



**DEPARTMENT OF BOTANY  
SHIVAJI UNIVERSITY, KOLHAPUR**

**M. SC. BOTANY REVISED SYLLABUS  
(AS PER NATIONAL EDUCATION POLICY 2020)**

**FROM JULY 2022**

**SHIVAJI UNIVERSITY, KOLHAPUR  
DEPARTMENT OF BOTANY**

**Revised Syllabus for the Master of Science in Botany  
(National Education Policy 2020)**

**Applicable from academic year 2022 – 2023 (July 2022)**

- ❖ For M.Sc. Part I (Semester I & II) as per Resolution No. .... dated ..... of Board of Studies in Botany and Resolution No. ....dated ..... of Academic Council of Shivaji University, Kolhapur.
  - ❖ For M. Sc. Part II (Semester III & IV) as per Resolution No..... dated ..... of Board of Studies in Botany and Resolution No. ....dated .... of Academic Council of Shivaji University, Kolhapur.
1. **Title:** M. Sc. Botany, Shivaji University, Kolhapur Revised Syllabus as per NEP 2020.
  2. **Faculty:** Faculty of Science and Technology.
  3. **Year of Implementation:** For M. Sc. I (Semester I and Semester II): From July 2022 and for M. Sc. II (Semester III and Semester IV): From July 2023.
  4. **Preamble:** Education is fundamental for achieving full human potential, developing an equitable and just society and promoting national development. Providing universal access to quality education is the key to India’s continued ascent and leadership on the global stage in terms of economic growth, social justice and equality, scientific advancement, national integration and cultural preservation. Universal high-quality education is the best way forward for developing and maximizing our country’s rich talents and resources for the good of the individual, the society, the country and the world. India will have the highest population of young people in the world over the next decade and our ability to provide high-quality educational opportunities to them will determine the future of our country.  
Higher education plays an extremely important role in promoting human as well as societal well-being and in developing India as envisioned in its Constitution—a democratic, just socially-conscious, cultured and human nation upholding liberty, equality, fraternity and justice for all. Higher education significantly contributes towards sustainable livelihood and economic development of the nation. As India moves towards becoming a knowledge economy and society, more and more young Indians are likely to aspire for higher education.  
India has tremendous biodiversity, genetic as well as of species and ecosystems which is a biological capital of our country. It contains over 7 per cent of the world’s biodiversity on 2.5 per cent of the Earth’s surface. This diversity can be attributed to the vast variety of landforms and climates resulting in habitats ranging from tropical to temperate, and from alpine to desert.

The number of plant species in India is estimated to be over 45,523 representing about 11.8 per cent of the world's flora. It is estimated that 32% of Indian plants are endemic to the country and found nowhere else in the world. Among the plant species the flowering plants have a much higher degree of endemism, a third of these are not found elsewhere in the world. There are 17,527 species, 296 subspecies, 2215 varieties, 33 subvarieties and 70 forma, altogether 20,141 taxa of angiosperms under 2991 genera and 251 families in India, representing approximately 7% of the described species in the world. About 5725 species of flowering plants are broadly considered as endemics and represent 33.5% of the flora, of which, 3471 species are found in the Himalayas, 2051 in the Peninsular India and 239 in Andaman & Nicobar Islands. Gymnosperms are woody perennials, either shrubs or trees. There are 58 taxa growing in wild under 15 genera and 8 families in India. Though they are lesser in number, provide timber, wood, resins, tars and turpentine. Estimated number of pteridophytes (fern and fern-allies) are about 1200 taxa under 204 genera are distributed in different biogeographic regions of India. The Eastern Himalaya and the Northeast India with about 845 taxa in 179 genera, representing approximately 67% of the pteridophytes known from the country, followed by southern India, including Eastern and Western Ghats, with 345 taxa in 117 genera and Northern India, including Western Himalaya, with 340 taxa in 101 genera. Bryophytes less known group of plants, comprising about 2800 species, is the second largest group of green plants in India, next only to the angiosperms. About 16 genera and 678 species are endemic to India. Liverworts are represented by ca. 850 species under 140 genera and 52 families. Lichens are a symbiotic association of fungi and algae and constitute a dominant component of epiphytic and saxicolous vegetation. At present about 2021 species of lichens in 248 genera are known to occur in India. Fungi range from microscopic organisms to huge solid bodies. Approximately 14,500 species in 2300 genera are found in India of which ca. 3500 species are endemic. Algae represented by over 6500 species in ca. 666 genera, they are found growing in a variety of habitats ranging from fresh water, marine, terrestrial and to soil. Of which 1924 species are endemic to the country. The major portion of Indian algal flora accounting for ca. 390 genera and 4500 species followed by terrestrial algae (125 genera and 615 spp.); soil algae (80 genera and 1500 spp.); marine algae (169 genera and 680 spp.).

## 5. General objectives of the course:

### a. Programme outcomes:

- i) **Rational thinking:** To check assumptions for their accuracy and validity.
- ii) **Biodiversity awareness:** To understand the local and global issues of environment and its sustainable development.
- iii) **Continuous learning:** To develop ability to engage independently on the context of human society and technological changes.
- iv) Solving problems related to food scarcity.

**b. Course outcomes:**

- i) Working knowledge of the basic concepts of Botany i. e. cellular, ecological, molecular, physiological, ecological organizations and evolutionary biology of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.
  - ii) Students will learn several biophysical techniques such as electrophoresis, microscopy, biostatistics, bioinformatics, centrifugation, chromatography, spectroscopy, radioisotope and culture techniques.
  - iii) Identification and understanding of basic concepts, plant diseases and several processes related to physiology, ecology, cell and molecular biology and biochemistry of plants under stress conditions.
  - iv) Identification and classification of algae, fungi, bryophytes, pteridophytes, gymnosperms, angiosperms; evolution of reproductive structures, phylogeny and interrelationship of the selected genera.
  - v) Understanding of basic concepts of population and how individuals of a population interact with the ecosystem.
  - vi) Knowledge of plant pathology, identification of disease, their causal organisms, symptomology and defence mechanism of the plants against selected diseases.
  - vii) Study of organs, their development, experimental embryology, apomixes and its types, polyembryony, experimental induction of polyembryony, palynology and its role in horticulture, agriculture and oil exploration programs.
  - viii) Understanding the processes of natural selection, migration, mutation, genetic drift and variation and application of this knowledge in crop improvement.
  - ix) Acquisition of skills required for the production of disease-free plants, development of hybrids, development of plants with novel traits. Intellectual property rights, their importance, ecological risks and ethical concerns.
  - x) Commercial storage products, knowledge and value-added structural components and information about active components.
6. The entire course of M. Sc. (Botany) will be of **four Semesters** spread over two years.
  7. Pattern of Examination: The examinations will be conducted **semester wise for both theory as well as practical courses.**
  8. **Fee structure:** As per Shivaji University guidelines.
  9. **Eligibility criteria for Admission:** B. Sc. in Botany.
    - a. A student shall be held eligible for admission to the M. Sc. Course in Botany who has passed the B. Sc. examination with Botany as a principal subject from Shivaji University, Kolhapur and also has passed the entrance examination conducted by the University.
    - b. A student from other university shall be eligible who qualifies entrance examination of Shivaji University and scores minimum 55% (B<sup>+</sup>) marks in the subject at the B. Sc. with Botany as a principal subject or with Botany at B. Sc. III level.
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- c. While preparing merit list the performance at B. Sc. III level and entrance examination will be given equal weightage (50:50).
- d. While preparing merit list for other university students, only the marks of entrance examination will be considered.

**10. Medium of Instruction:** English

**11. Structure of course:**

- a. There shall be **four theory courses** and **four practical courses** in every semester. Each theory course shall have four units and each practical course shall have two units.
- b. Department of Botany, Shivaji University, Kolhapur offers **two Open Elective Courses (OEC)** each of 100 marks for the students from other PG departments/ other than Botany of the Shivaji University which will be conducted as OEC–I in odd semester and OEC–II in even semester. For OEC maximum 50 students will be admitted at a time.
  - i) OEC–I: Plants – A Biological Capital – 60 Lectures (4 Credits).
  - ii) OEC–II: Plant Science, Human Progress and Prosperity – 60 Lectures (4 Credits).
- c. The Department offers following specializations at M. Sc. II (Semester III and IV):
  - i) Plant Physiology
  - ii) Mycology and Plant Pathology
  - iii) Cytogenetics and Plant Breeding
  - iv) Energy, Ecology and Environment
  - v) Angiosperm Taxonomy
  - vi) Plant Biotechnology
  - vii) Marine Botany (Temporarily suspended)
  - viii) Palaeobotany (Temporarily suspended)

**12. Scheme of teaching and Examination:**

- a. Each unit in theory course shall comprise 15 lectures, each of 60 minutes' duration and there shall be four lectures per theory course per week.
- b. Each practical course shall be of three hours' duration.
- c. Library/ Reference-work/ Excursion/ Field work/ Seminar/ Group Discussion/ Project work will be organized every week.
- d. Entire course of M. Sc. Botany will be of **2400** marks. Every Semester will be of 600 marks [400 marks for theory (four courses) and 200 marks for practical (two courses)].
- e. Examination of each **theory course** shall be of **100 marks** (80 university examination + 20 internal assessment). University examination of 80 marks (3 hours' duration) will be conducted at the end of each Semester. Internal assessment of 20 marks will be done before the semester examination during each semester.
- f. Examination of each practical course shall be of 50 marks (40 university examination + 10 internal assessment). University examination of 40 marks (3 hours' duration) will be conducted at the end of each semester. Internal assessment of 10 will be done before

the semester examination during each semester. However, at the end of 4<sup>th</sup> semester practical examination will be conducted for 150 marks and the project work will be evaluated for remaining 50 marks.

**g.** The question paper of theory course (80 marks) will consist of seven questions, carrying 16 marks each, of which the student shall have to attempt **five** questions. The last question will be **compulsory** consisting of short notes. The types of questions and their distribution will be as follows:

- i)** Descriptive or long answer type questions (60 %)
- ii)** Short answer type questions (40 %)

**13.** Standard of Passing: There will be separate passing for theory courses and practical courses. Minimum 40% marks will be required for passing separately for theory and practical courses.

**14.** Nature of Question paper and scheme of marking:

Q.1.	Based on Unit I	–	16 Marks
Q.2.	Based on Unit II	–	16 Marks
Q.3.	Based on Unit III	–	16 Marks
Q.4.	Based on Unit IV	–	16 Marks
Q.5a.	Based on Unit I	–	8 Marks
Q.5b.	Based on Unit II	–	8 Marks
Q.6a.	Based on Unit III	–	8 Marks
Q.6b.	Based on Unit IV	–	8 Marks
Q.7a-f.	Based on all units	–	16 Marks

**15.** Equivalence according with Titles and contents of papers:

Old Paper	New Paper
<b>Paper-I</b> (CC-101): Biology and Diversity of Algae, Fungi and Bryophytes	<b>Paper-I</b> (CC-101): Biology and Diversity of Algae, Fungi and Bryophytes
<b>Paper-II</b> (CC-102): Biology and Diversity of Pteridophytes, and Gymnosperms (Extant & Extinct).	<b>Paper-II</b> (CC-102): Biology and Diversity of Pteridophytes, and Gymnosperms Extant & Extinct
<b>Paper-III</b> (CC-103): Plant Ecology and Evolution	-----
<b>Paper-IV</b> (CC-104): Tools and techniques	<b>Paper-III</b> (CC-103): Tools and techniques
<b>Paper-V</b> (CC-201): Angiosperm Systematics	<b>Paper-V</b> (CC-201): Angiosperm Systematics
<b>Paper-VI</b> (CC-202): Plant Pathology	<b>Paper-VI</b> (CC-202): Plant Pathology
<b>Paper-VII</b> (CC-203): Plant Structure, Development and Reproduction	<b>Paper-VIII</b> (CC-204/CCO-204): Plant Structure, Development and Reproduction
<b>Paper-VIII</b> (CC-204): Cell and Molecular Biology	<b>Paper-VII</b> (CC-203): Cell and Molecular Biology

**16.** Special instruction if any: Passing in Non CGPA courses is mandatory.

17. A. Detailed titles of papers:

**M. Sc. I, Semester I:**

	Course No.	Course Code	Course Name	Credits			
CGPA	<b>M. Sc. I, Semester I: Core Course Botany (CC- 101 to 104) Theory</b>						
	Paper I	CC-101	Biology and Diversity of Algae, Fungi and Bryophytes	4	16	24	
	Paper II	CC-102	Biology and Diversity of Pteridophytes, and Gymnosperms: Extant & Extinct	4			
	Paper III	CC-103	Tools and techniques	4			
	Paper IV	CC-104/ CCO-104	Biodiversity: Conservation and Utilization	4			
	<b>M. Sc. I, Semester I: Core Course Botany (CCPR- 105) Practical</b>						
	Practical I	CCPR-105.1	Biology and Diversity of Algae, Fungi and Bryophytes	2	8		
	Practical II	CCPR-105.2	Biology and Diversity of Pteridophytes and Gymnosperms (Extant & Extinct)	2			
	Practical III	CCPR-105.3	Tools and techniques	2			
	Practical IV	CCPR-105.4	Biodiversity: Conservation and Utilization	2			
Non CGPA		AEC-106	Ability Enhancement Course	2			

**M. Sc. I, Semester II:**

	Course No.	Course Code	Course Name	Credits			
CGPA	<b>M. Sc. I, Semester II: Core Course Botany (CC- 201 to 204) Theory</b>						
	Paper-V	CC-201	Angiosperm Systematics	4	16	24	
	Paper-VI	CC-202	Plant Pathology	4			
	Paper-VII	CC-203	Cell and Molecular Biology	4			
	Paper-VIII	CC-204/ CCO-204	Plant Structure, Development and Reproduction	4			
	<b>M. Sc. I, Semester II: Core Course Botany (CCPR- 205) Practical</b>						
	Practical I	CCPR-205.1	Angiosperm Systematics	2	8		
	Practical II	CCPR-205.2	Plant Pathology	2			
	Practical III	CCPR-205.3	Cell and Molecular Biology	2			
	Practical IV	CCPR-205.4	Plant Structure, Development and Reproduction	2			
Non CGPA		SEC-206	Skill Enhancement Course	2			

- **CCO:** Core Course Optional.
- CC- 104/ CCO- 104 **OR** CC- 204/ CCO- 204: Students of Botany may take this paper or they may opt out this paper and earn credits equivalent to this paper from other Departments or certified open sources.
- The syllabus for AEC-106 and SEC-206 courses is available on university website link: <http://www.unishivaji.ac.in/syllabusnew/On-Campus-Science>

**B. Structure of the syllabus:**

<b>SEMESTER – I (DURATION 6 MONTHS)</b>											
	Sr. No.	Course Code	Teaching Scheme			Examination Scheme					
			Theory and Practical			University Assessment (UA)			Internal Assessment (IA)		
			Lecture (Per week)	Hours (Per week)	Credit	Maximum Marks	Minimum Marks	Exam Hours	Maximum Marks	Minimum Marks	Exam Hours
CGPA	1	CC-101	4	4	4	80	32	3	20	8	1
	2	CC-102	4	4	4	80	32	3	20	8	1
	3	CC-103	4	4	4	80	32	3	20	8	1
	4	CC-104/ CCO-104	4	4	4	80	32	3	20	8	1
	5	CCPR-105	16	16	8	200	80	--	--	--	*
<b>Total (A)</b>			--	--	24	520	--	--	80	--	--
Non-CGPA	1	AEC-106	2	2	2	--	--	--	50	20	2
<b>SEMESTER – II (DURATION 6 MONTHS)</b>											
CGPA	1	CC-201	4	4	4	80	32	3	20	8	1
	2	CC-202	4	4	4	80	32	3	20	8	1
	3	CC-203	4	4	4	80	32	3	20	8	1
	4	CC-204/ CCO-204	4	4	4	80	32	3	20	8	1
			16	16	8	200	80	--	--	--	*
<b>Total (B)</b>			--	--	24	520	--	--	80	--	--
Non-CGPA	1	SEC-106	2	2	2	--	--	--	50	20	2
<b>Grand Total (A+B)</b>			--	--	48	1040	--	--	160	--	--



**C. Other Features:**

- i) Intake capacity/ Number of students at M. Sc. I will be 50 per year.
- ii) The student may take exit after successful completion of M. Sc. I (Semester I & II) and acquire a certificate of 'PG Diploma in Botany'.

**D. General guidelines:**

- i) There shall be at least a short tour (up to 3 days) and a long tour (not exceeding 15 days) per year for all M. Sc. I and M. Sc. II students. The long tour may be arranged to a region out of the state covering various Botanical Regions/ Research Institutes/ Centres and Universities. Tours are the part of curriculum and are obligatory to each student, failing which they will not be considered eligible to appear for the examination. Under unavoidable circumstances, if the student fails to attend the tour, he/ she has to produce justifiable evidence for not attending the tour. However, in lieu of tour the candidate will have to complete the work assigned by the Department.
- ii) Following documents/ materials shall have to be produced by each student at the time of practical examination (at the end of each Semester):
  - a. Submission of a laboratory journal of practical records.
  - b. Submission of a set of micro preparations (semi-permanent/ permanent) of plant materials illustrating the subject matter of the relevant paper.
  - c. Submission of a field record book (**in his/ her own handwriting**) duly signed by the concerned teacher and at least 15 herbarium specimens (weeds and cultivated plants)/ preserved specimens per course collected by the candidate during the field work or excursion tour and regular visit to study area. Rare, endangered and threatened (RET) plant species should not be collected and used for submission.

## M. SC. PART I (SEMESTER I)

### PAPER I (CC - 101): BIOLOGY AND DIVERSITY OF ALGAE, FUNGI AND BRYOPHYTES

TOTAL LECTURES: [60]

#### UNIT I: ALGA [15]

- Origin, evolution and trends in classification of Algae; Evolution of Chloroplast in Algae; Outline of Robert E. Lee (2008) classification of algae.
- Thallus organization, types of reproduction and evolution of sexual reproduction in algae
- Occurrence and distribution, thallus organization, cell structure and reproduction of algal classes: Cyanophyceae, Rhodophyceae, Chlorophyceae, Ulvophyceae, Charophyceae Euglenophyceae, Phaeophyceae, Xanthophyceae and Bacillariophyceae.

#### UNIT II: FUNGI [15]

- Origin, evolution and trends in classification of fungi.
- Classification of fungi by Hawksworth *et al.* (1995).
- Biodiversity and Taxonomy of following phyla up to the level of order:  
**Chytridiomycota:** Chytridiales; **Zygomycota:** Glomales; **Ascomycota:** Taphrinales, Xylariales and Pezizales; **Basidiomycota:** Aphyllophorales, Uredinales, Ustilaginales Phallales and Nidulariales; **Oomycota:** Saprologniales, and Perenosporales;  
**Hypochoytridiomycota:** Hypochytriales; **Labyrinthulomycota:** Labyrinthulales; Plasmodiophoromycota Plasmodiophoromycetales; **Dictyostelliomycota:** Dictyostelliales; **Myxomycota:** Stemonitales.

#### UNIT III: BRYOPHYTES [15]

- Recent classification of Liverworts (Stotler & Stotler, 2000); Hornworts (Renzaglia, & Vaughn, 2000) and Mosses (Buck & Goffinet, 2000).
- Distribution, habit, morphology, reproduction, phylogeny and interrelationship of Classes: **Marchantiophyta: Marchantiopsida:** Sphaerocarpaceae, Marchantiales and Ricciales. **Jungermanniophyta: Jungermanniopsida:** Fossombroniales, Metzgeriales, Jungermanniales and Porellales.  
**Anthocerotophyta: Anthocerotopsida:** Anthocerotales, Notothyladales  
**Bryophyta: Takakiopsida:** Takakiales; **Sphagnopsida:** Sphagnales; **Polytrichopsida:** Polytrichales, Tetraphidales; **Andreaeopsida:** Andreaeales; **Bryopsida:** Diphysciales, Encalyptales.

#### UNIT IV: [15]

- Culture, Cultivation and methods of preservation of Algae, Fungi and Bryophytes
- Role of Algae in human welfare; Algae as a Source of Biofuel, Phytoremediation
- Industrial and Biotechnological applications of Algae
- Economic importance and Industrial applications of Fungi
- Economic and Ecological significance of Bryophytes

**M. SC. PART I (SEMESTER I)**  
**PRACTICAL I (CCPR-105.1)**

**UNIT I:** **[15]**

1. Preparation of Identification key and herbarium techniques in Algae, fungi and bryophytes.

**ALGAE**

2. Culture techniques in Algae.
3. Isolation of fungi from soil, air, water and host, their inoculation on culture media.
- 4-6. Study of Algal classes mentioned in theory paper (available specimens/slides): Cyanophyceae, Chlorophyceae, Xanthophyceae, Bacillariophyceae, Phaeophyceae, Rhodophyceae and Chrysophyceae

**UNIT II:** **[15]**

**FUNGI**

- 1-3. Detailed study of following types from each of the following orders (available specimens/slides): **Chytridiomycetes:** *Physoderma, Synchytrium*; **Zygomycetes:** *Glomus*; **Hemiascomycetes:** *Taprina*; **Pyrenomycetes:** *Claviceps, Xylaria*; **Discomycetes:** *Peziza*; **Teliomycetes:** *Melampsora, Uromyces, Ustilago*; **Hymenomycetes:** *Agaricus, Polyporus*; **Gasteromycetes:** *Cyathus, Phallus*; **Oomycetes:** *Saprolegnia, Plasmopara, Bremia, Albugo*; **Plasmodiophoromycetes:** *Plasmodiophora* (Slide); **Myxomycetes:** *Stemonitis*

**BRYOPHYTES**

- 4-6. Morphological, anatomical and reproductive studies of the following orders (available specimens/slides): **Marchantiopsida:** Marchantiales, Ricciales and Sphaerocarpaceae; **Jungermanniopsida:** Fossombroniales, Jungermanniales, and Metzgeriales; **Anthocerotopsida:** Anthocerotales, Notothyladales  
**Bryopsida:** Sphagnales, Funariales and Polytrichales.

**REFERENCE BOOKS:**

**ALGAE:**

- ❖ Bellinger, E.G. and D.C. Sigeo (2010). *Freshwater Algae: Identification and Use as Bioindicators*. A John Wiley & Sons, Ltd, Publication.
- ❖ Chapman, V.J. and D. J. Chapman (1965). *The Algae*
- ❖ Desikachary, T.V. (1972). *Taxonomy and Biology of Blue -green algae*
- ❖ Fritsch, F. E. (1965). *Structure and Reproduction of Algae*
- ❖ Gangulee, H.C. and A. K. Kar (1992). *College Botany Vol. III*
- ❖ Kumar, H.D. and H. N. Singh (1971). *Textbook of Algae*
- ❖ Pandey, B. P. (1994). *Textbook of Botany – Algae*
- ❖ Rogers, K. (2011). *Fungi, Algae and Protistis*. Britannica Educational Publishing
- ❖ Sahoo D and Seckbach J. (2015). *The Algae World*. Springer Science
- ❖ Sharma, O.P. (2011). *Textbook of Algae*
- ❖ Vashista, B. R. (1995). *Botany for degree students-Algae*
- ❖ Lee R.E. (2008). *Phycology*, 4<sup>th</sup> Edition Cambridge University Press

**JOURNALS:**

- ❖ Phykos
- ❖ Phycologia
- ❖ Seaweed Research
- ❖ Journal of Indian Botanical Society
- ❖ Indian Journal of Marine Biology

**FUNGI:**

- ❖ Ainsworth, G. G. and A.S. Sussman. *The Fungi Vols. I, II, III, IV- A and IV-B*
- ❖ Alexopoulos C.J., Mims C.W., Blackwell M. (2007). *Introductory Mycology* (Fourth Edition) Wiley India Pvt. Ltd
- ❖ Bessey, E. A. (1967). *Morphology and Taxonomy of Fungi*
- ❖ Dayal (1995). *Aquatic Fungi of India*
- ❖ Gangulee, H.S. and A. K. Kar (1992). *College Botany Vol. I*
- ❖ Mundkur B.B. and M.J. Trimukchar (1952). *Ustilaginales of India*
- ❖ Sharma, O.O. (1989). *Textbook of Fungi*
- ❖ Sparrdo F.K. (1960). *Aquatic phycomycetes*
- ❖ Subramanan, C. V. (1971). *Hyphomycetes*
- ❖ Thind K. S. (1977). *The Myxomycetes of India*

**BRYOPHYTES:**

- ❖ Buck, WR & Goffinet, B. (2000). *Morphology and classification of mosses*, pp 71-123 in Shaw, AJ & Goffinet, B. (eds). (2000). *Bryophyte Biology*.
- ❖ Cavers, R. (1964): Inter-relationship of Bryophytes
- ❖ Chopra, R. N. and P. K. Kumar (1988) *Biology of Bryophytes*.
- ❖ Crandall-Stotler, B & Stotler, R. (2000). *Morphology and classification of the Marchantiophyta*, pp 21-70 in Shaw, AJ & Goffinet, B. (eds). *Bryophyte Biology*.
- ❖ Goffinet, B. and A.J. Shaw (2009) *Bryophyte Biology*.
- ❖ Parihar, N. S. (1959): *An introduction to Embryophyta. Bol. I –Bryophyta*
- ❖ Ram Udar (1976): *Bryology in India*
- ❖ Renzaglia, KS & Vaughn, KC. (2000). *Anatomy, development and classification of hornworts*, pp 1-20 in Shaw, AJ & Goffinet, B. (eds). *Bryophyte Biology*.
- ❖ Smith, G. M. (1955): *Cryptogamic Botany Bol. II*
- ❖ Vanderpoorten, A. and B. Goffinet (2009). *Introduction to Bryophytes*.
- ❖ Vashishta B.R., Sinha A.K. and Adarsh Kumar (2011,2016). *Botany for Degree Students-Part III Bryophyta*.
- ❖ Vashishta, B.R. (1996): *Botany for degree students –Bryophyta*
- ❖ Watson, E.V, (1963): *British Mosses and Liverworts*
- ❖ **Watson, E.V, (1964): *The Structure and life of Bryophytes***

**M.SC. PART-I (SEMESTER – I)**  
**PAPER-II (CC-102): BIOLOGY AND DIVERSITY OF PTERIDOPHYTES AND**  
**GYMNOSPERMS (EXTANT & EXTINCT)**

**TOTAL LECTURES: [60]**

**UNIT I:**

**PTERIDOPHYTES: [15]**

- Trends in classification system.
- Classification given by Pteridophytes Phylogeny Group – I (PPG – I)
- Morphology, anatomy, reproduction of following orders: Psilotales (Ex. *Tmesipteris* and *Psilotum*); Lycopodiales (Ex. *Lycopodium*, *Lycopodiella*); Isoetales (Ex. *Isoetes*); Selaginellales (Ex. *Selaginella*); Equisetales (Ex. *Equisetum*); Marattiales (*Angiopteris*); Polypodiales (*Pteris*, *Microsorium*); Salviniiales (*Salvinia*).

**UNIT II: [15]**

**GYMNOSPERMS:**

- Classification of Gymnosperms (Latest system). [02]
- Study of morphology, anatomy, reproductive organs and affinities of extant members of orders: Coniferales, Ginkgoales, Taxales, Ephedrales, Welwitschiales [10]
- Applied aspects of Gymnosperms. [03]

**UNIT III: [15]**

- Morphology, anatomy and evolutionary trends in Lepidodendrales, Sphenophyllales, Psilophytales, Marattiales and Filicales [12]
- Evolution in reproductive characters of Cycadales [03]

**UNIT IV: [15]**

- Study of geological time scale. [02]
- Morphology, anatomy and evolutionary trends of following extinct groups.
- Pteridospermales, Bennettitales, Cordaitales, Cycadales. [10]
- Techniques used in the study of different fossil types. [03]

**M.SC. PART-I (SEMESTER – I)**  
**PRACTICAL II (CCPR-105.2)**

**UNIT I:** **[15]**

1-6. Morphological, anatomy and reproductive studies of the following members (available specimens/ slides) (Extant): Psilotales: *Psilotum*; Lycopodiales: *Lycopodium*, *Lycopodiella*; Selaginallales: *Selaginella*; Isoetales: *Isoetes*; Equisetales: *Equisetum*; Filicales: *Microsorium*, *Pteris*; Marattiales: *Angiopteris*; Salviniiales: *Salvinia*, *Marsilea*, *Azolla*.

**UNIT II:** **[15]**

1-6. Study of the morphology and anatomy of the vegetative and reproductive parts of extant gymnosperms: *Araucaria*, *Juniperus*, *Podocarpus*, *Pinus*, *Cycas*, *Zamia* and *Ephedra* from available specimens/ slides.

7-15. **Study of following extinct specimens:** Sigillariales: *Sigillaria* Stem; Sphenophyllales: *Sphenophyllum* Stem; Medullosales: *Pachytesta* Seed; Coniferales: *Elatocladus*; Angiosperms: *Saharianthus* flower.

**Palaeobotanical Techniques:** Peel technique, Paleopalynological techniques.

**REFERENCE BOOKS:**

- ❖ Andrews, H.N. 1961. *Studies in Paleobotany*.
- ❖ Arnold, C.A. 1972. *An introduction to paleobotany*.
- ❖ Bhatnagar, S.P. and Moitra A. 1996. *The Gymnosperms*.
- ❖ Bierhorst, D.W. 1971. *Morphology of vascular plants*.
- ❖ Bower, F. O. 1963. *The Ferns*.
- ❖ Chamberlain, C.J. 1966. *Gymnosperms, Structure and Evolution*.
- ❖ Coulter and Chamberlain, J. M. *Morphology of Gymnosperms*.
- ❖ Darroch, W.C. 1968. *Principles of Paleobotany*.
- ❖ Eames, A. J. and E. M. Giffard. 1950. *Comparative morphology of vascular plants*.
- ❖ Foster, A. S. and Gifford, E. M. 1959. *Comparative morphology of vascular plants*.
- ❖ Jermy, A. G. 1973. *The Phylogeny and Classification of ferns*.
- ❖ Parihar, N.S. 1959. *An Introduction to Pteridophyta*.
- ❖ Ramanujan, C.G.K. 1979. *Indian Gymnosperms in Time and Space*.
- ❖ Rashid, A. 1978. *An introduction to Pteridophytes*.
- ❖ Shukla, A.C. and Mishra, S.D. 1975. *Essentials of Paleobotany*.
- ❖ Spone, K.R. 1966. *Morphology of Pteridophytes*.
- ❖ Spone, K.R. 1967. *Morphology of Gymnosperms*.
- ❖ Stewart, W. N. 1983. *Paleobotany and the evolution of plants*. Cambridge U.S.
- ❖ Surange, K.R. 1968. *Indian Fossil Pteridophytes*.
- ❖ Trivedi, A. N. 2002. *Advances in Pteridology*.
- ❖ Vashishta, B.R. 1996. *Botany for degree students – Pteridophytes*.
- ❖ Vashishta, P.C. 1976. *The Gymnosperms*.

**JOURNALS:**

- ❖ American Fern Journal
- ❖ Indian Fern Journal
- ❖ Phytotaxa
- ❖ Taxon
- ❖ International Journal of plant sciences.

**M.Sc. PART-I (SEMESTER I)**  
**PAPER-III (CC-103): TOOLS AND TECHNIQUES**

**TOTAL LECTURES: [60]**

<b>UNIT I:</b>	<b>[15]</b>
<b>Laboratory discipline:</b> Safety and care, experimental report.	<b>[01]</b>
<b>SI System of measurement:</b> Fundamental and derived units	<b>[01]</b>
Structure and properties of water, Biological significance, Ionization of water, pH and Buffers, Computers in biology, Internet and Bioinformatics	<b>[03]</b>
<b>Microscopy:</b> Introduction, The light microscope, Fluorescence microscope, TEM, SEM, Phase contrast, Confocal microscope: Principles and working	<b>[05]</b>
<b>Biostatistics:</b> Measures of Dispersion and Variability. The variance and coefficient of variation, Correlation and regression, ANOVA, Chi square test for goodness of fit and independence	<b>[05]</b>
<b>UNIT II:</b>	<b>[15]</b>
<b>Separation Techniques:</b> Centrifugation: Basic principles of centrifugation, types, rotors, care and safety aspects of centrifuges, preparative and analytical centrifugation, density gradient centrifugation	<b>[04]</b>
<b>Chromatographic Techniques:</b> Principles, applications of Paper chromatography, TLC, Column chromatography, HPTLC, high pressure liquid chromatography, gas chromatography, Affinity and ion exchange chromatography.	<b>[06]</b>
<b>Electrophoretic Techniques:</b> Principle, support media, electrophoresis of proteins and nucleic acids, capillary and microchip electrophoresis, isoelectric focusing, staining, activity staining.	<b>[05]</b>
<b>UNIT III:</b>	<b>[15]</b>
<b>Spectroscopic Techniques:</b> Introduction, principles and applications in UV-Vis, fluorescence and AAS, Infrared and Raman, MALDI-TOF.	<b>[07]</b>
<b>Radioisotope Techniques:</b> Introduction, half-life, units of radio activity, Detection and measurement of radioactivity, autoradiography, counters, safety aspects.	<b>[06]</b>
Histochemical techniques and their applications, Flow cytometry: Principles and applications.	<b>[03]</b>
<b>UNIT IV:</b>	<b>[15]</b>
<b>Culture Technique:</b> Principles, types (bacterial, fungal, algal, plant) media preparation, sterilization, inoculation, Laminar air flow, autoclaves, thermobath, and incubators, Cryopreservation.	<b>[07]</b>
Microbial fermentation techniques	<b>[02]</b>
<b>Immunological techniques:</b> Immune response, Antibody and their specificity, Antigen-antibody interaction, Immuno- diffusion, Immuno- assay, Western Blotting.	<b>[06]</b>

**M.SC. PART-I (SEMESTER – I)**  
**PRACTICAL III (CCPR 105.3)**

**UNIT I:** **[15]**

- 1-2. Preparation of standard solutions, %, M, N, ppm and pH – measurement and preparation of buffers.
3. Analysis of given data using ANOVA
4. Determination of Correlation coefficient.
5. Separation of pigment by chromatographic techniques (TLC/ Column)
6. Verification of Beer and Lambert's law

**UNITS II:** **[15]**

- 1-2. Separation of proteins by gel electrophoresis
3. Study of instruments/equipment's: Flame photometer, Any type of Centrifuge, NMR, GC, HPLC, AAS, SEM, TEM and PCR.
4. Density gradient centrifugation – A separation technique
5. Micrometry

**REFERENCE BOOKS:**

- ❖ Practical cytology, applied genetics and Bio-statistics Goswami H.K. & R. Goswami (1993).
- ❖ Methods in plant molecular biology – M. A. Schwer and Zeclinskin (1989)
- ❖ Plant histochemistry – Jensen.
- ❖ Photosynthesis and production in a changing environment. A field and laboratory manual- Hall, Scurlik, Bolhar-Nordenkampt, Leagood and Long (1993)
- ❖ Experimental plant physiology – J. Arditti and Dunn, (1970).
- ❖ Techniques in Bioproductivity and photosynthesis by Coombs, Hall, Long and Sourlock, (1985)
- ❖ Methods in enzymology- Colowick and Kaplan.
- ❖ A Handbook of field and herbarium techniques- S. K. Jain and R. R. Rao (1977).
- ❖ Practical Biochemistry: Principles and Techniques. Ed. E. Wilson and J. Walker (2000).
- ❖ Modern Experimental Biochemistry-Boyer, R. (2005).
- ❖ Methods in Experimental Biology. Ralph, R. (1975).
- ❖ An Introduction to Biometry- Mungikar, A. M. (1997).
- ❖ Research Methodology for Biological Sciences (1<sup>st</sup> edn.). Gurumani, N. (2013).
- ❖ Botanical histochemistry: principles and practice- William A. Jensen (1962).
- ❖ Flow Cytometry: First Principles (Second Edition)- Givan A.L. (2001).
- ❖ Flow Cytometry Protocols (2nd edition), Methods in Molecular Biology (Volume 263)- Editors Hawley T.S. and Hawley R.G. (2004).
- ❖ Handbook of Histopathological and Histochemical Techniques (Including Museum Techniques) (Third Edition)- Culling C.F.A. (1974).
- ❖ Manual of Histological Techniques (1<sup>st</sup> Edition) - Mondal S.K. (2017)- Jaypee Brothers Medical Publishers



**M.SC. PART-I (SEMESTER – I)**

**PAPER-IV (CC – 104/ CCO –104): BIODIVERSITY: CONSERVATION AND UTILISATION**

**TOTAL LECTURES: [60]**

**UNIT I: [15]**

**BIOLOGICAL DIVERSITY:** Mega diversity countries, magnitude of biodiversity, direct, indirect and ethical values of biodiversity, loss of biodiversity, reasons for loss of biodiversity, Taxonomic initiatives, Systematic agenda 2020.

**ENDEMISM:** Definition, types of endemism, RED list categories of IUCN, Hot spots and Hottest hotspots, Keystone and Flagship species, Biodiversity of India, Hotspots of plant diversity in India, Plant endemism in India with special emphasis on Western Ghats.

**UNIT II: [15]**

Principles of Biodiversity Conservation, Status of plants based on International Union for Conservation of Nature (IUCN), General account of activities of BSI, NBPGR, CSIR, DBT, NGOs. Convention on Biological diversity (CBD) and Documentation of biodiversity.

**UNIT III: [15]**

***In- situ* conservation:** concept, Protected areas – 1. Protected Areas category-system proposed by IUCN, 2. Protected Area Network of India including sanctuaries, National parks, conservation reserves, community reserves. 3. Biosphere Reserves, Wetlands, Mangrove and Coral Reefs.

***Ex- situ* conservation:** Concept, Botanical gardens, Gene banks, Seed banks, Pollen bank, Cryobanks.

**UNIT-IV [15]**

**WILD PLANT RESOURCES AND THEIR UTILIZATION:** Wild Plants of ornamental potential, wild relatives of cultivated plants, wild edible plants and their nutritive value, under exploited medicinal plants, plants of commercial importance, energy plants, petrocrops, Plants suitable in phyto-remediation.

**M.SC. PART-I (SEMESTER – I)**  
**PRACTICAL IV (CCPR - 105.4)**

**UNIT V:** **[15]**

- 1-3. Preparation of plant-based products: dyes, essential oils, mosquito repellents, dhoop sticks
4. Study of endemic plants from Western Ghats (CR, EN, VU – 20 species)
5. Study of wild plants of Ornamental potential (15 plant species)
6. Wild relatives of cultivated plants (*Abelmoschus*, *Cucumis*, *Vigna*, Rice, *Sorghum*, Sugarcane, *Flemingia*, *Cajanus*, Banana etc.)

**UNIT VI:** **[15]**

- 1-2. Study of wild edible plants: microchemical test to detect sugar, starch, protein and lipids
3. Preparation of jam and jellies/ pickles/ sarbat/ herbal tea etc.
4. Plants of commercial importance: detection of alkaloids (Solanaceae members)
5. Energy plants: determination of lipids (Castor, *Jatropha* and *Pongamia* seeds)
6. Plants useful in Phytoremediation

**BOOKS AND REFERENCES:**

- ❖ A manual of ethnobotany Ed., S. K. Jain, Eciatic publications Jodhpur
- ❖ A New moral Economy to India's forests? – Roger Feffery and Nandini Sundar (1999).
- ❖ Advances in Oilseeds Production and Technology, G. V. Ramanamurthy. (1985)
- ❖ Agricultural Botany. N. T. Gill and K. C. Vear. (1969)
- ❖ Agroforestry India Perspective. L.K. Jha and P. K. Sengupta.
- ❖ Allen and Unwin Ltd., London (1954)
- ❖ Applied Ethnobotany – E.Varghese S-VD
- ❖ Complete Gardening of India. K. S. Gopaldaswaniengar, Rengedhy G. Parthasarathy and P. Mukadam. Pupl. (1991)
- ❖ Crop Protection Principles and Practices, S.R. Chapman and L.P. Carter. (1976)
- ❖ Dewick Paul M. (1998). Medicinal natural products (a biosynthetic approach), 1<sup>st</sup> edn.
- ❖ Economic Botany, B. B. Simpson and M-Conner
- ❖ Economic Botany, Hill A. Mcgrow Hill Book Company (1962)
- ❖ Energy Plant Species. Their use and impact on environment and development. (2005)
- ❖ European Pharmacopoeia 6<sup>th</sup> Edn. 2008.
- ❖ Farooqui A. A. and Shreeramu B.S. 2001. Cultivation of medicinal and aromatic crops.
- ❖ Field crops of India by A.K. Aiyer. Bangalore (1966)
- ❖ Forest Management (1996). P. R. Trivedy and K.M. Sudarshan.
- ❖ Forest Resources – Crises and Management Natraj Publishers, Dehradun.
- ❖ Vandana Shiva, V. M. Meherhomji and N.D. Joryal (1992)
- ❖ Forestry and the People (1994). L. K. Jha and P. K. Sen Sharma.
- ❖ Forestry Handbook Ed. R. D. Forbes (1955).
- ❖ Foristry Research and Education in India. P.D. Dogra and R C. Dhiman (edt.) 1994.

- ❖ Heywood, V.H. and Watson, R.T. (eds.). 1995. Global Biodiversity Assessment. UNEP.
- ❖ Indian Pharmacopoeia 2007.
- ❖ Leadley, E. and Jury, S. (eds.). 2006. Taxonomy and Plant Conservation.
- ❖ Montreal, Canada: CBD Secretariat.
- ❖ Peter B. Kaufman 1998 Natural Products from plants, 1<sup>st</sup> edn.
- ❖ Pushpangadam P, Nyman UIF, George V, 1995, Glimpses of Indian Ethanopharmacology Tropical Botanic Garden and Research Institute.
- ❖ Schirmer, R.E., 2000, Modern Methods of Pharmaceutical Analysis, Vol. 1, 2.
- ❖ Switzerland: CBD Interim Secretariat.
- ❖ Tayler, V.E.; Brady, L.R. and Robber, J. R. 1976, Pharmacognosy.
- ❖ Pharmacognosy. Lea and Fobiger, Philadelphia.
- ❖ UNEP. 1992. Convention on Biological Diversity (CBD): Text and Annexes. Geneva,
- ❖ UNEP. 2002. Global Taxonomy Initiative (GTI). Decision VI/8. UNEP/CBD/COP/6/20
- ❖ Wagner, H. 1984, Plant Drug Analysis.
- ❖ Wagner, H., 1977, New Natural Products and Plant Drugs with Pharmacological, Biological or Therapeutical Activity.
- ❖ Wallis, T. E., 1967, Practical Pharmacology.

**M.SC. PART- I (SEMESTER II)**  
**PAPER-V (CC– 201): ANGIOSPERM SYSTEMATICS**

**TOTAL LECTURES: [60]**

**UNIT I: [15]**

**Taxonomy:** Introduction, aims, principles and importance of taxonomy in charting, documentation, Bioprospecting, CBD implementation, conservation and sustainable use of plants. [05]

**Taxonomic Tools:** Herbarium, Botanical Gardens and their role in teaching, research and conservation; important herbaria and botanical gardens of the world and India, Important websites for taxonomic literature. [05]

**International Code of Nomenclature for Algae Fungi and Plants (ICN):** Brief history, Principles, Scientific names, Principle of priority, typification, valid and effective publication, nomina conservanda, nomina rejicienda. [05]

**UNIT II:**

**Evolutionary Concepts:** Key concepts in evolution- origin of intra-population variations, population and environment, general biological principle, transference of function, adaptive radiations, punctuated equilibrium. [05]

**Plant Speciation:** Morphological and biological species concept; allopatric, abrupt, sympatric, hybrid and apomictic speciation. [05]

**Reproductive Isolating Mechanisms:** Premating- temporal, habitat, floral, reproductive mode; post mating, prezygotic- incompatibility; post mating, postzygotic- incompatibility, hybrid inviability, hybrid floral isolation, hybrid sterility, hybrid breakdown. [05]

**UNIT III: [15]**

**Taxometrics:** Principles, Numerical taxonomy, methodology, merits and demerits [04]

**Cladistics:** Principles, cladistic approach in plant classification, methodology, merits and demerits. [04]

**Systems of Angiosperm Classification:** brief historical account of systems of classification, phylogenetic systems of angiosperm classification- Cronquist's systems of classification (up to subclass level), Angiosperm Phylogeny group, APG IV (2016) classification. [04]

**UNIT IV: [15]**

**Families of Angiosperms:** characteristic features, interrelationships, economic importance and classification as per APG-IV of the following groups and families:

**Anita grade:** Amborellaceae, Nymphaeaceae, Hydatellaceae; **Magnoliids:** Magnoliaceae; **Monocots:** Araceae; **Commelinoids:** Arecaceae; **Eudicots:** Papaveraceae, **Core Eudicots:** Amaranthaceae; **Eurosids-I:** Malpighiaceae; **Eurosids-II:** Malvaceae, **Asterids:** Sapotaceae; **Euasterids-I:** Gentianaceae, Acanthaceae; **Euasterid-II:** Apiaceae, Asteraceae.

**M. SC. PART I (SEMESTER I)**  
**PRACTICAL V (CCPR– 205.1)**

**UNIT I:** **[15]**

- 1-5.** Study of general characteristic features, diagnostic characters, floral diagram, floral formula and classification of flowering plant families: Amborellaceae, Nymphaeaceae, Hydatellaceae, Magnoliaceae, Araceae, Arecaceae, Papaveraceae, Amaranthaceae and Malpighiaceae as per APG-IV.

**UNIT II:** **[15]**

- 6-8.** Study of general characteristic features, diagnostic characters, floral diagram, floral formula and classification of flowering plant families: Malvaceae, Sapotaceae, Gentianaceae, Acanthaceae, Apiaceae and Asteraceae as per APG-IV.
- 9.** Identification of genus and species of locally available wild plants using regional and state floras. (At least 10 plants species belonging to locally available families of flowering plants)
- 10.** Preparation of dichotomous keys (indented and bracketed) for identification of taxa.
- 11.** Field trips within and around the University campus, compilation of field notes and preparation of herbarium sheets of weeds.

**REFERENCE BOOKS:**

- ❖ Briggs David 2009. Plant microevolution and Conservation in Human-influenced Ecosystems.
- ❖ Cronquist, A. 1981. An Integrated System of Classification of Flowering Plants.
- ❖ Cronquist, A. 1988. The Evolution and Classification of Flowering Plants (2<sup>nd</sup> ed.)
- ❖ Davis, P. H. and V. H. Heywood 1991. Principles of Angiosperm Taxonomy.
- ❖ Hutchinson, J. 1959. Families of Flowering plants.
- ❖ Judd W. S., Campbell, C. S., Kellogg, E. A., Stevens P. F. and M. J. Donoghue 2008. Plant Systematics: A phylogenetic Approach. Sunderland, Massachusetts, USA.
- ❖ Lawrence George H. M. 1951. Taxonomy of Vascular Plants.
- ❖ Leadlay E. and S. Jury (ed.) 2006. Taxonomy and Plant conservation.
- ❖ Manilal, K. S. and M. S. Muktesh Kumar [ed.] 1998. A Handbook of Taxonomic.
- ❖ Naik, V. N. 1984. Taxonomy of Angiosperms.
- ❖ Donald, L. J. 1993. Principles and Techniques of Contemporary Taxonomy.
- ❖ Simpson M. G. 2006. Plant systematics (Second Edition) Elsevier.
- ❖ Takhtajan, A. 1962. Flowering plants- Origin and Dispersal.
- ❖ Taylor, D. V. and L. J. Hickey 1997. Flowering Plants: Origin, Evolution and Phylogeny.

**M.SC. PART- I (SEMESTER II)**  
**PAPER-VI (CC– 202): PLANT PATHOLOGY**

**TOTAL LECTURES: [60]**

**UNIT I: [15]**

- 1. History of plant diseases:** beginning of modern plant pathology, Contributions of Prevost, Anton De Bary, Kuhn, Woronin, S. D. Garrett, J. G. Horsefall, K.C. Mehta, T. S. Sadavasivan, M. J. Trimulachari and A. Mahadevan.
- 2. Symptomology and Epidemiology:** Disease identification based on symptoms, (external and internal). Epidemiology: epiphytotics (Slow and rapid), disease forecasting.
- 3. Methods of Studying plant diseases and their diagnosis:** Field observation, collection of samples, laboratory studies, culturing of pathogenic organisms (fungi, bacteria and mycoplasma), Koch's postulates.
- 4. Stages of disease development:** Pre penetration, Penetration, post penetration and colonization.
- 5. Role of environmental factors in disease development. Defence mechanism in host:** Structural, physiological genetical and chemical.

**UNIT II: [15]**

- 1. Introductory Virology:** History of virology, Nomenclature and classification of plant viruses, ultrastructure of TMV, TYMV and Bacteriophages. Chemistry of plant viruses, isolation and purification of plant viruses. Economic importance of viruses.
- 2. MLO:** Classification, morphology and characteristics of MLO's Identification techniques of MLO's
- 3. History, symptomology, causal organism, etiology and management of Viral and MLO diseases:** Banana, Brinjal, Chilly, Tomato, Bhendi, Sugarcane, Beans, Papaya and Tobacco

**UNIT III: [15]**

History, symptomology, causal organism, etiology and management of fungal and bacterial diseases: Rice, Jowar, Wheat, Bajra, Sugarcane, Pigeonpea, Rajmah, Tomato, Potato, Cabbage, Bhendi, Brinjal, Cucurbits, Chilli, Fig, Onion, Ginger, and Turmeric.

**UNIT IV: [15]**

History, symptomology, causal organism, etiology and management of fungal and bacterial diseases: Maize, Cotton, Sunflower, Groundnut, Soybean, Sesamum, Banana, Custard apple Grapes, Mango, Coconut, Coffee, Teak, Dalbergia, Pomegranate, Bamboo, Gerbera and Rose.

**M. SC. PART I (SEMESTER I)**  
**PRACTICAL VI: (CCPR-205.2)**

**UNIT I:** **[15]**

- 1-6. Fungal Diseases:** Club root, Damping off, White rust, Early and late Blight, Downy mildew, Powdery mildew, Smut, Rust, Bunt, Blast, leaf spot, Tikka, Anthracnose, Die back, Rot and Wilt.

**UNIT II:** **[15]**

- 7. Bacterial Diseases:** Citrus canker, Bacterial Blight of Rice, Angular leaf spot of cotton, Oil post disease of Pomegranate. **Mycoplasmal Diseases:** Grassy shoot disease and Little leaf.
- 8. Viral Disease:** TMV, PMV Bunchy top of Banana and YVMV.
- 9. Phanerogamic plant Diseases:** Total and Partial root and stem parasites.
- 10. Nematode Disease:** Root knot
- 11-12.** Estimation of chlorophylls, sugars and polyphenols from healthy and infected leaves.

**REFERENCE BOOKS:**

- ❖ Agrios, G. N. 2006. Plant Pathology, 5<sup>th</sup> Edition
- ❖ Aneja, K. R. 1993. Experiments in Microbiology, plant pathology and Tissue culture.
- ❖ Cooke, A. A. 1981. Diseases of Tropical and Subtropical field, Fiber and oil plants.
- ❖ Gangopadhyay, S. 2004: Clinical Plant Pathology.
- ❖ Kujit, J. 1969: The Biology of parasitic flowering plants.
- ❖ Mahadevan, A. and R. Shridhar, 1982. Methods in physiological plant pathology
- ❖ Agarwal A. and Mehrotra, R. S. 2012: Plant Pathology.
- ❖ Nyvall, R. F. 1979. Field Crop Diseases Handbook.
- ❖ Paul Khurama, S. M. 1998: Pathological Problems of Economic crop plants and their management.
- ❖ Planke, J. E. and R. S. 1968: Disease Resistance in plants.
- ❖ Planke, J. E. and Vander. 1963: Plant Diseases Epidemics and control.
- ❖ Rangaswami, G. 1979: Diseases of crop plants in India.
- ❖ Singh R. S. 2009: Plant Diseases, 9th Edition.

**CURRENT AND BACK – VOLUMES OF FOLLOWING PERIODICALS:**

- ❖ Journal of phytopathology
- ❖ Indian journal of phytopathology
- ❖ Journal of Mycology and plant pathology
- ❖ Annual review of plant pathology

**M.Sc. PART-I (SEMESTER II)**  
**PAPER-VII (CC– 203): CELL AND MOLECULAR BIOLOGY**

**TOTAL LECTURES: [60]**

**UNIT I: [15]**

**Dynamic cell:** General account of plant cell structure and its organization, cell organelles-their structure and functions.

**Plasma membrane:** Structure, models and functions, sites for ATP ion carriers, channels and pumps, receptors, transport.

**Plasmodesmata:** structure, role in movement of molecules.

**UNIT II: [15]**

**Cell shape and motility:** The cytoskeleton, organization and role of microtubules and microfilaments, motor movements.

**Cell division:** Mitosis and meiosis.

**Cell cycle:** Cell cycle control system, cell cycle check points, Cyclin dependent kinases and cyclines.

**Concept of gene,** DNA replication in Prokaryotes and Eukaryotes, Reverse transcription, DNA modification and repair.

**UNIT III: [15]**

**Cell signalling:** Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors.

Signal transduction pathways, secondary Messengers. Regulation of signaling pathways, Two component systems of signalling: Bacterial and plant Light signaling in plants.

**UNIT IV: [15]**

**Cellular communication:** General principles of cell communication, Cell adhesion and role of different adhesion molecules, Gap junctions, Extracellular matrix and integrins.

**Cell apoptosis:** Intrinsic and Extrinsic pathways.



**M.SC. PART-I (SEMESTER II)  
PRACTICAL VII (CCPR– 205.3)**

**UNIT I:** **[15]**

1. Electron Micrograph studies of cell organelles.
2. Cell wall staining with calcaflour and fluorescent staining with FDA for cell viability
3. To study plasmodesmatal connections in plant cells
4. Determination of permeability of living cells to acids and bases/ Compare and contrast simple diffusion, facilitated diffusion, osmosis and dialysis.
5. Study of stages in cell cycle
6. Preparation of feulgen stained chromosomes in root tip cells.

**UNIT II:** **[15]**

1. Isolation and estimation of DNA
2. Isolation and estimation of protein from seeds.
3. Separation of DNA and proteins – by Electrophoresis.
4. Determination of melting temperature of DNA/Re-association Kinetics and estimation of Cot values
- 5-6. Study of enzyme activity: ATPase, Peroxidase, Catalase

**REFERENCE BOOKS:**

- ❖ Johnson Lewys – 2004: *Cell Biology*; Sarup and Sons, New Delhi
- ❖ E.J. Dupraw – 1970: *Cell and Molecular Biology*; Academic Press, London
- ❖ De Robertis and De Robertis – 1997: *Cell and Molecular Biology (VIII)*
- ❖ C. P. Swanson, T. Merz, and W.J. Young – 1982: *Cytogenetics*
- ❖ P.C.L. John (Ed.) – 1981: *The cell cycle*; Cambridge University press
- ❖ Benjamin Lewin: *Genes – VI, VII and VIII*; Oxford Press.
- ❖ R. A. Chapoldi 1977: *Membrane proteins and their interactions with lipids*
- ❖ N. Mortonosi (Ed.) – 1985: *The enzymes of Biological Membranes Vol. I, II and III*
- ❖ Watson and others – 2004: *Molecular Biology of the gene (V)*
- ❖ P.C. Turner and others – 2002: *Molecular Biology (II)*
- ❖ W. Ream and K. G. Field – 1999: *Molecular Biology Techniques*
- ❖ Brace Albertsetal – 1983: *Molecular Biology of the cell*
- ❖ Charlothe J. Avers – 1986: *Molecular cell Biology*.
- ❖ Sandhya Mitra – 1988: *Elements of Molecular Biology*
- ❖ C. B. Powar – 1992: *Cell Biology*

**JOURNALS:**

- ❖ Annual review of plant Biology
- ❖ Cell
- ❖ Cytologia
- ❖ Journal of Genetics
- ❖ The Journal of cytology and Genetics
- ❖ Journal of Experimental Biology
- ❖ The journal of Biochemistry
- ❖ Indian journal of Biochemistry and Biophysics.
- ❖ Trends in Biotechnology

**M.Sc. PART-I (SEMESTER II)**

**PAPER VIII (CC – 204/ CCO – 204) PLANT STRUCTURE, DEVELOPMENT AND REPRODUCTION**

**TOTAL LECTURES: [60]**

**UNIT I: [15]**

**Gametophyte in Angiosperms:** Development of male and female gametophyte (sporogenesis and gametogenesis). Structure of stigma and style, chemotropism, pollen wall proteins, stigma surface proteins.

**UNIT II: [15]**

**Fertilization and post fertilization events:** Pollination, double fertilization in plants and its importance, zygote formation, establishment of symmetry in plants, seed formation and germination. **Apomixis:** types, significance and importance.

**UNIT III: [15]**

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristems; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum*.

**UNIT IV: [15]**

**Palynology:** Scope and branches with special suggested readings

**Palynotaxonomy:** Pollen morphology and plant taxonomy with suggested readings to Gymnosperms and Angiosperms.

**Paleopalynology:** Principles, microfossil recovery theory and techniques, microfossil groups and oil exploration.

**Aeropalynology:** Principles, techniques, pollen analysis, pollen and spore allergy, allergic properties of pollen, pollen calendar and importance.

**Melittopalynology:** Bee colony, foraging behaviour of bees, unifloral and multifloral honey, application in crop productivity.

**Agropalynology:** Pollen viability, pollen germination, pollen storage and their significance.

**M.Sc. PART-I (SEMESTER II)**  
**PRACTICAL VIII (CCPR-205.4)**

**UNIT I:**

1. Study of living shoot apices by dissection using aquatic plants (*Ceratophyllum* & *Hydrilla*)
2. Study of different types of stomata
3. Study of different types of trichomes.
4. Study of ultrastructure of male gametophyte with the help of slides and microphotographs.
5. Study of ultrastructure of female gametophyte with the help of slides and microphotographs.
6. Study of few apomicts with the help of any suitable material.

**UNIT II:**

1. Study of polyembryonic seeds. (Mango, *Citrus*)
2. Study of pollen morphotypes (by at least 6 examples)
3. Study of aerospora by Gravity slide method and preparation of pollen calendar.
4. Study of allergic plants and their pollen.
5. Study of fertility by TTC (or Acetocarmine method)
6. Study of Pollen germination.

**REFERENCE BOOKS:**

**EMBRYOLOGY**

- ❖ Maheshwari, P. 1950: An introduction to the embryology of Angiosperm.
- ❖ Maheshwari, P. 1963: Recent advances on the embryology of Angiosperm.
- ❖ Johari, B M. 1963: Experimental embryology of vascular plants.
- ❖ Stanley, R G and F.L. Linkens 1974: Pollen biology, Biochemistry management
- ❖ Shivanna, K. R. and B M Johari 1989: The Angiosperm pollen, structure

**ANATOMY**

- ❖ Barnova, M A. 1987: Historical developments of the present classification of morphological types of stomata.
- ❖ Cutter, E G 1971 Plant Anatomy
- ❖ Dilcher, D D 1974: Approaches to the identification of angiosperms leaf remains.
- ❖ Emmes, E J. and M C Daniels, 1947: An introduction to plant anatomy.
- ❖ Easau, K. 1962: Plant anatomy –anatomy of seed plants.
- ❖ Fahn, A. 1969: Secretory Tissue system
- ❖ Foster, A S 1942: Practical plant anatomy
- ❖ Haberland, G. 1965: Physiological
- ❖ Masueth, J D. 1936: Plant anatomy
- ❖ Metcalfe, C R and L Chalk, 1950: Anatomy of the dicotyledons
- ❖ Solender, H. 1908: Systematics anatomy of the dicots
- ❖ Tomlinson, P S 1961: Anatomy of the monocotyledons.

## **PALYNOLOGY**

- ❖ Cunningham, D D1873: Microscopic examination of air.
- ❖ Fageri, K and J Inversen, 1964: Text book of pollen analysis.
- ❖ Nair, P K K1964: Advances in Palynology.
- ❖ Nair, P K K1966: Essentials of Palynology.
- ❖ Heslop-Harrison, Y. 1971: Pollen development and physiology.
- ❖ Gregory, P H, 1973: Microbiology of atmosphere.
- ❖ Erdtman, G.1988: Pollen morphology and plant taxonomy.
- ❖ Tilak, S T. 1989: Airborne pollen and fungal spores.
- ❖ Shivanna K R and N S Rangaswami1992: Pollen Biology, A Laboratory manual.
- ❖ Bhattacharya,K, M R Majumdar and S G Bhattacharya 2006: A Text book of Palynology.
- ❖ Shivanna K R and B M Johari,1985: The Angiosperm Pollen, structure and function.
- ❖ Pandey and Chadha, 1992: Plant Anatomy and Embryology.

## **JOURNALS:**

- ❖ Journal of Plant Sciences,
- ❖ Experimental Biology
- ❖ Developmental Biology
- ❖ Phytomorphology
- ❖ Currents sciences
- ❖ Plant Biology
- ❖ Int. Journal of Plant Sciences
- ❖ Pollen Biology and Fertilization
- ❖ Pollen Morphology
- ❖ Journal of Palaeontology

**M.Sc. I & II (ODD SEMESTER)**  
**OEC-I: PLANTS – A BIOLOGICAL CAPITAL**

**TOTAL LECTURES: [60]**

**UNIT I:**

**Plants, Human and Environment [15]**

1. Introduction to plants, plant resources and their importance in progress, prosperity and survival of human race.
2. Plants as key solution for major global problems viz. Energy, pollution control, agricultural productivity, global warming, climate change, soil fertility and conservation etc.

**UNIT II:**

**Plants and Industries [15]**

1. Medicinal plants of India
2. Ayurvedic medicines & their industrial formulation
3. Fermentation and Cottage Industries
  - a. Ethyl Alcohol Fermentation
  - b. Citric acid Fermentation
  - c. Mushroom Cultivation

**UNIT III:**

**Understanding Plant life [15]**

1. Seed germination, growth & Flowering
2. Soil and mineral Nutrition of plants
3. Organic farming
4. Storage of Agricultural produce
5. Fruits, Vegetables and Food grains

**UNIT IV:**

**Plants and plant products [15]**

1. Vegetables, oil yielding plants, wild edible plants, food crops, spices and condiments.
2. Forage- fodder plants
3. Fibre yielding plants, textile fibres, cordage fibres, fibres for stuffing
4. Important timber yielding plants and non-wood forest products
5. Petro and sericulture crops
6. Resin, dye, tannin and gum yielding plants and their applications in industry
7. Grasses, their economic importance and human civilization

**REFERENCE BOOKS**

- ❖ Jain, S. K. 2004. A manual of ethnobotany. 2nd edition, Scientific publishers, India.
- ❖ Ramanamurthy, G. V. 1985. Advances in Oilseeds Production and Technology.
- ❖ Gill, N. T. and K. C. Vear and D.J. Barnard. 1980. Agricultural Botany. 3<sup>rd</sup> edition.

- ❖ Jha, L.K. and P. K. Sarma.1993. Agrofresty: Indian Perspective.
- ❖ Varghese, E. 1996. Applied Ethnobotany: A case study among the Kharias of Central India.
- ❖ Chapman S. R. and Carter L.P. 1976. Crop Production: Principles and Practices.
- ❖ EL Bassam, N. 1998.Energy Plant Species: Their Use and Impact on Environment and Development.
- ❖ Aiyer, A. K. 1966. Field crops of India.
- ❖ Shiva Vandana, V. M. Meherhomji and N.D. Joryal. 1992. Forest Resources-Crises and Management.
- ❖ Jha, L. K. and P. K. Sen Sarma. 1994. Forestry for the People.
- ❖ Dogra, P.D. and R C. Dhiman (eds.). 1994. Forestry Research and Education in India.
- ❖ Handbook of Agriculture. 1969. ICAR, New Delhi.
- ❖ Wickens, G.E, N. Haq, P.Day (eds.). 1986. New Crops for Food and Industry.

**M.Sc. I & II (EVEN SEMESTER)**  
**OEC-II: PLANT SCIENCES, HUMAN PROGRESS AND PROSPERITY**

**TOTAL LECTURES: [60]**

**UNIT I: BIODIVERSITY AND ITS CONSERVATION [15]**

- a. Biodiversity of cryptogams**
  - 1. Biodiversity of Viruses
  - 2. Biodiversity of Bacteria
  - 3. Biodiversity of Fungi
  - 4. Biodiversity of Bryophytes
  - 5. Biodiversity of Pteridophytes
- b. Biodiversity of Phanerogams**
  - 1. Biodiversity of Gymnosperms
  - 2. Biodiversity of Angiosperms
- c. Conservation of Biodiversity**
  - 1. Ex-situ conservation methods
  - 2. In-situ conservation methods

**UNIT II: PLANT DISEASE MANAGEMENT [15]**

- 1. Methods of studying plant disease
- 2. Symptoms of plant Diseases
- 3. Principles of plant Disease control
- 4. Diseases of following crops & their management  
Sugarcane ii) Grape iii) Soybean iv) Rose & v) Carnation

**UNIT III: GREEN-HOUSE TECHNOLOGY [15]**

- 1. Glass house, polyhouse, shade house, mist chambers and growth chambers
- 2. Construction, operation, maintenance and management of greenhouse
- 3. Greenhouse environment: watering, fertigation and pest control

**UNIT IV: HORTICULTURE AND GARDENING [15]**

- 1. Methods of propagation: Propagation through Seeds, vegetative and micropropagation
- 2. Avenue trees, Climbers and lianas, Edge and hedge plants, Foliage and flowering
- 3. plants, Bulbous plants, Cycads and palms, Orchids and aquatic plants
- 4. Types of gardens, Landscape gardening, Indoor gardening and Kitchen gardening
- 5. Wild plants from Western Ghats having ornamental potential

**REFERENCES**

- ❖ Jain, S. K. 2004. A manual of ethnobotany. 2<sup>nd</sup> edition.
- ❖ Ramanamurthy, G. V. 1985. Advances in Oilseeds Production and Technology.
- ❖ Gill, N. T. and K. C. Vear and D.J. Barnard. 1980. Agricultural Botany.
- ❖ Jha, L.K. and P. K. Sarma.1993. Agrofrestry: Indian Perspective.

- ❖ Varghese, E. 1996. Applied Ethnobotany: A case study among the Kharias of Central India.
- ❖ Chapman S. R. and Carter L.P. 1976. Crop Production: Principles and Practices.
- ❖ EL Bassam, N. 1998. Energy Plant Species: Their Use and Impact on Environment and Development. Routledge.
- ❖ Aiyer, A. K. 1966. Field crops of India.
- ❖ Shiva Vandana, V. M. Meherhomji and N.D. Joryal. 1992. Forest Resources-Crises and Management.
- ❖ Jha, L. K. and P. K. Sen Sarma. 1994. Forestry for the People.
- ❖ Dogra, P.D. and R C. Dhiman (eds.). 1994. Forestry Research and Education in India.
- ❖ Handbook of Agriculture. 1969. ICAR, New Delhi.
- ❖ Wickens, G.E, N. Haq, P.Day (eds.). 1986. New Crops for Food and Industry.