22. To study different techniques of pollen storage



23. Effect of temperature and relative humidity on viability of stored pollen
24. Effect on Boron and Calcium on pollen germination and tube growth.
25. Semi-vivo technique to study pollen germination and pollen tube growth.
26. Multiple staining for localizing pollen tubes in the pistil
27. To study pollen germination and pollen tube growth in the pistil by employing aniline-blue fluorescence method
28. Cytochemical localization of esterase on stigma surfaces
29. 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)
30. Study of pollen contents by paper chromatography/TLC.
31. Colorimetric estimation of proteins/carbohydrates of pollen grains
32. To separate pollen proteins by SDS-PAGE electrophoresis
33. Enzyme bioassay in pollen grains.

M.Sc. PART –II PRACTICAL EXAMINATION

BOTANY (Practical –III)

R.T.M .NAGPUR UNIVERSITY

M.Sc. PART-II BOTANY

PRACTICAL-III –PALYNOLOGY (Elective)

Time: - hrs]

[Max. Marks-

1. Any ONE experiment from Section A.
2. Any ONE experiment from Section B.
3. Any ONE experiment from Section C.
4. Any ONE experiment from Section C.  
(Other than asked in Question 3)
5. Spots (1-5)
6. Practical Record, Permanent slides & field record and Viva-voce

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**RECOMMENDED READING**

1. Afzelius, B.M. 1956 Electron-microscope investigation into exine stratification *GranaPalynologica* (N.S.) 1:2,
2. Agashe S. N. – Paleobotany (1997) – Plants of the past their evolution paleoenvironment and applications inexploration of Fossil.
3. Agashe S. N. – Palynology and its Applications – Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
4. Alexander M.P. (1969). Differential staining of aborted and non-aborted pollen *Stain Technol* 44:117-122.
5. Alexander, M.P. (1987). A method for staining pollen tubes in pistil. *Stain Technol* 62, 107-112.
6. 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,
7. Baker, H.G. 1954. Aperture membranes in Studies of Pollen Morphology and Taxonomy. *Newphytologist*, 54(3),
8. Banerjee, U.C. 1965, *et al.* Exine plasticity during pollen grain maturation. *J.palynol.*: 70-89,
9. Banerjee, U.C.1967.U!trastructure of the tapetal membranes in grasses. *Grana palynologia*: 7,2-3,
10. Bhattacharya K., Majumdar M. and Gupta Bhattacharya S. (2006). A text book of Palynology.New Central Book Agency(P) Ltd.,Kolkata
11. Bhojwani, S .S. and S.P. Bhatnagar. 1978. The Embryology of Angiosperms. Vikas Publishing House, New Delhi,
12. Bir Bahadur 1998. Nectary biology. Datt sons publications, Nagpur Bombay,
13. Brooks. J. and G. Sha'w. 1978. Sporopollenin: A review of its chemistry, palaeochemistry and Geochemistry. *Grana*.17(2) : 91-98.

14. Caulton Eric, Agashe S. N. - Pollen and Spores applications with special emphasis on Aerobiology and Allergy-
15. Chowdhary, J.B. and T.M. Varghese. 1968. Pollen sterility in crop plants- A review *Palyn. Bull.* IV (2).
16. Colombo P.M., Lueehin F., Colombo B. (1977). On the control of the population effect on in vitro assays of pollen germination. *J Exp. Bot.* 28:425-438.
17. Cresti, M., Gori P., Pacini E. (eds.) (1988) Sexual reproduction in higher plants. Springer, Berlin Heidelberg New York Tokyo.
18. Cronquist, A. 1968. The evolution and classification of flowering plants, Nelson, London
19. Dafni Amots, Hesser Michel, Paeini Ettore – Pollen and Pollination- Springer Wien New York
20. Davis. P.H. and V.H. Heywood. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd, London,
21. Dumas C, Knox R.B. (1983). Callose and determination of pistil viability and incompatibility. *Theor Appl. Genet* 67: 1 -10.
22. Echlin, P. Pollen. 1968. *Scientific American* 218(4),
23. El-Gazzar and M.K. Hamza. 1973. Morphology of the twin Pollinia of Asclepiadaceae. *Pollen et spores* XV (3-4)
24. Erdtman, G, (1956) "Lo-analysis" and "Welcker's rule". *Sven Bot. Tidskr.* 50:1-7.
25. Erdtman, G. 1945. Pollen Morphology and Plant Taxonomy IV Labiatae, Verbenaceae, Avicenniaceae. *Svensk Botanisk Tidskrift.* 39(3),
26. Erdtman, G. (1966). Pollen morphology and plant taxonomy angiosperms hafner. New York.
27. Erdtman, G. (1969). Handbook of Palynology. Hafner, New York
28. Erdtman, G. 1943. An Introduction to Pollen Analysis. Chronica Botanica Co., Waltham, Mass. pp. 239,
29. Erdtman, G. 1952. Pollen Morphology and Plant Taxonomy (An Introduction to Palynology-1, Angiosperms). Aimqvist, and Wicksell, Stockholm,
30. Erdtman, G. 1956. Current Trends in Palynological Research Work *Grana Palynologica* (N.S.) 1:2,
31. Erdtman, G. 1960. The Acetolysis method revised description *Su. Bot. Tidskr.* 54(4).
32. Erdtman, G. 1964. Palynology. In: W.B. Turrill (Editor) *Vistas in Botany*. Macmillan Go., New York, Vol. 4:23-54,
33. Erdtman. G.1945.Pollen Morphology and Plant Taxonomy V on the occurrence of tetrads and dyads. *Su. Bot. Tidsker.* 39(3),
34. Faegri, K. 1956. Recent trends in Palynology. *Totan. Rev.* 22:639-644
35. Faegri, K. 1975..(3rd Revised Ed.) Text Book of Pollen Analysis. Blackwell Scientific Publ. Oxford,
36. Faegri, K. and J.Iversen. 1964. (2nd ed.) Text Book of Pollen Analysis. Blackwell Scientific Publ. Oxford.
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