



Estd. 1962  
"A++" Accredited by  
NAAC(2021)  
With CGPA 3.52

**SHIVAJI UNIVERSITY, KOLHAPUR - 416 004,  
MAHARASHTRA**

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**शिवाजी विद्यापीठ, कोल्हापूर - ४१६ ००४, महाराष्ट्र**

दूरध्वनी - ईपीएबीएक्स - २६०९०००, अभ्यासमंडळे विभाग दूरध्वनी ०२३१-२६०९०९३/९४



**SU/BOS/Science/480**

**Date: 01/07/2023**

**To,**

The Principal,  
All Concerned Affiliated Colleges/Institutions  
Shivaji University, Kolhapur

The Head/Co-ordinator/Director  
All Concerned Department (Science)  
Shivaji University, Kolhapur.

**Subject:** Regarding syllabi of M.Sc. Part-II (Sem. III & IV) as per NEP-2020 degree programme under the Faculty of Science and Technology.

**Sir/Madam,**

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the revised syllabi, nature of question paper and equivalence of M.Sc. Part-II (Sem. III & IV) as per NEP-2020 degree programme under the Faculty of Science and Technology.

| M.Sc. Part-II (Sem. III & IV) as per NEP-2020 |   |     |  |
|---|---|-----|--|
| 1.  | Mathematics   | 8.  | Botany                                   |
| 2.  | Mathematics (Distance Mode)                                   | 9.  | Electronics                              |
| 3.  | Mathematics (Online Mode)                                     | 10. | Zoology                                  |
| 4.  | M.Sc. Tech (Industrial Mathematics With Computer Application) | 11. | Agro Chemical and Pest Management (AGPM) |
| 5.  | Geography   | 12. | Alcohol Technology                       |
| 6.  | Statistics  | 13. | Sugar Technology                         |
| 7.  | Applied Statistics and Informatics                            | 14. | Geology                                  |

This syllabus, nature of question and equivalence shall be implemented from the academic year 2023-2024 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website [www.unishivaji.ac.in](http://www.unishivaji.ac.in)

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October /November 2023 & March/April 2024. These chances are available for repeater students, if any.

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

**Dy Registrar  
Dr. S. M. Kubal**

**Copy to:**

|   |  |    |                                      |
|---|--|----|--------------------------------------|
| 1 | The Dean, Faculty of Science & Technology      | 8  | P.G. Admission/Seminar Section       |
| 2 | Director, Board of Examinations and Evaluation | 9  | Computer Centre/ Eligibility Section |
| 3 | The Chairman, Respective Board of Studies      | 10 | Affiliation Section (U.G.) (P.G.)    |
| 4 | B.Sc. Exam/ Appointment Section                | 11 | Centre for Distance Education        |



ESTD: 1962  
NAAC A<sup>++</sup> Grade  
CGPA 3.52

**DEPARTMENT OF BOTANY**  
**SHIVAJI UNIVERSITY, KOLHAPUR**

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

**TO BE IMPLEMENTED FROM JULY - 2023**

**SHIVAJI UNIVERSITY, KOLHAPUR**

## DEPARTMENT OF BOTANY

### **Revised Syllabus for the Master of Science Part II in Botany (National Education Policy 2020) Applicable from academic year 2023 – 2024 (July 2023)**

- ❖ 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. **Medium of Instruction:** English
10. **Structure of course:**
- a. There shall be **four theory courses** and **four practical courses** in semester III. There shall be four theory courses, 3 practical courses and 1 project for semester IV. 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)
- d. **Practical:** A total 800 marks examination will be conducted for practical courses at the end of 2<sup>nd</sup> semester (400 marks practical examination will be conducted) and at the end of 4<sup>th</sup> semester (350 marks examination will be conducted and 50 marks for project evaluation).
- e. **Project work Evaluation:** By Internal and External Examiner at the end of Fourth Semester

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

| Old Paper   | New Paper  |
|---|--|
| <b>Paper-IX:</b> Cytogenetics and Crop improvement  | (CC-301): Cytogenetics and Crop improvement  |
| <b>Paper X:</b> Biotechnology and Genetic engineering   | (DSE-304): Biotechnology and Genetic Engineering   |
| <b>Paper XI:</b><br>XI) Advanced Plant Physiology and Plant Biochemistry<br>XI) Taxonomy of Fungi<br>XI) Cytogenetics<br>XI) Environment and its aspects<br>XI) The Evolution and Classification of Angiosperms<br>XI) General Marine Botany<br>XI) Plant Tissue culture  | CCS -302:<br>CCS 302.1- Advanced Plant Physiology and Plant Biochemistry<br>CCS 302.2- Taxonomy of Fungi<br>CCS 302.3- Cytogenetics<br>CCS 302.4- Environment and its aspects<br>CCS 302.5- The Evolution and Classification of Angiosperms<br>CCS 302.6- General Marine Botany<br>CCS 302.7- Plant Tissue culture                                     |
| <b>Paper XII:</b><br>XII) Plant Growth and Development<br>XII) Integrated Disease management<br>XII) Plant Breeding<br>XII) Population and Community Ecology<br>XII) Modern trend in Angiosperm Taxonomy<br>XII) Physiology and Biochemistry of Marine Plants<br>XII) Molecular Biotechnology and Genetic Engineering | CCS-303:<br>CCS 303.1- Plant Growth and Development<br>CCS 303.2- Integrated Disease management<br>CCS 303.3- Plant Breeding<br>CCS 303.4- Population and Community Ecology<br>CCS 303.5- Modern trend in Angiosperm Taxonomy<br>CCS 303.6- Physiology and Biochemistry of Marine Plants<br>CCS 303.7- Molecular Biotechnology and Genetic Engineering |
|   | CCPR-305: Practical (CCS-301, CCS-302, CCS-303, DSE-304)   |
|   | Non CGPA AEC-306 and ICT   |
| <b>M.Sc. II Semester IV</b>   |  |
| <b>Paper XIII:</b> Plant Physiology and Metabolism  | CC-401: Plant Physiology and Metabolism  |
| <b>Paper XIV:</b> Biodiversity: Conservation and Utilization  | CC-404: Plant Ecology and Evolution  |
| <b>Paper XV:</b><br>XV) Stress Physiology of Plants<br>XV) Industrial Mycology<br>XV) Molecular Genetics  | <b>CCS-402:</b><br>CCS 402.1-Stress Physiology of Plants<br>CCS 402.2- Industrial Mycology<br>CCS 402.3-Molecular Genetics   |

|  |  |
|--|--|
| XV) Experimental Ecology and Energy Studies<br>XV) Angiosperm Taxonomy Floristic and Biosystematics<br>XV) Marine Ecology<br>XV) Application and Prospects of Plant Tissue culture   | CCS 402.4-Experimental Ecology and Energy Studies<br>CCS 402.5-Angiosperm Taxonomy Floristic and Biosystematics<br>CCS 402.6-Marine Ecology<br>CCS 402.7-Application and Prospects of Plant Tissue culture   |
| <b>Paper XVI:</b><br>XVI) Applied Plant Physiology<br>XVI) Integrated Disease Management<br>XVI) Special Approaches in Genetic improvements of Crop plants.<br>XVI) Environmental issues, assessment and Restoration<br>XVI) Phylogeny and Floral Biology of Angiosperms<br>XVI) Applied Marine Botany<br>XVI) Application, Regulation and Patenting Biotechnology | <b>CCS 403:</b><br>CCS 403.1- Applied Plant Physiology<br>CCS 403.2- Integrated Disease Management<br>CCS 403.3- Special Approaches in Genetic improvements of Crop plants.<br>CCS 403.4- Environmental issues, assessment and Restoration<br>CCS 403.5- Phylogeny and Floral Biology of Angiosperms<br>CCS 403.6-Applied Marine Botany<br>CCS 403.7-Application, Regulation and Patenting Biotechnology |
|  | CCPR 405: Practical (401,402,403,DSE 404)  |
|  | Non CGPA- SEC:406 and Generic Elective   |

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

13. A. Detailed titles of papers:

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

|      | Course No.  | Course Code        | Course Name  | Credits |    |    |
|------|---|--------------------|--|---------|----|----|
| CGPA | M. Sc. II, Semester III: Core Course Botany (CC- 301 to 304) Theory |                    |  |         |    |    |
|      | Paper IX  | CC-301             | Cytogenetics and Crop improvement  | 4       | 16 | 24 |
|      | Paper X   | CCS -302           | CCS 302.1- Advanced Plant Physiology and Plant Biochemistry<br>CCS 302.2- Taxonomy of Fungi<br>CCS 302.3- Cytogenetics<br>CCS 302.4- Environment and its aspects<br><br>CCS 302.5- The Evolution and Classification of Angiosperms<br>CCS 302.6- General Marine Botany<br>CCS 302.7- Plant Tissue culture                                  | 4       |    |    |
|      | Paper XI  | CC-303             | CCS 303.1- Plant Growth and Development<br>CCS 303.2- Integrated Disease management<br>CCS 303.3- Plant Breeding<br>CCS 303.4- Population and Community Ecology<br>CCS 303.5- Modern trend in Angiosperm Taxonomy<br>CCS 303.6- Physiology and Biochemistry of Marine Plants<br>CCS 303.7- Molecular Biotechnology and Genetic Engineering | 4       |    |    |
|      | Paper XI  | CC-304/<br>CCO-304 | Biotechnology and Genetic Engineering  | 4       |    |    |
|      | M. Sc. II, Semester III: Core Course Botany (CCPR- 105) Practical   |                    |  |         |    |    |
|      | Practical   | CCPR-305           | Practical based on CCS-301, 302, 303, 304  | 2 x 4   | 8  |    |

|          |          |         |  |   |  |
|----------|----------|---------|--|---|--|
|          | IX - XII |         |  |   |  |
| Non CGPA |          | AEC-306 | Ability Enhancement Course               | 2 |  |
| Non CGPA |          | ICT     | Information and Communication Technology | 2 |  |

### M. Sc. II, Semester IV:

|      | Course No.   | Course Code        | Course Name   | Credits                                 |    |    |   |
|------|--|--------------------|---|---|----|----|---|
| CGPA | M. Sc. II, Semester IV: Core Course Botany (CC- 401 to 404) Theory |                    |   |   |    |    |   |
|      | Paper-XIII   | CC-401             | CC-401: Plant Physiology and Metabolism   | 4                                       | 16 | 24 |   |
|      | Paper-XIV  | CC-402             | CCS 402.1-Stress Physiology of Plants<br>CCS 402.2- Industrial Mycology<br>CCS 402.3-Molecular Genetics<br>CCS 402.4-Experimental Ecology and Energy Studies<br>CCS 402.5-Angiosperm Taxonomy<br>Floristic and Biosystematics<br>CCS 402.6-Marine Ecology<br>CCS 402.7-Application and Prospects of Plant Tissue culture  | 4                                       |    |    |   |
|      | Paper-XV   | CC-403             | CCS 403.1- Applied Plant Physiology<br>CCS 403.2- Integrated Disease Management<br>CCS 403.3- Special Approaches in Genetic improvements of Crop plants.<br>CCS 403.4- Environmental issues, assessment and Restoration<br>CCS 403.5- Phylogeny and Floral Biology of Angiosperms<br>CCS 403.6-Applied Marine Botany<br>CCS 403.7-Application, Regulation and Patenting Biotechnology | 4                                       |    |    |   |
|      | Paper-XVI  | CC-404/<br>CCO-404 | Plant Ecology and Evolution   | 4                                       |    |    |   |
|      | M. Sc. I, Semester II: Core Course Botany (CCPR- 205) Practical    |                    |   |   |    |    | 8 |
|      | Practical IX - XII   | CCPR 405           | Practical based on CC-401,402,403, 404  | 2x4                                     |    |    |   |
|      | Non CGPA   |                    | SEC:406   | Skill Enhancement Course                | 2  |    |   |
|      | GE   |                    | GE-407  | Horticulture and Green House Technology | 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/<br>CCO-104 | 4                    | 4                | 4      | 80                         | 32            | 3          | 20                       | 8             | 1          |
|  | 5       | CCPR-105           | 16                   | 16               | 8      | 200                        | 80            | --         | --                       | --            | *          |
| Total (A)                                |         |                    | --                   | --               | 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/<br>CCO-204 | 4                    | 4                | 4      | 80                         | 32            | 3          | 20                       | 8             | 1          |
|  |         |                    | 16                   | 16               | 8      | 200                        | 80            | --         | --                       | --            | *          |
| Total (B)                                |         |                    | --                   | --               | 24     | 520                        | --            | --         | 80                       | --            | --         |
| Non-CGPA                                 | 1       | SEC-206            | 2                    | 2                | 2      | --                         | --            | --         | 50                       | 20            | 2          |
| Grand Total (A+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 -II (SEMESTER III)

### PAPER IX (CC 301): CYTOGENETICS AND CROP IMPROVEMENT

[TOTAL LECTURES: 60]

#### UNIT I:

- ❖ **Cytology:** Chromatin organization, Chromosome structure and packaging of DNA, Molecular organization of centromere and telomere, Nucleolus and ribosomal RNA genes, Euchromatin and heterochromatin, Karyotype analysis and evolution, Banding patterns.
- ❖ Chromosome tracking/introgression using FISH and GISH, localization and mapping of genes or genomic segments

#### UNIT II:

- ❖ **Genetics of Prokaryotes and Eukaryotes:** Mapping of prokaryotic and eukaryotic genome, Mobile genetic elements and their significance, Gene families. Process of crop evolution and stabilization of polyploids (cytogenetic and genetic stabilization).
- ❖ **Crop Genetic Resources:** Centres of origin of cultivated plants, Importance of genetic conservation, Global network for genetic conservation and utilization in major crops of world, Institutes engaged in conservation and improvement of crop genetic resources, Wild relatives of crop plants, Gene banks, Gene sanctuaries

#### UNIT III:

- ❖ **Population and Evolutionary Genetics:** Evolutionary theory and population genetics, Theory of allele frequencies, Changes in genetic structure of population: Natural selection, Migration, Mutation, Genetic drift.
- ❖ Genetic variation in natural populations. Gene flow and population structure.

#### UNIT IV:

- ❖ **Classical and modern methods of crop breeding and improvement:** Genetic variability in crop plants, Methods of breeding in self and cross pollinated crops, Heterosis and hybrid development Use of cytoplasmic male sterility in hybrid breeding, Breeding methods in asexual and clonally propagated crops, clonal selection, Marker assisted breeding.

**M.SC. II SEMESTER - III**  
**PAPER IX (CCPR 305.1): PRACTICAL COURSE**

**UNIT V:**

- ❖ Determination of mitotic index
- ❖ Karyotype analysis of *Allium cepa*
- ❖ Isolation of plasmid from *E. coli*
- ❖ Orcein banding
- ❖ Field visit: National Research Institutes/NBPGR centre/Seed company

**UNIT VI:**

- ❖ Meiotic studies in *Allium cepa*
- ❖ Study of floral biology of crop plants
- ❖ Genetic problems on gene mapping in higher plants
- ❖ Centres of origin of crop plants
- ❖ Determination of allele frequency in population

**REFERENCE BOOKS:**

- ❖ **Bahekar V. S.** 1993. Problems in Genetics Vol. I Arati Prakashan , Aurangabad.
- ❖ **Chahal G. S. and Gosal S. S.** 2003, Principles and Procedures of Plant Breeding biotechnological and conventional approaches. Narosa Publishers, New Delhi.
- ❖ **Darnel, J., Lodish, H. and Baltimore, D.** 1990 Molecular cell biology. Scientific American Books.
- ❖ **Gardner, E. J.** 1991 Principles of Genetics. John Wiley and sons, New York.
- ❖ **Jahier, J.** 1996 Techniques of plant Cytogenetics. Oxford and IBH Publishing.
- ❖ **Lewin, B.** 2008, Genes IX. Oxford University Press,
- ❖ **Mandal, A. K., Ganguli, P. K. and Banarjee, S. P.** 1991 Advances in plant breeding Vol. I and II. CBS Publishers & Distributors.
- ❖ **Mayo, O.** 1980. The theory of Plant Breeding. Clarendon Press, Oxford.
- ❖ **Mitra Sandhya** 1994 Genetics a blueprint of life. Tata McGraw- Hill Publishing Company Ltd, New Delhi.
- ❖ **Roy Darbeshwar** 2000, Plant breeding analysis and exploitation of variance. Narosa Publishers, New Delhi.
- ❖ **Russell P. J.** 1998. Genetics (Fifth edition) Benjamin / Cummings Publishing Company Canada.
- ❖ **Sharma J. R.** 1998 Statistical and Biometrical techniques in Plant Breeding New Age International Publishers, New Delhi.
- ❖ **Sharma, A. K. and Sharma, A.** 1980. Chromosome techniques- Theory and practice. Butterworth and Co. (Publishers) Ltd., London.
- ❖ **Sharma, J. R.** 1994 Principles and practice of plant breeding. Tata McGraw Hill Publ. Co. Ltd., New Delhi.
- ❖ **Singh, B. D.** 2000. Plant breeding- Principles and methods. Kalyani Publishers, Ludhiana.
- ❖ **Snustad D. P. and Simmons M. J.** 2003, Principles of Genetics, (Third edition) John Wiley and Sons Inc.
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- ❖ **Swaminathan, M. S., Gupta, P. K. and Sinha, U.** 1983. Cytogenetics of crop plants. Macmillan India Ltd., Delhi.
- ❖ **Swanson, C. P.** 1968. Cytology and Cytogenetics. Macmillan and Co. Ltd., London.

- ❖ **Sybenga, J.** 1975. Meiotic configurations. Springer Verlag, Berlin, Germany.
- ❖ **Winkler, U. Ruger W. and Wackernagel W.** 1979. Bacterial, phage and molecular genetics. Narosa Publication, New Delhi.

**JOURNALS:**

- ❖ Indian Journal of Genetics and Plant Breeding.
- ❖ Journal of Genetics.
- ❖ Journal of Cytology and Genetics.
- ❖ Cytologia.
- ❖ Caryologia.
- ❖ International Journal of Food Science and Technology.
- ❖ Plant Breeding.
- ❖ Theoretical and Applied Genetics.

**M.SC. PART- II (SEMESTER III)**  
**PAPER X (CCS- 302.1): PLANT PHYSIOLOGY**  
**(SPECIAL PAPER I) ADVANCED PLANT PHYSIOLOGY AND PLANT BIOCHEMISTRY**  
**[TOTAL LECTURES: 60]**

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

- ❖ **Photosynthesis:** A brief outline of chlorophyll biosynthesis and the pigment organization in thylakoid membrane. Regulation of PCR Cycle and C<sub>4</sub> Pathway; RUBISCO and PEPCase; C<sub>3</sub> -C<sub>4</sub> intermediates.

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

- ❖ **Carbohydrate metabolism:** Regulation of starch and sucrose biosynthesis, Synthesis and degradation of cellulose, a brief idea of pectin biosynthesis and enzymes involved in pectin degradation.

**UNIT III:** **[15]**

- ❖ **Respiration:** Glycolysis in plants and its regulation, Regulation of Pentose Phosphate pathway and TCA Cycle, Regulation of electron transport chain and role of alternate oxidase.
- ❖ **Organic acid metabolism:** Metabolism and roles of oxalic acid, ascorbic acid and malic acid

**UNIT IV:** **[15]**

- ❖ **Secondary metabolites:** Shikimate pathway and its role in biosynthesis of secondary metabolites.
- ❖ **Phosphorus nutrition** – Forms of phosphorus in soil. Phosphorus uptake, factors controlling 'P' uptake, 'P' fractions in plants. Role of Pyrophosphate in plant metabolism.

## **PAPER X (CCSPR 305.2.1): PLANT PHYSIOLOGY: PRACTICAL COURSE - I**

### **UNIT V:**

- ❖ To study the effect of potassium on glycolytic enzyme pyruvate kinase.
- ❖ Estimation of starch.
- ❖ Study of Oxalic acid accumulation in leaf tissue.
- ❖ Estimation of Ascorbic acid.
- ❖ Estimation of Polyphenols.
- ❖ Estimation of Cellulose.

### **UNIT VI:**

- ❖ Study of Phosphorus distribution in different plant parts.
- ❖ Study of enzyme inorganic pyrophosphatase.
- ❖ Study of effect of light on chlorophyll biosynthesis.
- ❖ Study of enzyme polygalacturonase.

### **REFERENCE BOOKS:**

- ❖ **Bidwell, R. C. S.** (1979): Plant Physiology. Macmillan
- ❖ **Bonner, J. and Varner, J.E.** (1972): Plant Biochemistry. IBH.
- ❖ **Edwards G. and Walker D.,** eds. (1983). C3, C4: mechanisms, and cellular and environmental regulation, of photosynthesis. Oxford: Blackwell Scientific Publications.
- ❖ **Govindjee, H.** (ed.) (1982): Photosynthesis, Vol. 1 and Vol. 2. Academic Press, N.Y. (Vol. 1); 0-12- 294302-2 (Vol. 2))
- ❖ **Hopkins, W. C.** (1995): Introduction to Plant Physiology. Wiley, New York.
- ❖ **Krishnamurthy, H.N.** (1992): Physiology of Plant Growth and Development. Atma Ram and Sons, Delhi.
- ❖ **Marschner, H. W.** (1986): Mineral nutrition of Higher Plants. First Edition, Academic Press, Elsevier Science Ltd.
- ❖ **Marschner, H. W.** (2003): Mineral nutrition of Higher Plants. Second Edition, Academic Press, Elsevier Science Ltd.
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- ❖ **Mukherjee, S.P. and Ghosh A.N.** (1996): Plant Physiology. New Central Book Agency (P) Limited Tata McGraw Hill.
- ❖ **Noggle, G.R. and Fritz, G. J.** (1976): Introductory Plant Physiology. Prentice- Hall, Inc., Englewood Cliffs, NJ.
- ❖ **Pessarakli, M.** (Ed.). (2001). Handbook of Plant and Crop Physiology, 2nd Edition, Revised and Expanded. Marcel Dekker, Inc., New York
- ❖ **Pessarakli, M.** (Ed.). (2005). Handbook of Photosynthesis, 2nd Edition, CRC Press, Taylor & Francis Publishing Company, Florida
- ❖ **Randhir Singh and Sawhney S. K.** (1988): Advances in frontier Areas of Plant Biochemistry. Prentice Hall of India

- ❖ **Sadasivam S. and Manickam A.** (1996): Biochemical methods. New Age International.
- ❖ **Salisbury, F. B. and Ross, C.W.** (1992): Plant Physiology IV ed. Cengage Learning
- ❖ **Smith, H.** (1975): Phytochrome and Photomorphogenesis. McGraw-Hill Inc.,US
- ❖ **Taiz, L. and Zeiger, F.** (1998): The Plant Physiology. Second Edition, Sunderland: Sinauer Associates.
- ❖ **Wilkins, M. B.** (1976): Physiology of Plant Growth and Development. McGraw-Hill Publishing Company Limited

#### **JOURNALS**

- ❖ Annual Review of Plant Physiology and Molecular Biology
- ❖ Annual Review of Plant Physiology
- ❖ Indian Journal of Plant Physiology
- ❖ Journal of Experimental Botany
- ❖ Physiologia Plantarum, Sweden
- ❖ Plant Physiology, Bethesda, USA
- ❖ Plant Cell



**M. SC. PART- II (SEMESTER III)**  
**PAPER X (CCS- 302.2): MYCOLOGY AND PLANT PATHOLOGY**  
**(SPECIAL PAPER I) TAXONOMY OF FUNGI**

[TOTAL LECTURES: 60]

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

- ❖ **General features of fungi**
- ❖ **Various systems of classification of fungi:** Ainsworth (1973), Webster (1980) and Hawksworth *et al.* (1995).
- ❖ **Micrometry:** Study of micrometry and its significance in fungal taxonomy.
- ❖ **Culture:** Types of culture media and their preparation, special culture media.

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

- ❖ Criteria used in the classification of fungi.
- ❖ Morphology: External and Internal, Vegetative and Reproductive, Cytological and Genetical.

**UNIT III:**

- ❖ Criteria used in the classification of fungi
- ❖ Serological and Nutritional.
- ❖ Physiological and Biochemical.
- ❖ Host specificity.
- ❖ Ultrastructural and cultural.

**UNIT IV:**

- ❖ **Microtomy:** Types of microtomes, Techniques of microtomy, stains and fixatives used.
- ❖ Status of fungi and research in Mycology and Plant Pathology in India: An overview.

## PAPER X CCSPR 305.2.2: MYCOLOGY: PRACTICAL COURSE I

### UNIT V:

- ❖ Measurement of fungal dimensions and identification of fungal genera.
- ❖ Measurement of spore size and study of spore morphotypes, determination of standard deviation and frequency distribution, histogram and polygon.
- ❖ Preparation of culture media, PDA, Czapek Dox Agar and Richard's medium.

### UNIT VI:

- ❖ Microtomy of fungal specimens.
- ❖ Isolation of fungi from soil and their identification and classification
- ❖ Isolation of fungi from water and their identification and classification.
- ❖ Isolation of fungi from air and their identification and classification.
- ❖ Isolation of fungi from their host and their identification and classification.

### REFERENCE BOOKS:

- ❖ **Ainsworth, G.E., Sparrow, F. K. and A. S. Sussman.** 1973. The Fungi. Vol. I, II and III. Academic Press, New York.
- ❖ **Alexopoulos, C.J., C.W. Mims and M. Blackwell.** 1979. Introductory Mycology. A national book foundation, USA
- ❖ **Aneja K.R.** 1993 : Experiments in Microbiology, Plant Pathology and Tissue New Age international.
- ❖ **Barnett, H.L.** (1960): Illustrated genera of imperfect fungi. American Phytopathological Society, U.S.A.
- ❖ **Bessey, E.A.** (1967): Morphology and Taxonomy of fungi Blakiston Company, U.S.A.
- ❖ **Buller, A.H.R.** (1909-50): Researches on Fungi Vol. I-VIII. Longmans Green & Company, London, U. K.
- ❖ **Gangopadhyay, S.** (1994): Clinical Plant Pathology. Kalyani Publishers, Daryaganj, New Delhi.
- ❖ **Gangulee, H. S. and A. K. Kar** (1992): College Botany Vol. II. IV-A and IV-B. New Central Book Agency (P) Ltd., Kolkata. W. B.
- ❖ **Johanson, D.A.** (1940): Plant Microtechniques. McGraw-Hill Publishing Company Ltd., New York. U. S. A.
- ❖ **Kendrick, W.B.** (1979): Taxonomy of fungi imperfecti. Uni. Of Toronto Press, Canada
- ❖ **Pandey, B.P.** (1994): A Text Book of Botany: Fungi. International Publishing House, New Delhi.
- ❖ **Rangaswamy G.** (1975): Diseases of crop plants in India. PHI Learning Pvt. Ltd., M97 Cannaught Circle, New Delhi.
- ❖ **Raychudhary, S. R. et al.** (1975): Advances in Mycology and Plant Pathology.
- ❖ **Sharma, O. P.** (1989): Text Book of Fungi. Tata McGraw-Hill Education, 1989

### JOURNALS

- ❖ Annual Review of Plant Pathology.
- ❖ Canadian Journal of Botany.
- ❖ Mycologia.
- ❖ Indian Journal of Plant Pathology.

**M.Sc. PART- II (SEMESTER III)**  
**PAPER XI (CCS- 302.3): CYTOGENETICS AND PLANT BREEDING**  
**(SPECIAL PAPER- I) CYTOGENETICS**

**TOTAL LECTURES – 60**

**UNIT I:**

- ❖ Introduction to cytogenetics. Mitotic and meiotic cell division
- ❖ Meiosis: modes of meiosis, Chromosome disjunction. Genetic control of meiosis, mechanism
- ❖ and theories of crossing over, Recombination models, Synaptonemal complex

**UNIT II:**

- ❖ Structural variations in chromosomes, their cytological consequences, Structural hybrids, B chromosome its origin and consequences.
- ❖ Evolutionary significance of chromosomal aberration, balanced lethal and chromosome complexes.
- ❖ Numerical variation in chromosomes, sources and consequences including syndromes, classification, natural and induced polyploids, Utilization of aneuploids in gene location/mapping and gene transfer.
- ❖ Role of polyploids in crop breeding. Evolutionary advantages of autopolyploids Vs allopolyploids

**UNIT III:**

- ❖ **Genome analysis in crop plants:** Triticales, Wheat, Cotton, Tobacco.
- ❖ Meiotic analysis in hybrids
- ❖ **Alien genetic resources in crop improvement:** Alien addition and substitution lines, hybrids between species with same chromosome number, alien translocation, hybrids between species with different chromosome number, gene transfer using amphidiploids, bridge species

**UNIT IV:**

- ❖ Apomixis; types of apomixes in higher plants, evolutionary significance in plant breeding and genetic disadvantages
- ❖ Chromosome hybridization case studies: production and use of haploids, dihaploids and double haploids in genetics and breeding.
- ❖ *Drosophila* genetics: Life cycle, special type of chromosome, genetic regulation of development
- ❖ in *Drosophila*

## PAPER XI (CCPR 305.2.3): CYTOGENETICS AND PLANT BREEDING: PRACTICAL COURSE I

### UNIT V

- ❖ Smear preparations in *Sorghum bicolor*, *Zea mays*, *Delphinium malbaricum*,
- ❖ *Lycopersicum esculentum*, *Coix lachryma-jobi*, *Solanum sp.*
- ❖ Meiotic analysis in plants (Stages, chiasma, chiasma terminalization by using photographs,
- ❖ Pachytene analysis).
- ❖ Meiotic studies in structural hybrids (*Setcreatia sp* *Cyanotis sp*)
- ❖ Study of B chromosome in *Maize/Drimia*
- ❖ Cytological analysis of polyploidy in plants.

### UNIT VI:

- ❖ Study of life cycle in *Drosophila melanogaster*
- ❖ Special type of chromosomes in *Drosophila melanogaster*
- ❖ Study of bacterial conjugation
- ❖ Study of bacterial transduction
- ❖ Study of transformation in *E. coli*
- ❖ Induction of mutation and study of mutants in *E. coli*
- ❖ GUS expression in plants

### REFERENCE BOOKS:

- ❖ **Khush G. S.** 1973. Cytogenetics of aneuploides. Academic Press New York USA.
- ❖ **Burnham C. R.** 1962. Discussions in Cytogenetics. Burgess Publishing Co. Minnesota.
- ❖ **Harti D. L. and Jones E. W.** 1998. Genetics: Principles and Analysis 4th Edition. Jones and Barew Publishers Massachusetts USA.
- ❖ **Karp G.** 1999. Cell and Molecular Biology : Concepts and Experiments, John Wiley and Sons Inc USA.
- ❖ **Fikui K. and Nakayama S.** 1996. Plant chromosomes; Laboratory Methods CRC Press Boca Ration Florida.
- ❖ **Gupta P. K.** 1999. Cytogenetics. Rastogi Publication Meerut.
- ❖ **Prasad G.** 1998. Introduction to Cytogenetics. Kalyani Publishers, New Delhi.
- ❖ **Sinha U. and Sinha S.** 1998. Cytogenetics, Plant Breeding and Evolution. Vikas Publishing house Pvt. Ltd. New Delhi
- ❖ **Swaminathan M. S., Gupta P. K. and Sinha U.** 1974. Cytogenetics of Crop Plants MacMillan India Ltd. New Delhi.
- ❖ **Swanson C. P., Merz T. and Young J.** 1973. Cytogenetics. Prentice Hill of India Private Ltd. New Delhi.

**M. Sc. PART- II (SEMESTER III)**  
**PAPER X (CCS- 302.4): ENERGY, ECOLOGY AND ENVIRONMENT**  
**(SPECIAL PAPER I) ENVIRONMENT AND ITS ASPECTS**

**TOTAL LECTURES: 60**

**UNIT I:**

- ❖ **Abiotic Environment:** Liebig's Law of Minimum, Shelford's law of tolerance, Law of Limiting Factors.
- ❖ **Environment in Terrestrial Ecosystems:** Classification of Biotic and Abiotic atmosphere, Interaction between organisms in an ecosystem. Light effects on plant life.
- ❖ **Climate:** Classification of climate, structure of atmosphere, Edaphic factors, Climograph

**UNIT II:**

- ❖ **Soil Process:** origin and formation of soil, weathering process (Physical and chemical weathering Soil composition, Soil texture, Soil complex).
- ❖ **Soils:** Soil profile, Formation of humus.
- ❖ **Soil erosion,** Causes, Soil conservation methods, Soil types of India.

**UNIT III:**

- ❖ **Land use classification,** integrated land use planning and water shade management, Waste land development, concept of soil map.
- ❖ **Water:** Resources and Management. Surface and subsurface of water, Demand of Water (Agriculture, Domestic and Industrial), Hotspots of surface water, Role of state/ central commission in water resource management.

**UNIT IV**

- ❖ **Environment in aquatic ecosystem:**
- ❖ **Marine Environment:** Light, Waves, Currents, Winds, Tides, Zonation in the sea
- ❖ **Fresh water environment:** Wind, Current, Temperature

## **PAPER X: CCPR 305.2.4: ENVIRONMENT AND ITS ASPECTS: PRACTICAL COURSE I**

### **UNIT V:**

- ❖ Analysis of water samples from polluted and non-polluted lakes for DO.
- ❖ Determination of BOD at Room Temperature.
- ❖ Study of wilting coefficient.
- ❖ Study of effect of effluents on plant growth.
- ❖ Field visits to Industrial area

### **UNIT VI:**

- ❖ Determination of quality of water by physical parameters (colour, EC, pH, TSS, TDS and TS).
- ❖ Study of MPN as hydrobiological indicator.
- ❖ Study of soil profile.
- ❖ Determination of organic matter from soil.
- ❖ Ecological instruments used in air and water pollution studies.

### **REFERENCE BOOKS:**

- ❖ **Agarwal, S. K.** (1992): Fundamentals of Ecology. New Delhi: Ashish Publishing House.
- ❖ **Bradbury, I. K.** (1990): The Biosphere. Published by John Wiley & Sons, Chichester.
- ❖ **Das, S. M.** (1989): Handbook of Limnology and water pollution with practical Methodology. Published by South Asian Publishers, New Delhi.
- ❖ **Etherington, J. R.** (1975): Environment and plant ecology : aims and development. Publisher Wiley.
- ❖ **Freedman, H. I.** (1980): Deterministic mathematical models in population ecology. Marcel Dekker Inc., New York.
- ❖ **Greig Smith, P.** (1983): Quantitative Plant Ecology. *Publisher:* WILEYBLACKWELL
- ❖ **Grims, J. P. et al** (1988): Comparative Plant Ecology. Colvend, Dalbeattie, Kirkcudbrightshire [Scotland]: Castlepoint Press.
- ❖ **Hashimoto, Y. et al** (1990): Measurement techniques in plant sciences. San Diego, Calif.: Academic Press
- ❖ **Kershaw, K. A.** (1964): Quantitative and dynamic ecology. Publisher: Edward Arnold
- ❖ **Kormondy, E. J.** (1996): Concept of ecology. Publisher: Benjamin Cummings.
- ❖ **Krebs, C. J.** (1978): Ecology. Harper & Row., New York.
- ❖ **Lieth, H. F. et al** (1973): Patterns of primary production in the biosphere. Kluwer Academic Publishers-Plenum Publishers.
- ❖ **Misra, K. C.** (1989): Manual of plant ecology. Oxford and IBH Publishing Co., New Delhi.
- ❖ **Misra, R. and Das, R. R.** (1971): Proceedings of the school of plant ecology. Publisher: Calcutta Oxford & IBH Pub. Co.
- ❖ **Odum, E. P.** (1971): Ecology. Publisher: Saunders.
- ❖ **Odum E. P.** (3rd ed. 1996): Fundamentals of Ecology. Natraj Publishers, Dehra Dun.
- ❖ **Pandeya S. C. et al** (1963): Research methods in plant ecology. Asia Publishing House.
- ❖ **Watt K. E. F.** (1973): Principles of Environment Sciences. Published by McGraw-Hill.

## M. Sc. PART- II (SEMESTER III)

### PAPER X (CCS- 302.5): ANGIOSPERM TAXONOMY

#### (SPECIAL PAPER-I) THE EVOLUTION AND CLASSIFICATION OF ANGIOSPERMS

TOTAL LECTURES: 60

#### UNIT I:

- ❖ **Principles and Practices in Plant Taxonomy:** Definitions and concepts, importance of taxonomy and need for classification, hierarchical classification, Alpha and Omega taxonomy, taxonomy as synthetic discipline.
- ❖ **The New Global Taxonomy Initiatives:** Systematic agenda - 2000, systematic knowledge and value of biodiversity, the missions of systematic agenda-2000. Biodiversity strategy and systematics Agenda for 2020.
- ❖ **A Brief History of Pre-Darwinian Classifications:**
- ❖ Systems based on habit: Theophrastus, Albert Magnus, Otto Brunfels, Jerome Bock, Andrea Cesalpino, Jean Bauhin, Joseph Pitton de Turnefort, John Ray
- ❖ The sexual system: Carolus Linnaeus and his students
- ❖ Systems based on form-relationships: Michel Adanson, Jean B. A. P. M. de Lamarck, De Jussieu, De Candolle, Bentham and Hooker.

#### UNIT II:

- ❖ **A Brief History of Post Darwinian Classifications:** The evolutionary theory by Darwin and Wallace. Systems based on phylogeny:
- ❖ The Englerian School of thoughts: August Wilhelm Eichler, Adolph Engler, Alfred Rendle, Carl Christian Mez, August A. Pulle, Carl Skottberg, B. Hayata
- ❖ The Ralian School of thoughts: Richard von Wettstein, Charles E. Bessey, Hans Hallier, John Hutchinson, Oswald Tippo, G. Gunderson, Lyman Benson.
- ❖ **Recent Systems of Classifications:** Broad outline of classification by Armen L. Takhtajan and R. M. T. Dahlgren
- ❖ APG IV: Basal angiosperms, Magnoliids, Monocots, Commelinids, Eudicots, Core Eudicots, Rosids, Fabids, Malvids, Asterids, Lamiids and Campanulids.

#### UNIT III:

- ❖ **Evolution of Flowering Plants:** Angiosperm apomorphies- Flower, Stamens, Reduced male gametophyte, Carpel, Two integuments, Reduced female gametophyte, Endosperm formation, Sieve tube members, Angiosperm specializations, Vessels. Origin of angiosperms.
- ❖ **Taxonomic Hierarchy:** Ranks of Taxa, Forms of scientific names; major categories: division, class, order, family; minor categories: genus, species and intraspecific categories.
- ❖ **Plant Morphology:** Plant structure - Roots, Stems, Leaves, Flowers, Perianth, Androecium, Nectaries, Gynoecium, Carpel, Pistil, Inflorescences, Fruits and seeds.

#### UNIT IV:

- ❖ **Morphological variations, systematic position, interrelationships, phylogeny and economic importance of following families:** ANITA GRADE, Hydatellaceae, Austrobaileyaceae; MAGNOLIIDS: Lauraceae, Piperaceae, Aristolochiaceae; MONOCOTS: Alismataceae, Hydrocharitaceae, Potamogetonaceae, Aponogetonaceae; COMMELINIDS: Commelinaceae, Typhaceae, Eriocaulaceae, Zingiberaceae, Costaceae, Musaceae.

## PAPER X (CCPR 305.2.5): ANGIOSPERM TAXONOMY: PRACTICAL COURSE I

### UNIT V:

- ❖ Exercises on nomenclature problems.
- ❖ Describing new taxon.
- ❖ Study of flowers of primitive families: Magnoliaceae, Lauraceae, Aristolochiaceae, Piperaceae, Ranunculaceae, Alismataceae, Nymphaeaceae.
- ❖ Identification of wild and cultivated plant species using regional and national floras.
- ❖ Study of different types of ovules and placentations.

### UNIT VI:

- ❖ Descriptions, Sketching, classification and identification of families: ANITA GRADE- Hydatellaceae, Austrobaileyaceae; MAGNOLIIDS- Lauraceae, Piperaceae, Aristolochiaceae; MONOCOTS- Alismataceae, Hydrocharitaceae, Potamogetonaceae, Aponogetonaceae; COMMELINIDS- Commelinaceae, Typhaceae, Eriocaulaceae, Zingiberaceae, Costaceae, Musaceae.
- ❖ Any additional practical/s based on theory syllabus will be added whenever necessary.

### REFERENCE BOOKS:

- ❖ **Cronquist, A.** 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York.
- ❖ **Cronquist, A.** 1988. The Evolution and Classification of Flowering Plants (2nd ed.). Allen Press, U.S.A.
- ❖ **Davis, P. H.** and **V. H. Heywood** 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi.
- ❖ **Manilal, K. S.** and **M. S. Muktesh Kumar** [eds.] 1998. A Handbook of Taxonomic Training. DST, New Delhi.
- ❖ **Naik, V. N.** 1984. Taxonomy of Angiosperms. Tata McGraw-Hill, New Delhi.
- ❖ **Quicke, Donald L. J.** 1993. Principles and Techniques of Contemporary Taxonomy. Blakie Academic & Professional, London.
- ❖ **Taylor, D. V.** and **L. J. Hickey** 1997. Flowering Plants: Origin, Evolution and Phylogeny. CBS Publishers & Distributors, New Delhi.
- ❖ **Lawrence, G. H. M.** 1951. Taxonomy of Vascular Plants. Oxford and IBH Publ. Co. Pvt. Ltd. New Delhi.
- ❖ **Takhtajan, A.** 1969. Flowering plants-Origin and Dispersal. Oliver and Boyd, Edinburgh.
- ❖ **Hutchinson, J.** 1959. Families of Flowering plants. Clarendon Press, Oxford.
- ❖ **Judd Walter S., Campbell, C. S., Kellogg, E. A., Stevens, P.F.** and **M. J. Donoghue.** 2008. Plant Systematics- A Phylogenetic Approach. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.
- ❖ **Simpson, M. G.** 2010. Plant Systematics. Elsevier, Amsterdam.



**M. SC. PART- II (SEMESTER III)**  
**PAPER X (CCS- 302.6): MARINE BOTANY**  
**(SPECIAL PAPER I) GENERAL MARINE BOTANY**

**TOTAL LECTURES: 60**

**UNIT I:**

- ❖ **Marine environment and organisms:** Benthic & Pelagic environment, Classification of marine organisms-Plankton, Nekton, Benthos, Marine Plant Groups
- ❖ **Marine phytoplankton:** Classification & diversity, Buoyancy, Red tides
- ❖ **Microbial diversity in marine habitat:** Brief idea of Marine Fungi, Actinomycetes, Marine Bacteria, Viruses & Marine Lichens.
- ❖ **Coral reefs:** Types, Biology, Zooxanthellae, Reef algae & herbivores, Importance.

**UNIT II:**

- ❖ **Microalgae:** Classification & Salient features of Cyanophyta, Pyrrophyta, Chrysophyta, Cryptophyta, Examples from each division.
- ❖ **Macroalgae:** Classification of Seaweeds, General characteristics, life cycle & type studies of Chlorophyta (*Ulva*, *Enteromorpha*), Phaeophyta (*Sargassum*, *Padina*) & Rhodophyta (*Gracilaria*, *Porphyra*), Evolution of thallus in different classes.

**UNIT III:**

- ❖ **Biodiversity of mangroves:** Definition of the term 'mangrove', biodiversity, brief idea of Creek, Estuary, Lagoon and Delta. Distribution & biogeography of Indian mangroves, East and west coast mangroves, Mangrove forest types.
- ❖ **Salient Features of Important Mangrove Families:** Rhizophoraceae, Sonneratiaceae, Avicenniaceae, Myrsinaceae, Acanthaceae. Mangrove associates.

**UNIT IV:**

- ❖ **Salt marshes:** Salt marsh flowering plants-Occurrence, Taxonomy, Distribution, Morphological and anatomical adaptations, Ecological roles, Salt marsh ferns, bryophytes, algae.
- ❖ **Sea grasses:** Taxonomy, Distribution, Morphological & anatomical adaptations, Ecological roles, Sea grasses & Human affairs.
- ❖ **Sand dunes:** Occurrence, Formation of coastal sand dunes. Classification, Embryo dune, Yellow dune, Grey dune, Succession in dune vegetation, Dune vegetation.

## PAPER X (CCPR 305.2.6): MARINE BOTANY PAPER XI: PRACTICAL COURSE I

### UNIT V:

- ❖ Study of characteristic features of Chlorophyta Ex. Enteromorpha, Chaetomorpha, Ulva, Caulerpa.
  - ❖ Study of characteristic features of Phaeophyta Ex. Padina, Dictyota, Sargassum.
  - ❖ Study of characteristic features of Rhodophyta Ex. Gracilaria, Gelidium, Hypnea.
  - ❖ Sampling and identification of marine phytoplankton.
  - ❖ Study of sand dune plants (Canavalia, Derris, Pandanus, Spinifex, Ipomoea etc.).
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### UNIT VI:

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- ❖ Type study of mangroves from Avicenniaceae (*Avicennia* species)
  - ❖ Type study of mangroves from Rhizophoraceae (*Rhizophora*, *Bruguiera*, *Ceriops*, *Kandelia*)
  - ❖ Type study of mangroves from Sonneratiaceae (*Sonneratia*)
  - ❖ Type study of mangroves from Myrsinaceae (*Aegiceras*) and Acanthaceae (*Acanthus*)
  - ❖ Study of important mangrove associates.
- 

### Reference Books:

- ❖ **Alexopoulos, C.J. & Bold, H.C.** (1967). Algae & Fungi: Current Concepts in Biology Series. The Macmillan Company, London.
- ❖ **Chapman, V. J.** (1976). Coastal Vegetation. II nd edition Pergamon Press. New York
- ❖ **Chaudhuri, A. B.** (2007). Biodiversity of Mangroves.
- ❖ **Desikachary, T. V.** (1975). Marine Plants. N. C. E. R. T. New Delhi.
- ❖ **Kamat, N. D.** (1982). Topics in Algae. Sai Kripa Prakashan, Aurangabad
- ❖ **Kumar H. D. 1990.** Introduction to Phycology. Affiliated East West Press pvt. Ltd. publ. New Delhi.
- ❖ **Kumar H.D. and H.N. Singh** (1990). Algae. Affiliated East West Press pvt. Ltd. publ. New Delhi.
- ❖ **McConnaughey, B. H** (1974). Introduction to Marine Biology. 2<sup>nd</sup> ed. Mosby publisher.
- ❖ **Naskar Kumudranjan** (2004.) Manual of Indian Mangroves. Daya Publishing House, New Delhi.
- ❖ **Sambamurthy, A.V.S.S.** (2005). A Text Book of Algae. I. K. International Pvt. Ltd. New Delhi.

- ❖ **Santhanam, R.; Ramnathan,N.; Venkataramanjan K. & Jegathanam,G.** (1987). Phytoplankton of Indian Seas. & Aspects of Marine Botany. Daya Publication Home. Delhi.
  - ❖ **Sen Neera and Kumudranjan Naskar,** (2003). Algal Flora of Sundarbans. Mangal Daya
  - ❖ **Stein, J. R.** (1973) Handbook of Phycological Methods. Cambridge University Press.
  - ❖ **Trainor, F. R.** 1978. Introductory Phycology. John Wiley, New York.
  - ❖ **Vashishta, B. R.** (1995). Algae. S. Chand and Co. Ltd., New Delhi.
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**M. Sc. PART-II (SEMESTER III)**  
(CCS- 302.7): Plant Biotechnology  
**(SPECIAL PAPER I) PLANT TISSUE CULTURE**

**Total Lectures: 60**

**UNIT I:**

**Plant tissue culture:** Objective and goals of Plant tissue culture; Laboratory design and development, operation and management

**Plant tissue Nutrition:** Basic principles of *in vitro* culture, Factors influencing morphogenesis and Physiological significance of tissue nutrition

**Media preparation:** Media preparation and handling, Sterilization technique, Equipment and apparatus, Procedure of media preparation and stock solution

**UNIT II:**

**Types of Cultures:** Explant culture, Callus formation and culture, Callus desiccation, Organogenesis, Meristem culture, Axillary bud culture, Protocols and schedule of observation.

**Organ culture:** anther, ovary culture, embryo rescue  
Hardening of tissue cultured plants

**UNIT III:**

Cell suspension culture: Batch culture, continuous culture (Open, Closed), semi culture, Growth measurements, Synchronization of suspension culture cells, Application.  
Cell line isolation

Somaclonal variation: Nomenclature; schemes for obtaining somaclonal variations- without invitro selection and with invitro selection; factors influencing somaclonal variation; Applications; Basis of somaclonal variations, Limitations; Gametoclonal variations.

**UNIT IV:**

Protoplast isolation, culture and somatic hybridization

Cell immobilization and synseed production

Cryopreservation: Introduction, principle, procedure, importance and future prospects

**Paper X CCPR 305.2.7: PLANT BIOTECHNOLOGY PAPER XI: PRACTICAL  
COURSE I**

**UNIT V:**

- ❖ Media preparation and Sterilization techniques
- ❖ Callus culture
- ❖ Meristem culture
- ❖ Organogenesis

**UNIT VI:**

- ❖ Technique of hardening
- ❖ Anther culture
- ❖ Cell suspension culture
- ❖ Embryo rescuing
- ❖ Visit to commercial greenhouse/ Tissue culture laboratory

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**Reference Books:**

- ❖ **Bhojwani, S. S. and Razdan, M. K.** 1983. Plant tissue culture, theory and practice. Elsevier Publ.
- ❖ **Dixon, R. A.** 1985. Plant cell culture- a practical approach. Oril Press Oxford.
- ❖ **Doddas, J. H. and Roverts, L.W.** 1985. Experiments in plant tissue culture. Cambridge Uni. press.
- ❖ **Evans *et al.*** 1983. Hand book of plant cell culture vol. I, II, III. McMillan Publ. Co., New York.
- ❖ **Gamborg, O. L. and Phillips, G. C.** 1966. Plant, tissue and organ culture- fundamental Methods. Narosa Publishing House, New Delhi.
- ❖ **Narayanswamy, S.** 1997. Plant cell and tissue culture. Tata McGraw Hill Publishers, New Delhi.
- ❖ **Nelson, P. V.** 1973. Greenhouse operation and management. Reston Publishing Co. Inc.
- ❖ **Old, R. W. and Primerose, S. B.** 2002. Principles of gene manipulation. Blackwell, Oxford, England.
- ❖ **Raghavan, V.** 1997. Molecular embryology of flower plants. Cambridge Uni. Press.
- ❖ **Ravishankar, G. A. and Venkataraman, L. V.** 1997. Biotechnological applications of plant tissue and cell culture. Oxford and IHB Publishing Co. Pvt. Ltd., New Delhi.
- ❖ **Reddy, S. M., Srivastava, H. P., Purohit, D. K. and Reddy, S. R.** 1997. Microbial biotechnology. Scientific Publishers, Jodhpur, India.
- ❖ **Reinsert, J. and Bajaj, Y. P. S.** 1976. Plant cell, tissue and organ culture. Springer Verlag, Berlin.
- ❖ **Street, H. E.** 1974. Tissue culture. Academic Press, New York.
- ❖ **Thorpe, T. A.** 1981. Plant tissue culture. Academic Press, New York
- ❖ **Vasil, I. K.** 1984. Cell culture and somatic cell genetics of plants (I). Laboratory procedures and their applications. Academic Press Inc.

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

Paper XI (CCS- 303.1): Plant Physiology

**(SPECIAL PAPER II) PLANT GROWTH AND DEVELOPMENT**

**Total Lectures: 60**

**UNIT I:**

**Growth and morphogenesis:** Photomorphogenesis; History and discovery of phytochromes and cryptochromes and their photochemical and biochemical properties. phytochrome biosynthesis, cellular localization, roles, mechanism of action of photo morphogenetic receptors.

**UNIT II:**

**Pollen germination:** Physiology of pollen germination and pollen-pistil interaction.

**Senescence and PCD:** Biochemical changes during senescence of leaves and petals. Regulation of senescence, Programmed Cell Death.

**Seed Development:** Biochemical changes during seed development.

**UNIT III:**

**Post harvest physiology:** Ripening of fruit and its regulation. Metabolism of leafy vegetables during storage.

Role of biotechnology and mutants in physiological studies.

**UNIT IV:**

**Plant growth regulators:** Discovery, role and possible mechanism of action of Triacontanol, Brassins, Salicylic acid, Jasmonates and Polyamines. Role of plant growth retardants- CCC, Maleic hydrazide, Trizoles and TIBA.

## **PAPER XI (CCPR 305.3.1): PLANT PHYSIOLOGY: PRACTICAL COURSE II**

### **UNIT V:**

- ❖ Hormonal regulation of leaf and petal senescence.
- ❖ Study of changes in RNA and Proteins during senescence.
- ❖ Study of changes in starch content during seed development.
- ❖ Study of changes in protein content during seed development.

### **UNIT VI:**

- ❖ Study of enzyme pectinase/pectin methyl esterase during ripening of fruit.
- ❖ Study of changes in respiration rate during ripening of fruits.
- ❖ Study of lipid accumulation during development of oil seeds.
- ❖ Effect of chemical compounds on pollen germination.
- ❖ Study of effect of different PGRs on seedling growth and vigour.

### **Reference Books:**

- ❖ **Bidwell, R. C. S.** (1979): Plant Physiology. Macmillan
- ❖ **Bonner, J. and Varner, J.E.** (1972): Plant Biochemistry. IBH.
- ❖ **Edwards G. and Walker D., eds.** (1983). C3, C4: mechanisms, and cellular and environmental regulation, of photosynthesis. Oxford: Blackwell Scientific Publications.
- ❖ **Govindjee, H.** (ed.) (1982): Photosynthesis, Vol. 1 and Vol. 2. Academic Press, N.Y. (Vol. 1); 0-12- 294302-2 (Vol. 2))
- ❖ **Hopkins, W. C.** (1995): Introduction to Plant Physiology. Wiley, New York.
- ❖ **Krishnamurthy, H.N.** (1992): Physiology of Plant Growth and Development. Atma Ram and Sons, Delhi.
- ❖ **Marschner, H. W.** (1986): Mineral nutrition of Higher Plants. First Edition, Academic Press, Elsevier Science Ltd.
- ❖ **Marschner, H. W.** (2003): Mineral nutrition of Higher Plants. Second Edition, Academic Press, Elsevier Science Ltd.
- ❖ **Moore, T.C.** (1974): Research experience in Plant Physiology, A Laboratory manual. Springer-Verlag, Berlin.
- ❖ **Mukherjee, S.P. and Ghosh A.N.** (1996): Plant Physiology. New Central Book Agency (P) Limited Tata McGraw Hill.
- ❖ **Noggle, G.R. and Fritz, G. J.** (1976): Introductory Plant Physiology. Prentice- Hall, Inc., Englewood Cliffs, NJ.
- ❖ **Pessarakli, M.** (Ed.). (2001). Handbook of Plant and Crop Physiology, 2nd Edition, Revised and Expanded. Marcel Dekker, Inc., New York
- ❖ **Pessarakli, M.** (Ed.). (2005). Handbook of Photosynthesis, 2nd Edition, CRC Press, Taylor & Francis Publishing Company, Florida
- ❖ **Randhir Singh and Sawhney S. K.** (1988): Advances in frontier Areas of Plant Biochemistry. Prentice Hall of India

- ❖ **Sadasivam S.** and **Manickam A.** (1996): Biochemical methods. New Age International.
- ❖ **Salisbury, F. B.** and **Ross, C.W.**(1992): Plant Physiology IV ed. Cengage Learning
- ❖ **Smith, H.** (1975): Phytochrome and Photomorphogenesis. McGraw-Hill Inc.,US
- ❖ **Taiz, L.** and **Zeiger, F.** (1998): The Plant Physiology. Second Edition, Sunderland: Sinauer Associates.
- ❖ **Wilkins, M. B.** (1976): Physiology of Plant Growth and Development. McGraw-Hill Publishing Company Limited

### **Journals**

- ❖ Annual Review of Plant Physiology and Molecular Biology
  - ❖ Annual Review of Plant Physiology
  - ❖ Indian Journal of Plant Physiology
  - ❖ Journal of Experimental Botany
  - ❖ Physiologia Plantarum, Sweden
  - ❖ Plant Physiology, Bethesda, USA
  - ❖ Plant Cell
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**M. Sc. PART-II (SEMESTER III)**

**Paper XI (CCS- 303.2) MYCOLOGY AND PLANT PATHOLOGY**

**(SPECIAL PAPER II) INTEGRATED DISEASE MANAGEMENT**

**Total Lectures: 60**

**UNIT I:**

**Principles of plant pathology:** History, Classification of crop diseases. Deficiency of micronutrients.

**Seed pathology:** Methods of detection of internal and external seed borne Fungi, Bacteria and Viruses, biodeterioration and mycotoxins.

**UNIT II:**

Role of enzymes and toxins in disease development. Cell wall degrading enzymes: Cellulolytic,

Pectolytic, Proteolytic and Lipolytic. Toxins: lycomarsmine, alternic acid, Fusaric acid, Piricularin, Victorin and aflatoxins.

**UNIT III:**

Physiology and Biochemistry of host pathogen interaction: Respiration, Photosynthesis, Proteins, Nucleic acids, phenols- phytoalexins and plant growth regulators.

**UNIT IV:**

Genetics of host pathogen interaction, gene for gene hypothesis, protein for protein hypothesis, antigen and antibody reaction. Immunoglobulins, application of immunological techniques, physiological specializations.

## **Paper XI (CCPR 305.3.2): MYCOLOGY AND PLANT PATHOLOGY: PRACTICAL COURSE II**

### **UNIT V:**

- ❖ Estimation of fungal enzyme (Cellulases, Amylases and Pectinases).
- ❖ Estimation of nucleic acids from healthy and infected plants.
- ❖ Use of biocontrol agents (*Trichoderma* spp.) against plant pathogens.
- ❖ Extraction and detection of aflatoxins from infected seeds.

### **UNIT VI:**

- ❖ Estimation of protein from healthy and infected plants.
- ❖ Study of external and internal seed mycoflora.
- ❖ Immunological techniques-purification and fragmentation of immunoglobulins.
- ❖ Symptomology and histo-pathology of diseases mentioned in the theory.

### **Reference Books:**

- ❖ **Agrios, G. N.** (2006). Plant Pathology (5<sup>th</sup> Edition). Academy Press, London.
- ❖ **Aneja, K. R.** (1993). Experiments in Microbiology, Plant Pathology and Tissue Culture. New Age international.
- ❖ **Cooke, A. A.** (1981). Diseases of Tropical and Subtropical Field, fiber and Oilplants.
- ❖ **Gangopadhyay, S.** (1994). Clinical Plant Pathology. Kalyani Publishers, Daryaganj, New Delhi.
- ❖ **Gangulee, H. S. and Kar, A. K.** (1992). College Botany Vol. II. New Central Book Agency (P) Ltd., Kolkata. W. B.
- ❖ **Jha, D. K.** (1993). A text book on Seed Pathology. Vikas Publishing House Pvt. Ltd., 576 Masjid Road, jangpura, New Delhi-110014.
- ❖ **Kuljit, J.** (1969). The Biology of parasitic flowering plants. Uni. Of California Press, U. S. A.
- ❖ **Mahadevan, A. and Shridhar, R.** (1982). Methods in Physiological Plant. PHI Learning Pvt. Ltd., M97 Cannaught Circle, New Delhi.
- ❖ **Mehrotra, R. S.** (1980). Plant Pathology. Tata McGraw-Hill Publishing Company Ltd., New Delhi.
- ❖ **Nair, L. N.** (2007). Topics in Mycology and Plant Pathology. New Central Book Agency (P) Ltd., Kolkata. W. B.
- ❖ **Neergard, P.** (1977). Seed Pathology. Vol. I & II, Macmillan Press, London.
- ❖ **Nyvall, R. F.** (1979). Field Crop Diseases Handbook.
- ❖ **Padoley, S. K. and Mistry, P. B.** A manual of plant Pathology.
- ❖ **Paul Khurana, S. M.** (1998). Pathological problems of Economic Crop Plants and their Management.
- ❖ **Plank, J. E. Vander** (1968). Plant Diseases, Epidemics and Control. Academy Press, London.
- ❖ **Plank, J. E. Vander** (1968). Disease Resistance in Plants. A. P. London and New York.
- ❖ **Rangaswamy, G.** (1975): Diseases of crop plants in India. Diseases of crop Plants in India. PHI Learning Pvt. Ltd., M97 Cannaught Circle, New Delhi.
- ❖ **Singh, R. S.** (1963): Plant Diseases. Oxford and IBH Publishing

**M. Sc. PART- II (SEMESTER III)**  
**Paper- XI (CCS- 303.3): Cytogenetics and Plant Breeding**  
**(SPECIAL PAPER II) PLANT BREEDING**

**Total Lectures: 60**

**UNIT I:**

Objectives of Plant Breeding, Domestication, Selection under domestication; Introduction, Quarantine; and Acclimatization of plants, Germplasm: Gene pool concept, Genetic erosion, Exploration and collection of germplasm, conservation and utilization, Mechanism of pollination control: self-incompatibility and male sterility, Concept of plant ideotype and its role in crop improvement.

**UNIT II:**

Inheritance of qualitative and quantitative characters, Biometrical techniques in plant breeding: Introduction, Assessment of variability, Components of variance, Genetic diversity, QTL and linkage maps. Heritability, estimation of variance components additive and dominance variances, combining ability GSC, SCA effects.

**UNIT III:**

Aids to Selection: Correlation coefficient analysis, Path analysis and Discriminant functions. Choice of parents and breeding procedures: Diallele, Partial diallele, Triallele, Line tester, Generation mean analysis, Biparental cross analysis with various designs and Varietal adaptation Cultivar development: testing, release and notification maintenance. Plant breeders' right and regulations for plant variety protection and farmers right, DUS testing

**UNIT IV:**

Breeding for biotic and abiotic stresses: Disease and Insect resistance; Drought, Salinity, Heat and cold resistance. Mutation breeding  
Variety development and seed production

## **PAPER XII (CCPR 305.3.3) CYTOGENETICS AND PLANT BREEDING: PRACTICAL COURSE II**

### **UNIT V**

- ❖ Germplasm collection, cataloguing, data storage and retrieval
- ❖ To study crossability between cultivars
- ❖ Study of pollen germination and demonstration of incompatibility.
- ❖ Study of cytoplasm male sterility
- ❖ Designing field experiments
- ❖ Floral biology of self pollinated and cross pollinated species
- ❖ Genome analysis in wheat/*Gossypium*.

### **UNIT VI**

- ❖ Metroglif analysis
- ❖  $D^2$  analysis
- ❖ Estimation of heritability
- ❖ Screening of germplasm for biotic and Abiotic stresses
- ❖ 5. To study the effect of mutagen on germination, seedling growth and on mitosis
- ❖ 6. Field and lab visits of self and cross pollinated plants
- ❖ 7. Induction of polyploidy using Colchicine.

### **Reference Books:**

- ❖ **Singh, B. D.** 2000. Plant breeding- Principles and methods. Kalyani Publishers, Ludhiana.
- ❖ **Sharma, J. R.** 1994. Principles and practice of plant breeding. Tata McGraw Hill Publ. Co. Ltd., New Delhi.
- ❖ **Siddiqui B. A. and Khna S.** 1999. Breeding in crop plants. Mutation and In vitro mutation breeding . Kalyani Publishers New Delhi
- ❖ **IAEA 1995.** Induced mutations and Molecular techniques for crop improvement. Proc FAO/IAEA Symposium Vienna
- ❖ **IAEA 1991.** Plant Mutation Breeding crop improvement Proc. FAO/IAEA Symposium (Vol 1&2)Vienna
- ❖ **Micke A.** 1991. Induced Mutation for crop improvement. Gamma Field Symposia No.30 Institute of Radiation Breeding Pullman USA.
- ❖ **Allard R. W.** 1960. Principles of Plant Breeding John Wiley and Sons, New York.
- ❖ **Hays H. K., Immer F.R. and Smith D.C.** 1955. Methods of Plant Breeding. McGraw Hill Book Company Inc New York.
- ❖ **Fehr W. R.** 1987. Principles of Cultivar Development (2 Volumes) MacMillan Publishing Co. New York.
- ❖ **Poehlman J.M.** 1986. Breeding Field Crops AVI Publishing Company Connecticut. NEW YORK
- ❖ **Sharma J. R.** 1998. Statistical and Biometrical techniques in Plant Breeding New Age International Publishers New Delhi.
- ❖ **Singh R. K. and Singh B. D.** 1997. Biometrical Methods in Quantitative genetic Analysis. Kalyani Publishers, New Delhi.
- ❖ **Vijendra Das L. D.** 2000. Problems Facing Plant Breeding CBS Publishers New Delhi

- ❖ **Rosielle A. A. and Hamblin J.** 1981 Theoretical aspects of selection for yield in stress and non- stress environments Crop Sci, 21: 932-946.
- ❖ **Levitt J.** 1980. Response of Plants to Environmental Stress: Water, Salt and Other stresses. Academic Press, New York.
- ❖ **Bulm A.** 1988. Plant Breeding for stress Environments. CRC Press Florida.
- ❖ **Chopra V. L.** 1989. Plant Breeding .oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- ❖ **Roy Darbeshwar** 2000, Plant breeding analysis and exploitation of variance. Narosa Publishers New Delhi.

**Journals:**

- ❖ Indian Journal of Genetics and Plant Breeding.
- ❖ Journal of Genetics
- ❖ Caryologia
- ❖ Journal of Cytology and Genetics
- ❖ International Journal of Food Science and Technology
- ❖ Cytologia
- ❖ International Journal of Plant Breeding

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## M.Sc. PART- II (SEMESTER III)

### PAPER XI (CCS- 303.4): ENERGY, ECOLOGY AND ENVIRONMENT

#### (SPECIAL PAPER II) POPULATION AND COMMUNITY ECOLOGY

TOTAL LECTURES: 60

##### UNIT I:

- ❖ **Population Ecology:** Population growth and regulation, Density dependent and Independent regulation: Role of different factors
- ❖ **Genecology:** Ecads, Ecotypes, Characteristics of Ecotype, Origin of new ecotype and significance, concept of niche.

##### UNIT II:

- ❖ **Community Ecology:** Methods of Community studies.
- ❖ **Units of vegetation:** Classification of communities, Physiognomic classification, Phytosociological classification.
- ❖ **Clementsian unit of vegetation:** Plant formation, Associations, Faciation, Lociation, Consociation, Society, Aspects of society, Main concepts.
- ❖ **Community Nature:** Individualistic and organismic nature of communities, community stratification.

##### UNIT III:

- ❖ **Functional Aspects of Community:** Community Periodism, Photoperiodism, Community Metabolism
- ❖ **Community Sability:** Maturation of Communities, Climax community, Regulation of communities.
- ❖ **Community Stability:** Edges and Ecotone Community as Indicator

##### UNIT IV:

- ❖ **Forest Ecology:** Scope and relevance, Forest types of India, Structure of forest ecosystem. Accumulation and decomposition of forest litter, Forest humus, the geochemical, biogeochemical cycling of nutrients.
- ❖ **Statistical thinking in Ecology:** Ecosystems and scale, theory, knowledge and research design, Ecological study unit, Experimental versus observation methods in ecology, hypothesis testing, formulating right problem, Publish or Perish.

**PAPER XI (CCPR 305.3.4): POPULATION AND COMMUNITY ECOLOGY:  
PRACTICAL COURSE II**

**UNIT V:**

- ❖ Study of litter production.
- ❖ Determination of similarity index and association index.
- ❖ Study of stratification and physiognomy.
- ❖ 4-5. Determination of IVI.
- ❖ Study of population growth curve.

**UNIT VI:**

- ❖ Study of vegetation by transects method.
- ❖ Measurement of biomass production.
- ❖ Biomass profile of the plant community.
- ❖ Comparison of plant communities from polluted and non-polluted areas.
- ❖ Statistical analysis of ecological data
- ❖ Study of population dynamics
- ❖ Visit to local protected or conserved area.

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**Reference Books:**

- ❖ **Abe, T., Levin, S. A. and Higashi, M.** (1997) (ed.): Biodiversity an Ecological Perspective. Springer Verlag.
- ❖ **Bradbury I.K.** 1990): The Biosphere.
- ❖ **Brij Gopal and Bhardwaj, N.** (1979): Elements of Ecology. Sahibabad: Vikas Publishing House PVT. Ltd.
- ❖ **Galston, K. J.** (1996): Biodiversity: A biology of numbers and differences. Kluwer Academic Publishers, Dordrecht, the Netherlands.
- ❖ **Greig Smith P.** (1983): Quantitative Plant Ecology. *Publisher: WILEYBLACKWELL*
- ❖ **Hamson, H. C. and Churchill, E. D.** (1961): The Plant Community. Reinhold publishing corporation, New York.
- ❖ **Hashimoto Y et al** (1990) : Measurement techniques in plant sciences. San Diego, Calif. : Academic Press.
- ❖ **Kormondy E. J.** (1996) (4th ed.): Concept of ecology. Publisher: Benjamin Cummings.
- ❖ **Krattiger, A. I. et al** (1994): Widening Perspectives on Biodiversity. Kluwer Academic Publishers.
- ❖ **Krebs C. J.** (1978) : Ecology. Harper & Row., New York.
- ❖ **Misra K. C.** (1989) : Manual of plant ecology. Oxford and IBH Publishing Co., New Delhi.
- ❖ **Nair, P. K. G.** (1990): Principles of Environmental Biology. Himalaya Publishing House (Bombay).
- ❖ **Odum E. P.** (3rd ed. 1996) : Fundamentals of Ecology. Natraj Publishers, Dehra Dun.
- ❖ **Pandeya S. C., Puri, G. S. and Singh, J. S.** (1968) : Research methods in plant ecology. Asia Publishing House.
- ❖ **Shukla, R. S. and Chandel, P. S.** (1983): Plant Ecology. Oxford and IBH, publishers, New Delhi, India.
- ❖ **Walter, H.** (1979); Vegetation of the Earth and Ecological Systems of Geobiosphere. Springer, New York.
- ❖ **Weaver, J. E. and Clements, F. S.** (1938): Plant Ecology. Springer, New York.
- ❖ **Willis, A. J.** (1973): Introduction to Plant Ecology. *Willis A J. Publisher.*
- ❖ **Yadav, P. S. and Singh, J. S.** (1997): Progress in Ecology vol. II. Today & Tomorrow's Printers & Publishers, New Delhi.

## M. Sc. PART-II (SEMESTER III)

Paper XI (CCS- 303.5): Angiosperm Taxonomy

### (SPECIAL PAPER II) MODERN TRENDS IN ANGIOSPERM TAXONOMY

Total Lectures: 60

#### UNIT I:

- ❖ **Embryology in relation to taxonomy:** Embryological characters of taxonomic importance, utilisation of embryological data in solving taxonomic problems at different levels.
- ❖ **Anatomy in relation to taxonomy:** Vegetative, wood and floral anatomy, anatomical characters of taxonomic importance, use of anatomical data in understanding interrelationship and evolution of angiosperms and solving taxonomic problems.
- Palynotaxonomy:** Pollen morphology-Polarity, symmetry, NPC of pollen, exine stratification, excrescences, L/O pattern, palynogram; pollen characters of taxonomic importance

#### UNIT: II

- ❖ **Cytotaxonomy:** Chromosome number, Basic chromosome number, polyploidy, aneuploidy, chromosome morphology, karyotype, chromosome banding, meiotic analysis and plant systematics, scope and limitations.
- ❖ **Chemotaxonomy:** Origin of chemotaxonomy, classes of compounds and their biological significance, Stages in chemotaxonomic investigations, techniques, Use of chemical criteria in plant taxonomy; Proteins and taxonomy: seed proteins, techniques of protein electrophoresis, protein analysis procedures, analysis of amino acid sequence and its significance in systematics; serology and taxonomy: history, precipitation reaction, techniques, antigen, antisera, antibody, application of serological data in systematics.

#### UNIT: III

- ❖ **Ultrastructural systematics:** SEM and TEM studies and plant systematics; SEM and plant surface structure, TEM and dilated cisternae of endoplasmic reticulum and sieve element plastids, applications of data in the classification of higher taxa.
- ❖ **Molecular Systematics:** Molecular diagnostic tools, Restriction Fragment Length Polymorphism (RFLPs), Random Amplified Polymorphic DNA (RAPD), Polymerase Chain Reaction (PCR) analysis, specific applications of RAPD, AFLP in molecular systematics. Molecular data and systematic position of Hydatellaceae.
- ❖ **Plant geography, ecology and systematics:** Patterns of geographic distribution, Disjunction and Vicariance, Vicariance biogeography, Endemism, Centres of diversity, Ecological differentiation, Alien plants, Phenotypic plasticity

#### UNIT: IV

- ❖ **Morphological variations, systematic position, interrelationships, phylogeny and economic importance of following families:** EUDICOTS: Menispermaceae, Ranunculaceae, Nelumbonaceae; CORE EUDICOTS: Nyctaginaceae, Portulacaceae, Polygonaceae, Loranthaceae, Santalaceae. ROSIDS: Vitaceae, Zygophyllaceae, Oxalidaceae, Euphorbiaceae, Rhizophoraceae, Passifloraceae, Polygalaceae.



## **PAPER XI (CCPR 305.3.5): ANGIOSPERM TAXONOMY: PRACTICAL COURSE II**

### **UNIT V:**

1. Microtome technique for study of embryological characters
2. Study of wood characters: vessels, storied and nonstoried wood
3. Semipermanent pollen preparations by acetolysis and study of different pollen morphotypes.
4. Study of chromosomes and Karyotype analysis.
- 5-6. Interpretation of flavonoids/alkaloids data for taxonomy using chromatography.

### **UNIT VI:**

1. Exercise on Numerical taxonomy
2. Study of plant surface attributes with the help of SEM photographs and sieve tube plastid and dilated cisternae of endoplasmic reticulum with the help of TEM photographs
- 3-6. Descriptions, Sketching, classification and identification of families:  
EUDICOTS: Menispermaceae, Ranunculaceae, Nelumbonaceae;  
CORE EUDICOTS: Nyctaginaceae, Portulacaceae, Polygonaceae, Loranthaceae, Santalaceae;  
ROSIDS: Vitaceae, Zygophyllaceae, Oxalidaceae, Euphorbiaceae, Rhizophoraceae, Passifloraceae, Polygalaceae. Any additional practical/s based on theory syllabus will be added whenever necessary. (At least two local tours should be arranged to study vegetation, ecology and flowering of the region in first term. Student is supposed to submit herbarium specimens (50) and plant materials in the form of slides (5) and preserved specimens.)

### **Reference Books:**

- ❖ **Bhojwani, S. S. and Bhatnagar, S. P. 1984.** Embryology of Angiosperms. Vikas Publ. House, New Dehli.
- ❖ **Cronquist, A. 1988.** The Evolution and Classification of Flowering Plants (2nd ed.) Allen Press, U.S.A.
- ❖ **Cronquist, A. 1981.** An Integrated System of Classification of Flowering Plants. Columbia University Press, New York.
- ❖ **Davis, P. H. and V. H. Heywood 1991.** Principles of Angiosperm Taxonomy. Today and Tommorrow Publications, New Delhi.
- ❖ **Erdtman, G. 1952.** Pollen Morphology and Plant Taxonomy. Angiosperms. Almquist and Wiksell. Stockholm.
- ❖ **Fahn, A. 1979.** Plant Anatomy, Pergamon Press, London.
- ❖ **Erdtman, G. 1952.** Pollen Morphology and Plant Taxonomy. Angiosperms. Hafner Publ. Co. New York.
- ❖ **Johri, B. M. 1984.** Comparative embryology of Angiosperms. Ind. Nat. Sc. Acad. New Delhi.
- ❖ **Maheshwari, P. 1985.** An Introduction to Embryology of Angiosperms. Tata McGraw Hill, New Delhi.

- ❖ **Manilal, K. S. and M. S. Muktesh Kumar [ed.] 1998.** A Handbook of Taxonomic Training. DST, New Delhi.
- ❖ **Naik, V. N. 1984.** Taxonomy of Angiosperms Tata McGraw-Hill, New Delhi.
- ❖ **Nair, P. K. K. 1966.** Pollen morphology of Angiosperms. Periodical Expert Book Agency, New Delhi.
- ❖ **Quicke, Donald, L. J. 1993.** Principles and Techniques of Contemporary Taxonomy. Blakie Academic & Professional, London.
- ❖ **Taylor, D. V. and L. J. Hickey 1997.** Flowering Plants: Origin, Evolution and Phylogeny. CBS Publishers & Distributors, New Delhi.
- ❖ **Lawrence, G. H. M. 1951.** Taxonomy of Vascular Plants. Oxford and IBH Publ. Co. Pvt. Ltd. New Delhi .
- ❖ **Paech, K. and M. V. Tracey. 1956.** Modern Methods of Plant Analysis. Vol-I & II. Springer-Verlag.
- ❖ **Shivanna, K. R. and N. S. Rangaswamy. 1992.** Pollen Biology- A Laboratory Manual. Springer-Verla
- ❖ **Sharma A. K. and A. Sharma. 1980.** Chromosome Technique: Theory and Practices (3rd ed.) Butterworths, London.
- ❖ **Judd Walter S., Campbell, C. S., Kellogg, E. A., Stevens, P.F. and M. J. Donoghue 2008.** Plant Systematics-A Phylogenetic Approach Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.
- ❖ **Simpson, M. G. 2010.** Plant Systematics. Elsevier, Amsterdam.
- ❖ **Stace, C. A. 1989.** Plant Taxonomy and Biosystematics. Edward Arnold, London.

**M. Sc. PART-II (SEMESTER III)**  
**Paper XI (CCS- 303.6): Marine Botany**  
**(SPECIAL PAPER II) PHYSIOLOGY AND BIOCHEMISTRY OF**  
**MARINE PLANTS**

**Total Lectures: 60**

**UNIT I:**

- ❖ **Photosynthesis in Marine Algae:** Overview, light harvesting, Photosynthetic pigments (chlorophylls, phycobiliproteins, carotenoids), effect of low light condition. Photosynthetic carbon fixation- Dark Reactions, Inorganic carbon sources and uptake, Photosynthetic pathways in seaweeds, Light independent carbon fixation, C<sub>3</sub> versus C<sub>4</sub> characteristics of seaweeds. Carbon metabolism and calcification
- ❖ **Storage and Structural Components in Algae:** Seaweed polysaccharides; Alginates, Agars, Carrageenans, Fucoidan, Laminaran, Xylans, Mannans, Algal Starches, Polysaccharide synthesis, Low Molecular Weight compounds in algae-Fatty acids, Lipids, Steroids, Triterpenoids etc.

**UNIT II:**

- ❖ **Salt Regulation in Halophytes:** Salt regulation strategies, salt secretion through glands, Ultrastructure of salt glands, Salt glands in mangroves, Mechanism of salt secretion, Salt retransportation, Salt bladders, Leaf succulence, Selective ion absorption.
- ❖ **Salinity and Metabolism:** Water relations, osmoregulation and photosynthesis in mangroves. Significance of vivipary in mangroves. Salinity and Water relations in seagrass communities. Salinity, salt regulation and photosynthesis in salt marshes.

**UNIT III:**

- ❖ **Bioactive Compounds in Mangroves:** Chemical classes- Heterocyclic compounds, alkaloids, lignins & polysaccharides, lipids, flavonoids, phenolics, tannins, saponins, limonoids etc. Traditional Products, Toxicants & medicines from mangroves.
- ❖ **Mangrove Research and Activities:** Contributions of Indian and Global Institutions- UNESCO, UNDP, ITTO, ISME, NIO, MSSRF, GEER, ENVIS and SUK.

**UNIT IV:**

- ❖ **Mineral Nutrition in Algae:** Nutrient requirement, Essential elements, vitamins for growth of algae. Availability in sea water, Uptake, Factors affecting, Metabolic role of major elements and trace elements.
- ❖ **Algal Research:** Contributions of major Research Institutes- CSMCRI (Bhavnagar), Krishnamoorthy Institute of Algology (Mandapam, Chennai), NIO (Goa), Department of Botany (SUK).
- ❖ **Algal Biotechnology:** Present status & future prospects.

## **PAPER XI CCPR 305.3.6: MARINE BOTANY: PRACTICAL COURSE II**

### **UNIT V:**

- ❖ Estimation of pigments from marine algae-I: Chlorophylls a, b, c and d.
- ❖ Estimation of pigments from marine algae-II: Carotenoids and Phycobilins.
- ❖ Isolation of agar agar from seaweeds.
- ❖ Extraction of alginic acid from seaweeds.
- ❖ Estimation of total carbohydrates from marine algae.

### **UNIT VI:**

- ❖ Phytochemical analysis of seaweeds through qualitative tests.
- ❖ Detection of phenols as bioactive compound in mangroves.
- ❖ Determination of alkaloids from mangroves.
- ❖ Estimation of total lipids from seaweeds.
- ❖ Estimation of tannins from mangroves (bark, stems and leaves).
- ❖ Detection of bioactive compounds from mangroves using, phytochemical tests

### **Reference Books:**

- ❖ **Chapman, V. J.** (1976): Costal Vegetation. IInd edition Pergamon Press.  
New York.
- ❖ **Ring, M.** (1982): The Biology of Marine Plants. Edward Arnold Publishers, London.
- ❖ **Gerald, E.** Ecophysiology of Economic Plants in Arid and Semiarid Land.
- ❖ **Jackson, D. F.** (1972): Algae and Man. Plenum Press.
- ❖ **Lobban, C. S. & Harrison, P. J.** (1985): Seaweed Ecology and Physiology.  
Cambridge University Press.
- ❖ **Lobban, C. S. And Wynne, M. J.** 1981. The Biology of Seaweeds. Botanical  
Monographs Volume 17. Blackwell Scientific Publications.
- ❖ **Sambamurthy, A. V. S. S.** (2005): A Text Book of Algae. 1<sup>st</sup>. Ed.I. K. International  
Pvt. Ltd. New Delhi.
- ❖ **Stein, J. R.** (1973): Handbook of Phycological & Biochemistry.
- ❖ **Stewart, W. D.** (1974): Algal Physiology & Biochemistry.
- ❖ **Tasks for Vegetation Science.** 1983. Physiology and Management of Mangroves.  
Vol. 8, Dr. W. Junk Publishers.
- ❖ **Waisel, Y.** (1972): Biology of Halophytes Academic Press, London and New York.

**M. Sc. PART-II (SEMESTER III)**  
(CCS- 303.7): Plant Biotechnology  
**(SPECIAL PAPER II) MOLECULAR BIOTECHNOLOGY AND GENETIC  
ENGINEERING**

**Total Lectures: 60**

**UNIT I:**

- ❖ Fundamentals of molecular biotechnology
- ❖ Vectors in gene cloning and their selection
- ❖ Molecular research procedure; Gene amplification, basic PCR, its modification, application, DNA polymorphism

**UNIT II:**

- ❖ Use of various enzymes in recombinant DNA technology Recombinant DNA and gene cloning, Techniques of restriction mapping, construction of chimeric DNA, cloning in bacteria and eukaryotes, molecular probes, southern northern and western blotting, dot and slot blots, constriction and screening of genomic and cDNA libraries, chromosome walking and chromosome jumping libraries

**UNIT III:**

- ❖ Isolation, sequencing and synthesis of genes: Isolation of genes, DNA sequencing, synthesis, gene synthesis machines plant genetic engineering: gene transfer technique

**UNIT IV:**

- ❖ **Genomics:** Human genome project, Nucleotide sequence databases
- ❖ **Proteomics:** Protein sequence information, composition and properties, Sequence comparison and protein databases
- ❖ **Enzymology:** IUB system, characteristics of enzyme and enzyme- substrate complex, Effect of temperature, pH, and substrate concentration on reaction rate
- ❖ **Immunology:** Immune system, Antibodies, Molecular biology of antibodies, Interferons and Vaccines

## **CCPR 305.3.7: PLANT BIOTECHNOLOGY PAPER XII: PRACTICAL COURSE II**

### **UNIT V:**

- ❖ Estimation and comparison of genomic DNA by UV-vis spectrophotometry
- ❖ DNA purification by gel electrophoresis
- ❖ Isolation of proteins
- ❖ Two- dimensional (2-D) paper chromatography of amino acids

### **UNIT VI:**

- ❖ Genetic transformation: GUS
- ❖ Isolation of protoplast
- ❖ Restriction digestion of DNA
- ❖ Determination of optimum temperature for enzyme activity

### **Reference Books:**

- ❖ **Chavala, H. S.** 1998. Biotechnology in crop improvement. International Book Distributing Co. New Delhi.
- ❖ **Glick, B. R. and Pasternak, J. J.** 1994. Molecular Biotechnology- Principles and applications of recombinant DNA. ASM Press, Washington.
- ❖ **Gupta, P. K.** 2000. Elements of Biotechnology. Rastogi Publisher, Meerut, India.
- ❖ **Jogdand, S. N.** 1997. Gene Biotechnology, Himalaya Publishing House, Mumbai, India.
- ❖ **Joshi, P.** 1998. Genetic Engineering and its applications. Agrobotanica.
- ❖ **Kakralya, B. and Ahuja, I.** 2001. Transgenic Plants-Promise or Danger. Agrobios, India.
- ❖ **Mitra, S.** 1996. Genetic Engineering- principles and practice. Mcmilan, India ltd.

**M. Sc. PART- II (SEMESTER III)**  
**(DSE- 304) Biotechnology and Genetic Engineering**

**Total Lectures: 60**

**UNIT I:**

- ❖ Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors. *In vitro* mutagenesis and deletion techniques, gene knock-out in bacterial and eukaryotic organisms, RNA interference and CRISPER cas9.
- ❖ Process and Techniques in plant transformation, Binary vectors for plant transformation

**UNIT II:**

- ❖ DNA sequencing methods, strategies for genome sequencing.
- ❖ Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques.
- ❖ Isolation, separation and analysis of carbohydrate and lipid molecules.
- ❖ RFLP, RAPD, SSR and AFLP techniques.

**UNIT III:**

- ❖ Concept, principle and applications of recombinant DNA technology
- ❖ Enzymes used in recombinant DNA technology, Restriction mapping, Cloning vectors, Construction of chimeric DNA
- ❖ Strategies for engineering resistant plants for biotic and abiotic stresses.
- ❖ Transgenic crops for nutritional quality improvement.

**UNIT IV:**

- ❖ Screening of transgenics using blotting techniques- Southern, Northern and Western.
- ❖ Genomics: *Arabidopsis* genome, Comparative genomics, Functional genomics
- ❖ Proteomics: Rationale, basic assumptions, methods for protein engineering
- ❖ Intellectual property rights (IPR) and protection (IPP): Concept, importance, ecological risks, ethical concerns and economic concerns.

**Paper XII (CCPR 305.4.7): BIOTECHNOLOGY AND GENETIC ENGINEERING:  
PRACTICAL COURSE- II**

**UNIT V:**

- ❖ Preparation of MS medium for Plant tissue culture and sterilisation techniques.
- ❖ Callus culture
- ❖ Micro propagation
- ❖ *Agrobacterium* mediated transformation (Hairy roots/ tumor formation)
- ❖ Isolation and culture of soil/ root nodule bacteria

**UNIT VI:**

- ❖ Isolation of genomic DNA.
- ❖ Agarose gel electrophoresis.
- ❖ Cell line isolation for secondary metabolites.
- ❖ Nucleotide sequence and BLAST.
- ❖ Patent filing pre-requisites

**Reference Books:**

- ❖ **Gupta, P. K.** 2010. Plant Biotechnology. Rastogi Publications, Meerut.
- ❖ **Glick, B. R. and Pasternak, J. J.** 1994. Molecular Biotechnology- Principles and Applications of Recombinant DNA. ASM Press, Washington D. C.
- ❖ **Gupta, P. K.** 2009. Biotechnology and Genomics. Rastogi Publications, Meerut.
- ❖ **Trehan, K.** 1994. Biotechnology. Wiley Eastern Limited, New Delhi.
- ❖ **Ramawat, K. G.** 2006. Plant Biotechnology. S. Chand and Company Ltd., New Delhi.
- ❖ **Trivedi, P. C.** (ed.) 2000. Plant Biotechnology- Recent Advances. Panima Publishing Corporation, New Delhi.
- ❖ **Chawla, H. S.** 1998. Biotechnology in Crop Improvement. International Book Distributing Company, Lucknow.
- ❖ **Aneja, K. P.** 1996. Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation. Weshwa Prakashan, New Delhi.
- ❖ **Sullia, S. B. and Shantharam, S.** 2005. General Microbiology. Oxford & IBH Publ. Ltd., New Delhi.
- ❖ **Tauro, P.; Kapoor, K. K. and Yadav, K. S.** 1996. An Introduction to Microbiology. Wiley Eastern Limited, New Delhi.
- ❖ **Razdan, M. K.** 1994: An Introduction to plant tissue culture. Oxford & IBH Publ. Ltd., New Delhi.
- ❖ **Kumar, H. D.** 1993. Molecular Biology and Biotechnology, Vikas Publ., New Delhi.
- ❖ **Gamborg, O. L., Phillips, G. C.** 1995. Plant Cell, Tissue and Organ Culture- Fundamental Methods. Narosa Publ. House, New Delhi.
- ❖ **Reinhert, J. and Bajaj, Y. P. S.** 1977. Applied and fundamental aspects of plant cell, tissue and organ culture, Springer Verlag, Berlin.
- ❖ **Dodds, J. H. and Roberts, L. W.** 1985. Experiments in plant tissue culture. Cambridge University Press, Cambridge.
- ❖ **Boyce, C.O.L.** 1986. Novo's Handbook of Practical Biotechnology. Novo Industry.



**M.Sc. II PART-II (SEMESTER IV)**  
**(CC401): Plant Physiology and metabolism**

**Total Lectures: 60**

**UNIT I:**

- ❖ Active and passive mechanisms of solute transport, Mechanisms of phloem loading and unloading of photoassimilates, source-sink relationship and its applications.

**UNIT II:**

- ❖ **Photosynthesis:** Photo oxidation of water and  $C_3$  pathway, RUBISCO, Sub classification of  $C_4$  plants, PEPcase, ecological significance and modification of CAM.
- ❖ **Respiration:** Overview of plant respiration, Anaerobic respiration, Modern concept of electron transport and ATP synthesis. Inhibitors of respiration. Gluconeogenesis.

**UNIT III:**

- ❖ **Nitrogen metabolism:** Nitrate and ammonium assimilation; amino acid biosynthesis.
- ❖ **Secondary metabolites** - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.

**UNIT IV:**

- ❖ **Plant hormones** – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action of auxins, cytokinins, gibberellins and Absciscic acid.
- ❖ **Stress physiology** – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

## **Paper XIII CCPR 405: PLANT PHYSIOLOGY AND METABOLISM**

### **PRACTICAL COURSE**

#### **UNIT IV:**

- ❖ Determination of lipid peroxidation in plants under stress.
- ❖ Determination of rate of respiration in germinating seeds under aerobic and anaerobic conditions.
- ❖ Estimation of free amino acid.
- ❖ Study of enzyme Nitrate reductase.
- ❖ Effect of PGR's on seed germination and seedling growth.

#### **UNIT V:**

- ❖ Estimation of enzyme Phenyl Alanine Ammonia Lyase.
- ❖ Separation of secondary metabolites using TLC.
- ❖ Measurement of RWC in plants under stress.
- ❖ Estimation of proline from stress and non-stress plants.

#### **REFERENCE BOOKS**

- ❖ **Bidwell, R. C. S.** (1979): Plant Physiology. Macmillan
- ❖ **Bonner, J.** and Varner, J.E. (1972): Plant Biochemistry. IBH.
- ❖ **Buchnan, B.B., Gruissem, W. And Jones, R.L. (2000)** Biochemistry and Molecular Biology of Plants. Wiley-Blackwell
- ❖ **Edwards G.** and Walker D., eds. (1983). C3, C4: mechanisms, and cellular and environmental regulation, of photosynthesis. Oxford: Blackwell Scientific Publications.
- ❖ **Govindjee, H.** (ed.) (1982): Photosynthesis, Vol. 1 and Vol. 2. Academic Press, N.Y. (Vol. 1); 0-12- 294302-2 (Vol. 2))
- ❖ **Hopkins, W. C.** (1995): Introduction to Plant Physiology. Wiley, New York.
- ❖ **Krishnamurthy, H.N.** (1992): Physiology of Plant Growth and Development. Atma Ram and Sons, Delhi.
- ❖ **Marschner, H. W.** (1986): Mineral nutrition of Higher Plants. First Edition, Academic Press, Elsevier Science Ltd.
- ❖ **Marschner, H. W.** (2003): Mineral nutrition of Higher Plants. Second Edition, Academic Press, Elsevier Science Ltd.
- ❖ **Moore, T.C.** (1974): Research experience in Plant Physiology, A Laboratory manual. Springer-Verlag, Berlin.
- ❖ **Mukherjee, S.P.** and Ghosh A.N. (1996): Plant Physiology. New Central Book Agency (P) Limited Tata McGraw Hill.
- ❖ **Noggle, G.R.** and Fritz, G. J. (1976): Introductory Plant Physiology. Prentice- Hall, Inc., Englewood Cliffs, NJ.
- ❖ **Pessaraki, M.** (Ed.). (2001). Handbook of Plant and Crop Physiology, 2nd Edition, Revised and Expanded. Marcel Dekker, Inc., New York

- ❖ **Pessarakli, M.** (Ed.). (2005). Handbook of Photosynthesis, 2nd Edition, CRC Press, Taylor & Francis Publishing Company, Florida
- ❖ **Randhir Singh** and Sawhney S. K. (1988): Advances in frontier Areas of Plant Biochemistry. Prentice Hall of India
- ❖ **Sadasivam S.** and Manickam A. (1996): Biochemical methods. New Age International.
- ❖ **Salisbury, F. B.** and Ross, C.W. (1992): Plant Physiology IV ed. Cengage Learning
- ❖ **Sinha R.K.** (2014) Modern Plant Physiology Second Edition, Narosa Publishing House Pvt. Ltd.
- ❖ **Smith, H.** (1975): Phytochrome and Photomorphogenesis. McGraw-Hill Inc.,US
- ❖ **Taiz, L.** and Zeiger, F. (1998, 2002, 2006): The Plant Physiology. Second Edition, Third Edition, Sunderland: Sinauer Associates.
- ❖ **Wilkins, M. B.** (1976): Physiology of Plant Growth and Development. McGraw-Hill Publishing Company Limited

### **Journals**

- ❖ Annual Review of Plant Physiology and Molecular Biology.
- ❖ Annual Review of Plant Physiology
- ❖ Indian Journal of Plant Physiology.
- ❖ Journal of Experimental Botany.
- ❖ Physiologia Plantarum Sweden.
- ❖ Plant Physiology (Bethesda, USA).
- ❖ Plant Cell

**M.Sc. PART- II (SEMESTER IV)**  
(CCS402.1): Plant Physiology  
(SPECIAL PAPER III) **STRESS PHYSIOLOGY OF PLANTS**

**Total Lectures: 60**

**UNIT I:**

- ❖ **Water stress:** Causes of water stress: Arid and Semiarid regions, Drought effect on physiological processes in plants, Mechanism of stomatal action, various mechanisms of drought resistance in plants, Antitranspirants, Drought hardening, Transgenic approach.
- ❖ **Flooding stress:** Nature of waterlogging stress. Effect of flooding stress on physiological processes in plants. Wetland and non-wetland species. Mechanism of waterlogging tolerance.

**UNIT II:**

- ❖ **Salt stress:** Definition of saline soil, Causes of soil Salinization. A brief outline of Salt affected soils in India, Physiological responses of plants to salinity stress, Halophytes and glycophytes mechanism of salinity tolerance in higher plants, Genetic engineering for salt tolerance.
- ❖ **Ionic stress:** Effect of ion toxicity (iron, zinc), heavy metals toxicity and aluminum toxicity in plants, Phytoremediation, Mechanism of aluminium tolerance, Transgenic approaches.

**UNIT III:**

- ❖ **Thermal stresses:** Effect of high and low temperatures on plant metabolism, Mechanisms of high and low temperatures tolerance, Cold hardening, Role of HSP.
- ❖ **Radiation stress:** Influence of high light intensity on photosynthesis, Photoprotection mechanisms, Effect of UV radiations on plants, Mechanism of UV tolerance.
- ❖ **Oxidative stress:** Generation of reactive oxygen species, Effect of ROS on metabolism,
- ❖ ROX detoxification mechanisms in plants, Transgenic approaches.

**UNIT IV:**

- ❖ **Gaseous stress:** Effect of elevated CO<sub>2</sub> concentration on plant metabolism, Effect of air pollutant SO<sub>2</sub> and O<sub>3</sub> on plants.
- ❖ **Biotic stress:** Effect of fungal infection on plant metabolism, Biochemical mechanism of disease resistance, Allelopathy.

## **PAPER XIV (CCPR 405.1): PLANT PHYSIOLOGY: PRACTICAL COURSE III**

### **UNIT V:**

- ❖ Measurement of osmotic potential of controlled and stressed tissue.
- ❖ Determination of chlorophyll stability index.
- ❖ Effect of foliar applications of some commercial PGR's and biotonics on crop productivity parameters (carbohydrate status).
- ❖ Study of effect of fungal infection on polyphenol oxidase activity.

### **UNIT VI:**

- ❖ Study of free radicals scavenging enzymes, catalase in healthy and infected plants.
- ❖ Study of super oxide dismutase in healthy and infected plants.
- ❖ Study of effect of source manipulation on sink capacity in any crop plant.
- ❖ Study of effect of weedicides on some aspects of weed metabolism (chlorophylls/ nitrate reductase)
- ❖ Determination of Harvest Index (HI) of different crops (Wheat and chickpea)

### **Reference Books:**

- ❖ **Buchnan, B.B., Gruissem, W. And Jones, R.L. (2000)** Biochemistry and Molecular Biology of Plants. Wiley-Blackwell.
- ❖ **Cherry, J. H. (ed.) (1989)** Environmental Stress in Plants: Biochemical and Physiological Mechanisms Associated with Environmental Stress Tolerance in Plants (NATO ASI Series G, vol. 19). Springer, Berlin.
- ❖ **Fitter, A.H. and R.K.M. Hay, (1987)** Environmental Physiology of Plants. Academic Press, San Diego, CA, 2nd. ed.
- ❖ **Hale, M.G. and Orcutt, D.M. (1987)** The Physiology of plants under stress. John Wiley and Sons, New York.
- ❖ **Kozlowski, T.T. (1984)** Flooding and Plant Growth. Ed. T.T. Kozlowski. Academic Press, Orlando, FL.
- ❖ **Levitt, J. (1980)** Responses of plants to environmental stresses: Vol.II, Water, Radiation, Salt and other. Academic Press, New York.
- ❖ **Mansfield, T.A. (1976)** Effects of Air Pollutants on Plants. CUP Archive
- ❖ **Mehrotra, R. S. (1980):** Plant Pathology. Tata McGraw-Hill
- ❖ **Paleg, L.G. and Aspinal, D. (1982)** The Physiology and Biochemistry of Drought resistant in Plants. Academic Press, Sydney.
- ❖ **Poljakoff-Mayber, A. and Gale, J. (eds.). (1975)** Plants in saline environments. Springer Verlag, New York, USA.
- ❖ **Rice, E. L. (1974)** Allelopathy, Academic Press, New York, San Francisco, London
- ❖ **Srivastava Y.N. (2009).** Environmental Pollution APH Publishing Corporation, New Delhi
- ❖ **Turner, N. C., and Kramer, P. J. (1980)** Adaptation of Plants to Water and High Temperature Stress. Wiley, New York
- ❖ **Taiz, L. and Zeiger, F. (1998, 2002, 2008):** The Plant Physiology. (Second Edition 1998, Third Edition 2002, Fourth Edition 2008) Sunderland: Sinauer Associates.

## **Journals**

- ❖ Allelopathy Journal
- ❖ Annual Review of Plant Physiology and Molecular Biology.
- ❖ Annual Review of Plant Physiology
- ❖ Indian Journal of Plant Physiology.
- ❖ Journal of Experimental Botany.
- ❖ Physiologia Plantarum, Sweden.
- ❖ Plant Physiology, Bethesda, USA
- ❖ Plant Cell

**M. Sc. PART-II (SEMESTER IV)**  
**Paper XIV (CCS402.2): Mycology and Plant Pathology**  
**(SPECIAL PAPER III) INDUSTRIAL MYCOLOGY**

**Total Lectures: 60**

**UNIT I:**

- ❖ **Role of fungi in industry:** Scope and their utility.
- ❖ **Commercial fungal strains:** Selection, improvement, development and their maintenance.
- ❖ **Fermentation:**
- ❖ Industrial alcohol production through fermentation
- ❖ Industrial production of organic acids: citric, fumaric, itaconic and kojic acid.

**UNIT II:**

- ❖ Industrial production of enzymes: amylases, proteases, pectinases and invertases.
- ❖ Industrial production of vitamins: vitamin B<sub>12</sub>, riboflavin, vitamin A.
- ❖ Industrial production of gibberellins.

**UNIT III:**

- ❖ Industrial production of antibiotics
- ❖ Production of ergot alkaloids.
- ❖ Economics of fermentation.

**UNIT IV:**

- ❖ Edible fungi, their nutritional value and role in cottage industry.
- ❖ Large and small scale cultivation technique of *Agaricus bisporus*, *Pleurotus* spp., *Volvariella volavacea* and their preservation, diseases and their control, cost benefit analysis.

**PAPER XIV CCPR 405.2: MYCOLOGY & PLANT PATHOLOGY  
PRACTICAL COURSE III**

**UNIT V:**

- ❖ Maintenance of fungal strains using different methods.
- ❖ Production of industrial alcohol by fermentation technique.
- ❖ Detection of citric acid from mycelial biomass using circular paper chromatography.
- ❖ Detection of antibiotics from mycelial biomass.
- ❖ Production of ergot alkaloid by using fungal elicitors.

**UNIT VI:**

- ❖ Preparation of spawn: Grain, Perlite and manure spawn.
- ❖ Cultivation of mushroom.
- ❖ Study of some enzymes (amylases, proteases, pectinases and invertases) of fungal origin.

**Reference Books:**

- ❖ **Casida**, L. E. Jr. (1964). Industrial Microbiology. John Wiley and Sons, USA
- ❖ **Whipps**, J. M. and Lumsden, R. D. (1989). Biotechnology of fungi for improving plant growth. Press Syndicate of the University of Cambridge, UK
- ❖ **Turner** (1971). Fungal metabolism. Academic Press, USA
- ❖ **Atal** (1978). Indian Mushroom Science-I. Indo American Literature House
- ❖ **Kannaiyan** (1980). A hand book of edible mushrooms. Today's and Tomorrow's. Publ.
- ❖ **Purkhyastt** (1976). Indian edible mushrooms. Firma KLM, 1976 Cornell University
- ❖ **Smith**, J. F. and Barry, D. R. The filamentous fungi Vol.I Industrial Mycology Vol.II and III. Edward Arnold, London.
- ❖ **Dodge**, C.W. (1935). Industrial Mycology.
- ❖ **Prescott**, S. G. and Dunn, C. D. (1959). Industrial Microbiology. AVI Pub.n Com. Westport, CT
- ❖ **Christensen**, C. M. (1975): Mould, Mushrooms and Mycotoxins. University of Minnesota press, Minneapolis
- ❖ **Rose**, A. H. (1961). Industrial Microbiology. Butterworths, London
- ❖ **Singer**, R. (1961). Mushrooms and Truffles cultivation and utilization. Leonard Hill, Ltd.,
- ❖ **Rhodes**, A. and Fletcher, D. L (1966). Principles of industrial microbiology. Pergamon Press, Oxford, UK
- ❖ **Gray**, W. D. (1970). The use of fungi as food and food processing. Cleveland, Oh: CRC Press, USA
- ❖ **Lodder**, J. (1970). The Yeast. North- Holland, Amsterdam
- ❖ **Chang**, S. T. and Hays, W. A. (1978). The biology and cultivation of edible mushrooms. Academic Press, New York.
- ❖ **Aneja**, K. R. (1993). Experiments in Microbiology, Plant Pathology and Tissue Culture.
- ❖ **Onions**, A. H. S. D. Allsopp and Eggins, H. O. W. (1981). Smith's Introduction to Industrial Mycology. New Age International Publishers
- ❖ **Barger**, G. (1931). Ergot and Ergotism. Edward Arnold
- ❖ **Fletcher**, J. T., White, P. F. and Gaze, R. H. (1989). Mushrooms: Pest and Disease Control. Inter- cept, Ltd., VCH Publishers, Suite 909, 220 East 23rd Street, New York,



**M.Sc. PART-II SEMESTER IV**  
**Paper XIV (CCS402.3): Cytogenetics and Plant Breeding**  
**(SPECIAL PAPER- III) MOLECULAR GENETICS**

**Total Lectures: 60**

**UNIT I:**

- ❖ Microbial Genetics: Genetic studies in microorganisms with special reference to *Escherichia coli* and *Agrobacterium* spp.
- ❖ Genetic exchange in bacteria- an overview (mutants, conjugation, Transduction and transformation) site directed mutagenesis.

**UNIT II:**

- ❖ The Genetics of Viruses: The structure and life cycle of bacterial virus, Mapping the bacteriophage genome (Phage phenotypes, genetic recombination in phage, fine structure and deletion mapping), T4 genetic map, bacteriophage X 174.
- ❖ Molecular analysis of DNA, RNA and proteins using blotting techniques and micro arrays; molecular markers (third and fourth Generation ) and their uses.

**UNIT III:**

- ❖ **PCR and DNA sequencing:** PCR and its types. Classical methods for DNA sequencing,
- ❖ Automatic DNA sequencer, Restriction maps and molecular maps. Genome wide association studies (GWAS)

**UNIT IV:**

- ❖ **Bioinformatics, Genomics and Proteomics:** Bioinformatics tools for analyzing genomic information; Biological databases, Comparative genomics- Ancient duplications and Palaeopolyploidy, Phylogenetic analysis. Genomes of higher plants- *Arabidopsis*, Rice, Soybean, Maize and grapevine.
- ❖ Comparative genomics tools and techniques, macro and microsynteny, evolutionary principles and applications

**(CCPR 405.3) CYTOGENETICS AND PLANT BREEDING PAPER XV**  
**PRACTICAL COURSE III**

**UNIT V:**

- ❖ *In silico* studies (Identification of SSRs, Primer designing and Similarity search analysis using different BLAST programs)
- ❖ Preparation of linkage map using mapmaker and join map
- ❖ QTL analysis using QTL Cartographer and QTL Network
- ❖ EST analysis in crops
- ❖ Study of polymorphism in crop plants using molecular markers (RAPD/ ISSR)
- ❖ Demonstration of southern blotting
- ❖ Phylogenetics analysis

**UNIT VI:**

- ❖ Study of restriction digestion analysis by gel electrophoresis
- ❖ Secondary metabolite production and analysis
- ❖ Anther culture and haploid production
- ❖ Cell line isolation
- ❖ Hairy root culture
- ❖ Study of transgenic plants
- ❖ Detection and estimation of protease inhibitors from cereals/pulses

**Reference Books:**

- ❖ **Twyman R. M.** 1998. Advanced molecular Biology. Viva Books Pvt. Ltd. New Delhi.
- ❖ **Wolfe S. L.** 1993. Molecular and cellular biology. Wadwith Publishing Co. California USA.
- ❖ **Lewin, B.** 2008, Genes IX Oxford University Press, New York.
- ❖ **Brown T. A.** 1998. Genomes. John Wiley and sons Singapore.
- ❖ **Alberts B. et al** 1994. Molecular biology of the cell 3rd Edition Garland Publishing, New York.
- ❖ **Singh B. D.** 1990. Fundamentals of Genetics. Kalyani Publishers Ludhiana.
- ❖ **Latchman D. S.** 1990. Gene regulation an eukaryotic perspective. Unwin Hyman Publication London.
- ❖ **Klug W. S. and Cummings M. R.** 1983. Concepts of Genetics. Charles E. Merrill Publishing Company London.
- ❖ **Jain H. K.** 1999. Genetics Principles, Concepts and Implications. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- ❖ **Gupta P. K.** 1985. Genetics Rastogi Publications Meerut.
- ❖ **Griffith A. J. F. Miller J. H., Suzuki D. T., Lewontin R. C. and W. M. Gelbart** 1996. An introduction to Genetics Analysis. 6th Edition W. H. Freeman New York.
- ❖ **Strickberger M. W.** 1996 Genetics 3rd Edition MacMillan Publishing Co. New Delhi.

**Journals:**

- ❖ Annual review of Microbiology
- ❖ Journal of Cytology and Genetics
- ❖ Cytologia
- ❖ Caryologia
- ❖ Indian Journal of Experimental Biology
- ❖ Journal of Experimental Botany
- ❖ Trends in Biotechnology (Elsevier)

**M.Sc. II PART- II (SEMESTER IV)**  
**(CCS402.4): Energy, Ecology and Environment**  
**(SPECIAL PAPER III) EXPERIMENTAL ECOLOGY AND ENERGY STUDIES**

**Total Lectures: 60**

**UNIT I:**

- ❖ **Ecological Methods:** Autecology and synecology, Bigger unit of vegetation, Seed output, Germination capacity. Various methods involved in aquatic studies.
- ❖ **Methods of community study:** Minimal area curve, Quadrats, point, Transects, Grid, Use of GPS in Mapping.
- ❖ Measurement of primary productivity in terrestrial and aquatic ecosystems.

**UNIT II:**

- ❖ **Systems Ecology:** Introduction and basic elements of system ecology.
- ❖ **Construction of model:** Conceptual model, Auxiliary variables, Forester diagrams.
- ❖ **Methods** to study ecology of genetic erosion to construct model and examples  
**Phytoremediation:** Classification of phytoremediation and their application.

**UNIT III:**

- ❖ **Energy Sources:** Biomass as a source of energy, Composition of biomass (cellulose, hemicelluloses, lignin), Terrestrial biomass, aquatic biomass.
- ❖ **Bio energy:** Energy plantation, Social forestry, Silviculture, Energy farms, Petroleum plants, Hydrocarbon from higher plants (Hevea, Euphorbia), Algal hydrocarbons

**UNIT IV:**

- ❖ **Energy from Waste:** Biogas production, Biomass to electricity, Bio village concept, Eco Cook stoves.
- ❖ **Rain harvesting:** Harvesting system and techniques, Methods and Advantages  
**Vermicomposting technology** – Role of earth worm, Process of vermin composting, applications.
- ❖ **Conventional energy sources:** Coal and Natural gas, Hydropower, Nuclear energy
- ❖ **Non-conventional energy:** Solar energy, Wind energy, Geothermal energy

**PAPER XV (CCPR 405.4): ECOLOGY**  
**PRACTICAL COURSE III**

**UNIT V:**

- ❖ Survey and mapping of area by GPS.
- ❖ Seed germination under various treatments for tree species.
- ❖ Study of seed output and reproductive capacity.
- ❖ Study of petro crops and energy plants.
- ❖ 5-6 Study of effect of natural light intensity on primary productivity of an aquatic ecosystem.

**UNIT VI:**

- ❖ Setting up of an ecological model.
- ❖ Use of ecological model in the field study.
- ❖ Determination of Leaf Area Index (LAI).
- ❖ Induction of rooting.
- ❖ Statistical analysis of ecological data.
- ❖ Determination of calorific value of wood

**Reference Books:**

- ❖ **Agarwal S. K.** (1992): Fundamentals of Ecology. New Delhi: Ashish Publishing House.
- ❖ **Bradbury I. K.** (1990): The Biosphere. Published by John Wiley & Sons, Chichester.
- ❖ **Das S. M.** (1989): Handbook of Limnology and water pollution with practical Methodology. Published by South Asian Publishers, New Delhi.
- ❖ **Etherington J.R.** (1975): Environment and plant ecology: aims and development. Publisher Wiley.
- ❖ **Freedman H. I.** (1980): Deterministic mathematical models in population ecology. Marcel Dekker Inc., New York.
- ❖ **Greig Smith P.** (1983): Quantitative Plant Ecology. *Publisher: WILEYBLACKWELL*
- ❖ **Grims J. P. et al** (1988): Comparative Plant Ecology. Colvend, Dalbeattie, Kirkcudbrightshire [Scotland]: Castlepoint Press.
- ❖ **Hashimoto Y et al** (1990): Measurement techniques in plant sciences. San Diego, Calif.: Academic Press
- ❖ **Kershaw K. A.** (1964): Quantitative and dynamic ecology. Publisher: Edward Arnold
- ❖ **Kormondy E. J.** (1996): Concept of ecology. Publisher: Benjamin Cummings.
- ❖ **Krebs C. J.** (1978): Ecology. Harper & Row., New York.
- ❖ **Lieth H. F. et al** (1973): Patterns of primary production in the biosphere. Kluwer Academic Publishers-Plenum Publishers.
- ❖ **Misra K. C.** (1989): Manual of plant ecology. Oxford and IBH Publishing Co., New Delhi.
- ❖ **Misra R. and Das R. R.** (1971): Proceedings of the school of plant ecology. Publisher: Calcutta Oxford & IBH Pub. Co.
- ❖ **Odum E. P.** (1971): Ecology. Publisher: Saunders
- ❖ **Odum E. P.** (3rd ed. 1996): Fundamentals of Ecology. Natraj Publishers, Dehra Dun.
- ❖ **Pandeya S. C. et al** (1963): Research methods in plant ecology. Asia Publishing House.
- ❖ **Watt K. E. F.** (1973): Principles of Environment Sciences. Published by McGraw-Hill.

**M. Sc. PART II (SEMESTER IV)**  
**Paper XIV: (CCS 402.5): Angiosperm Taxonomy**  
**(SPECIAL PAPER III) ANGIOSPERM TAXONOMY FLORISTICS AND**  
**BIOSYSTEMATICS**

**Total Lectures: 60**

**UNIT I:**

- ❖ **Floristic:** Need and significance of floristic studies, methodology, analysis and data presentation.
- ❖ **Taxonomic literature:** General taxonomic indexes, world floras and manuals, monographs and revisions, bibliographies, catalogues, review serials, periodicals, glossaries, dictionaries, cultivated and economic plants, maps and cartography, biographical references, dates of publication, location of type specimens, dictionaries and addresses, colour charts, outstanding botanical libraries.
- ❖ **Botanical keys:** Diagnostic, synoptic and artificial keys-Single access (sequential)-bracketed and indented keys and multi-access keys, edge-punched and body-punched (polyclave) keys, tabular and lateral keys; computerized keys, their merits and demerits.

**UNIT: II**

- ❖ **History of botanical exploration in India:** Beginning of botany in India, contributions made in earlier phase by Garcia d'Orta, C. Acosta, Van Rhee, John Burman, John Koenig, Robert Kyd, Buchanan, Roxburgh, N. Wallich, William Griffith, Robert Wight, Thomas Thomson, J. D. Hooker, Collet, Brandis, T. Cooke, Duthie, Fyson, Gamble, Haines, Parkinson, Prain, Santapau, and recent works with special emphasis on Maharashtra. Botanical Survey of India (BSI).
- ❖ **Biosystematics:** Aims, concepts of species, steps in biosystematic study, biosystematic categories- ecotype, ecospecies, cenospecies, comparium, methods in biosystematic studies, ecotypic variations and taxonomy, scope and limitations.

**UNIT: III**

- ❖ **Origin of agriculture and rise of food crops:** Introduction, food plants, origin and spread of *Homo sapiens*, centres of plant domestication of major crops, crop dispersal and distribution.
- ❖ **Plant domestication:** Introduction, Evolution of farming, Plant domestication, origin of crops, changes during domestication, genetic regulation of domestication syndromes, evolution of weeds, genetic diversity and domestication.
- ❖ **Crop plants and their wild relatives:** Cereal grains (rice, sorghum, wheat), legumes (chickpea, black gram, mung bean, cowpea, moth bean), starch plants (banana, yam), fruits (apple, citrus, grape, peach, strawberry), vegetables (cucurbits)

**UNIT: IV**

- ❖ **Morphological variations, systematic position, interrelationships, phylogeny and economic importance of following families:**
- ❖ **ROSIDS:** Rhamnaceae, Moraceae, Urticaceae, Cucurbitaceae, Begoniaceae, Casuarinaceae, Lythraceae, Onagraceae, Myrtaceae, Melastomataceae, Rutaceae, Meliaceae, Sapotaceae, Lecythidaceae, Solanaceae.

## **Paper XIV (CCPR 405.5): ANGIOSPERM TAXONOMY: PRACTICAL COURSE III**

### **UNIT I:**

- ❖ Herbarium technique
- ❖ Botanical keys
- ❖ Study of ecotypes/ variations in population of species
- ❖ Identification of taxa with the help of computerized key
- ❖ Study of weeds found in the region
- ❖ Study of crop plants and their wild relatives (cereals and legumes)

### **UNIT II:**

- ❖ Study of crop plants and their wild relatives (Fruit and vegetables)
- ❖ Description, sketching, classification and identification of families: ROSIDS- Rhamnaceae, Moraceae, Urticaceae, Cucurbitaceae, Begoniaceae, Casuarinaceae, Lythraceae, Onagraceae, Myrtaceae, Melastomataceae, Rutaceae, Meliaceae, Sapotaceae, Lecythidaceae, Solanaceae and identification of wild and cultivated plants represented in local flora.
- ❖ Any additional practical/s based on theory syllabus will be added whenever necessary.

### **Reference Books:**

- ❖ **Cronquist, A. 1981.** An Integrated System of Classification of Flowering Plants. Columbia University Press, New York.
- ❖ **Cronquist, A. 1988.** The Evolution and Classification of Flowering Plants (2<sup>nd</sup> ed.) Allen Press, U.S.A.
- ❖ **Davis, P. H. and V. H. Heywood 1991.** Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi.
- ❖ **Endress Peter, K. 1994.** Diversity and Evolutionary Biology of Tropical Flowers. Cambridge.
- ❖ **Judd Walter S., Campbell C. S., Kellogg, E. A., Stevens P.F. and M. J. Donoghue 2008.** Plant Systematics-A Phylogenetic Approach. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.
- ❖ **Judd Walter S., Campbell C. S., Kellogg, E. A., Stevens P.F. and M. J. Donoghue 2008.** Plant Systematics-A Phylogenetic Approach. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.
- ❖ **Lawrence, G. H. M. 1951.** Taxonomy of Vascular Plants. Oxford and IBH Publ. Co. Pvt. Ltd. New Delhi.
- ❖ **Naik, V. N. 1984.** Taxonomy of Angiosperms. Tata McGraw-Hill, New Delhi.
- ❖ **Quicke, Donald, L. J. 1993.** Principles and Techniques of Contemporary Taxonomy. Blakie Academic & Professional, London.
- ❖ **Rao, R. R. 1994.** Biodiversity of India (Floristic Aspects). Bishen Singh Mahendra Pal Singh, Dehra-Dun.
- ❖ **Rao, R. R. 1994.** Biodiversity of India (Floristic Aspects). Bishen Singh Mahendra Pal Singh, Dehradun.
- ❖ **Richard, A. J. 1997.** Plant Breeding Systems. (2ed.) Chapman and Hall.
- ❖ **Shivanna, K. R. and B. M. Johri 1985.** The Angiosperm Pollen: Structure and Function. Wiley Eastern limited, New Delhi.
- ❖ **Taylor, D. V. and L. J. Hickey 1997.** Flowering Plants: Origin, Evolution and Phylogeny. CBS Publishers & Distributors, New Delhi.

**M. Sc. PART-II (SEMESTER IV)**  
**Paper XIV (CCS 402.6): Marine Botany**  
**(SPECIAL PAPER III) MARINE ECOLOGY**

**Total Lectures: 60**

**UNIT I:**

- ❖ **Marine environment:** Exposed coasts, estuaries, oceans.
- ❖ **Abiotic factors** - Geological factors- oceans, ocean floor, classification of coasts. Physical factors- light, temperature, water movements (waves, tides, currents), Chemical factors-sea water, salinity, O<sub>2</sub> & CO<sub>2</sub> in sea water, ionic concentration & nutrients.
- ❖ **Biotic factors:** Food webs & chains, succession in marine communities, biological interactions.
- ❖ **Zonation of marine algae:** Intertidal, submerged, sublittoral zonation pattern, seasonality.

**UNIT II:**

- ❖ **Ecology of mangroves:** Morphological, anatomical and physiological adaptations in mangroves. Vivipary and its role in mangroves. Zonation and succession in mangroves.
- ❖ **Faunal components of mangrove habitat-** Invertebrates, birds, reptiles, fishery resources, mammals, sediment fauna.
- ❖ **Mangrove conservation, restoration & management**
- ❖ **Legal Framework:** Forest Conservation Act, Coastal Regulation Zone (CRZ), Biodiversity and wild life act.

**UNIT III:**

- ❖ **Coastal vegetation and organic matter export:** Decomposition, Detritus food chain, Ecological role of microbes. Microbial diversity in mangrove ecosystem - N<sub>2</sub> fixing, PO<sub>4</sub>-solubilizing, S-reducing, methanogenic bacteria, Actinomycetes and fungi in mangrove ecosystem.
- ❖ **Coral Reefs:** Occurrence, distribution and types. Formation and erosion of coral reefs. Calcification, nutrient cycling, reef micro and macro algae, natural and anthropogenic stresses, management & restoration of coral ecosystem, concept of marine park/ marine protected areas.

**UNIT IV:**

- ❖ **Marine pollution:** Types, sources, heavy metal pollution-effects on algal metabolism, oil spills, fate of oil and effect on algal metabolism, synthetic organic chemicals- herbicides, insecticides, industrial chemicals (pcbs), complex wastes and eutrophication, pulp mill effluent, domestic wastes, radioactive pollution, biological damage and indirect damage, management and restoration. Biomagnification.
- ❖ **Ecological role of mangrove ecosystem:** Screening of solar radiations, control of cyclones, flood, prevention of coastal erosion, support for fishes and wild life population, protection to other ecosystems.

## **PAPER XIV (CCPR 405.6): MARINE BOTANY: PRACTICAL COURSE III**

### **UNIT V:**

- ❖ Determination of EC, pH, salinity and chlorinity of seawater.
- ❖ Determination of nitrate content of seawater.
- ❖ Determination of phosphate content from seawater.
- ❖ Study of salts glands, trichomes, sclereids in mangroves.

### **UNIT VI:**

- ❖ Study of vivipary in mangrove families.
- ❖ Study of faunal members from mangroves ecosystem.
- ❖ Determination of oil and grease / hydrocarbon content of polluted sea water
- ❖ Study of zonation pattern in mangroves.
- ❖ Determination of sulphate content from marine sediment/soil.

### **Reference Books:-**

- ❖ **Chapman, V. J. (1976).** Coastal Vegetation. 2<sup>nd</sup> edition Pergamon Press. New York.
- ❖ **Daves, C. J (1985).** Marine Botany Physiology and Ecology of Seaweeds.
- ❖ **Dawson (1960).** Marine Botany.
- ❖ **Gerald, E.** Ecophysiology of Economic Plants in Arid and Semiarid Land.
- ❖ **Lobban, C. S. & Harrison, P. J. (1985).** Seaweed Ecology and Physiology. Cambridge University Press.
- ❖ **McConnaughey, B. H (1974).** Introduction to Marine Biology.
- ❖ **Naskar, Kumudranjan, Dwijendra Narayan Guha ,Bakshi.** Mangrove Swamps of the Sundar bans. An Ecological Perspective. Naya Prakash.
- ❖ **Naskar, Kumundrajan and Rathindranath Mandal (1999).** Ecology and Biodiversity of Indian Mangroves, Vol. I and II.
- ❖ **Pandey B.P. (1994).** Algae. S. Chand and Co. Ltd., New Delhi. Current trends in life science, Vol.23: Agromicrobes, Today and Tomorrow. Publ. New Delhi.
- ❖ **Parsons, T. R., Maita, Y & Lalli, C. M.** A Manual of Chemical and Biological Methods for Sea Water Analysis.
- ❖ **Ranade, D. R. & Gadre, R. V. (1988).** Microbial Aspects of Anaerobic Digestion. Laboratory
- ❖ **Saenger, P. (2002).** Mangrove Ecology, Silviculture and Conservation. Springer.
- ❖ **Soepadmo, E. A. N. Rao and Macintosh, D. J. (1988).** Proceedings of Asian Symposium. Mangrove Environment Research Management, Kuala Lumpur.
- ❖ **Stein, J. R. (1973)** Handbook of Phycological Methods. Cambridge University Press.
- ❖ **Tait, R. V. (1981)** Elements of Marine Ecology.
- ❖ **Zha, M. N. (1999).** Current Trends in Life Sciences Vol.23, Agromicrobes. Today and Tomorrow. Publ. New Delhi.



**M. Sc. PART-II (SEMESTER IV)**  
**Paper XIV (CCS 402.7): Plant Biotechnology**  
**(SPECIAL PAPER III) APPLICATION AND PROSPECTS OF PLANT TISSUE**  
**CULTURE**

**Total Lectures: 60**

**UNIT I:**

- ❖ Application of biotechnology in conservation of plant generic resources: *In- situ* conservation, *Ex- situ* conservation
- ❖ **Application of tissue culture in agriculture:** Plant improvement through tissue culture technology; production of resistant lines to biotic and abiotic stresses

**UNIT II:**

- ❖ Applications of tissue culture in horticulture, forestry and sericulture: micropropagation of Banana, Bamboo, *Tectona*, *Nothapodytes* and *Morus* Tissue culture in orchids and *Gerbera*
- ❖ Prospects in plant tissue culture industry in India; Applications in public sector

**UNIT III:**

- ❖ Secondary metabolite production from callus and cell suspension,
- ❖ Biotransformation, process design and product recovery from cultured plant cells. Factors affecting product yield, bioreactors
- ❖ Secondary metabolites from immobilized plant cells; production of single cells proteins

**UNIT IV:**

- ❖ Transgenic plants for crop improvement: Resistance to abiotic stresses (salt, oxidative, herbicide and drought resistance); Resistance to biotic stresses (fungi, insect and virus resistance) Molecular farming, edible vaccines

## Paper XIV (CCPR 405.7): PLANT BIOTECHNOLOGY

### PRACTICAL COURSE III

#### UNIT V:

- ❖ *In vitro* culture of any RET plant species
- ❖ Screening of cell cultures for abiotic (PEG)/ biotic (fungal) stress
- ❖ Micropropagation of Banana
- ❖ *In vitro* germination of orchid seeds
- ❖ Micropropagation of *Gerbera*

#### UNIT VI:

- ❖ Hairy root culture
- ❖ Production of synseeds and cell immobilization
- ❖ Effect of elicitor (Chitosan) on production of secondary metabolites from cell culture
- ❖ Study of transgenic plants (Bt/ Terminator/ edible vaccines etc.)

#### Reference Books:

- ❖ **Altman**, A. 1998. Agricultural Biotechnology. Marcel Dekker, New York.
- ❖ **Chavala**, H. S. 1998. Biotechnology in crop improvement. International Book Distributing Co. New Delhi.
- ❖ **Glick**, B. R. and Pasternak, J. J. 1994. Molecular Biotechnology- Principles and applications of recombinant DNA. ASM Press, Washington.
- ❖ **Gupta**, P. K. 2000. Elements of Biotechnology. Rastogi Publisher, Meerut, India.
- ❖ **Kakralya**, B. and Ahuja, I. 2001. Transgenic Plants-Promise or Danger. Agrobios, India.
- ❖ **Ravishankar**, G. A. and Venkataraman, L. V. 1997. Biotechnological applications of plant tissue and cell culture. Oxford and IHB Publishing Co. Pvt. Ltd., New Delhi.
- ❖ **Reddy**, S. M., Srivastava, H. P., Purohit, D. K., and Reddy, S. R. 1997. Microbial biotechnology. Scientific Publishers, Jodhpur, India.
- ❖ **Schlegel**, H. G. 1995. General microbiology. Cambridge University Press.
- ❖ **Trehan**, K. 1994. Biotechnology. Wiley Eastern Ltd. New Delhi.

**M. Sc. PART-II (SEMESTER IV)**  
**Paper XV (CCS403.1): Plant Physiology**  
**(SPECIAL PAPER IV) APPLIED PLANT PHYSIOLOGY**

**Total Lectures: 60**

**UNIT I:**

- ❖ **Crop growth and its regulation:** Growth analysis of crop plants and its significance. Factors controlling crop productivity, Harvest Index (HI), Water Use Efficiency (WUE).
- ❖ **Nutriophysiology:** Foliar diagnosis of critical nutrient status. Applications of lime and gypsum lime as soil additives. Role of chelates in mineral utilization. Foliar applications of mineral elements. Biofertilizers, CO<sub>2</sub> as a fertilizer.

**UNIT II:**

- ❖ **Reproductive physiology:** Role of PGRs in flowering, sex determination and fruit development.
- ❖ Ethylene and post-harvest physiology.
- ❖ Source-Sink capacity in crop plants and its significance.

**UNIT III**

- ❖ **Plant growth regulators in agriculture and horticulture:** Mode of applications of PGR's, Pre sowing soaking treatment, foliar application and other modes
- ❖ **Roles:** Ethylene and ethylene generating compounds, long chain alcohols, Brassinosteroids, plant growth retardants, amino acid mixtures and other commercial products. Biotonics.

**UNIT IV:**

- ❖ Invading weeds, crop-weed interaction, weedicides and their mode of action
- ❖ Physiological aspects of transgenic crops.
- ❖ A brief idea of crop physiological research in India.

## **Paper XV (CCPR 405.3.1): PLANT PHYSIOLOGY**

### **PRACTICAL COURSE IV**

#### **Project work based on special papers.**

#### **Reference Books**

- ❖ **Asana, R.D. and Sarin, M.N. (1968)** Crop physiology in India. Tech. Bull. 16. Indian Coun. Agric. Res. (Agric. Ser.)
- ❖ **Buchnan, B.B., Gruissem, W. And Jones, R.L. (2000)** Biochemistry and Molecular Biology of Plants. Wiley-Blackwell
- ❖ **Evans, L.T. (1972):** Crop Physiology. Some Case Histories. Cambridge, NY
- ❖ **Fageria, N. K. (1992):** Maximizing crop yield. CRC Press
- ❖ **Fitter, A.H. and R.K.M. Hay (1987)** Environmental Physiology of Plants. (Second Edition) Academic Press, San Diego, CA
- ❖ **Gupta U.S. (1988)** Progress in Crop Physiology. Oxford and IBH. Pub. Co.
- ❖ **Gupta U.S. (1995)** Production and Improvements of Crops for Drylands. Oxford and IBH. Pub. Co.
- ❖ **Krishnamurthy, H.N. (1992):** Physiology of Plant Growth and Development. Atma Ram and Sons, Delhi.
- ❖ **Nickell, L.G. (1982)** Plant Growth Regulators- Agricultural Uses. Springer Verlag, New York
- ❖ **Pessarakli, M. (Ed.). (2001).** Handbook of Plant and Crop Physiology, 2nd Edition, Revised and Expanded. Marcel Dekker, Inc., New York
- ❖ **Taiz, L. and Zeiger, F. (1998, 2002, 2008):** The Plant Physiology. (Second Edition 1998, Third Edition 2002, Fourth Edition 2008) Sunderland: Sinauer Associates.

#### **Journals**

- ❖ Annual Review of Plant Physiology and Molecular Biology.
- ❖ Annual Review of Plant Physiology
- ❖ Indian Journal of Plant Physiology.
- ❖ Journal of Experimental Botany.
- ❖ Physiologia Plantarum Sweden.
- ❖ Plant Physiology (Bethesda, USA).
- ❖ Plant Cell.

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

**(CCS403.2): Mycology and Plant Pathology**

**(SPECIAL PAPER IV) INTEGRATED DISEASE MANAGEMENT**

**Total Lectures: 60**

**UNIT I:**

- ❖ **Methods of disease diagnosis:** Field observation, isolation and identification of Pathogens.
- ❖ **Integrated management of plant diseases:** Definition of IDM, international approach, Quarantine laws, Culture methods, avoidance of pathogen, breeding and use of disease resistant varieties. Seed certification.

**UNIT II:**

- ❖ Chemical methods, formulation and classification of fungicides, contact and systemic fungicides, uptake and mode of action. Seed, soil, plant treatments of fungicides, fungicide resistance in plant pathogens and their management. Antibiotics and biological control of plant pathogenic fungi. Biological control agents, VA-Mycorrhiza, *Trichoderma viride*, *T. harzianum*, *Pseudomonas fluorescens*, *Glomus* spp. Use of botanicals and other biopesticides.

**UNIT III:**

- ❖ **Integrated management of some important diseases:** History, symptomology, pathogen, etiology and management: Jowar (Head and Grain smut), Bajara (Green ear), Wheat (Rust and Bunt), Rice (Blast), Groundnut (Leaf spot and Rust), Sunflower (Downy mildew), Soybean (Mosaic), Cotton (Angular leaf spot).

**UNIT IV:**

- ❖ **Integrated management of some important diseases:** Sugarcane (Whip smut and Grassy shoot), Banana (Blight), Citrus (Canker), Grapes (Powdery mildew, Anthracnose, Downy mildew), Pigeon pea (Wilt), Bhendi (Yellow vein mosaic virus), Potato (Early and late blight), Tomato (Early blight).

**Paper XV (CCPR 405.3.2): MYCOLOGY AND PLANT PATHOLOGY:  
PRACTICAL COURSE IV**

**Project work based on special papers.**

**References Books**

- ❖ **Lalithakumari D.** (2000). Fungal Protoplast: A Biotechnological Tool: Oxford and IBH Publishing Co. Pvt.Ltd.
- ❖ **Mathews, R. E. F.** (1970). Plant Virology. Academic Press, New York
- ❖ **Tilak, S.T.** (1998). Aerobiology. Satyajeet Prakashan
- ❖ **Kenneth M. Smith** (1968). Plant Viruses. Academic Press, New York
- ❖ **Bawden, F. C.** (1964). Plant Viruses and Virus Diseases. Biotech Books, New Delhi
- ❖ **Mehrotra, R. S.** (1980). Plant Pathology Tata McGraw-Hill Publishing Company Ltd.
- ❖ **Agrios, G. N.** (2006). Plant Pathology (5th Edition). Academic Press, New York
- ❖ **Ny Vall, R. F.** (1979). Field Crop Diseases Handbook. Wiley
- ❖ **Singh, R. S.** (1963). Plant Diseases.—
- ❖ **Padoley, S. K. and P. B. Mistry:** A manual of Plant pathology. International Book House, New Delhi
- ❖ **Gangopadhyay, S.** (1984): Clinical Plant Pathology Kalyani Publishers

## **M.Sc. PART-II SEMESTER IV**

### **Paper XV (CCS 403.3): Cytogenetics and Plant Breeding**

#### **(SPECIAL PAPER IV) SPECIAL APPROACHES IN GENETIC IMPROVEMENT OF CROP PLANTS**

**Total Lectures: 60**

##### **UNIT I:**

- ❖ Functional genomics: Genome annotation
- ❖ RNA interference mechanism, synthesis and its applications, Virus induced gene silencing
- ❖ (VIGS), VIGS in plant genomic research
- ❖ Transcriptomics and methods of transcriptome analysis

##### **UNIT II:**

- ❖ Quantitative trait loci (QTL), Methods of QTL analysis by using molecular markers.
- ❖ Mapping population (RIL, NILS, DH, back cross) their mechanism and development.
- ❖ Bulk segregation analysis. Allele Mining for crop improvement: Approaches for allele mining, significance of novel alleles, applications of allele mining.
- ❖ Marker assisted selection for crop improvement: Selection of markers, breeding schemes involved, gene pyramiding applications of MAS.
- ❖ Epigenetics and Epigenomics for crop improvement

##### **UNIT III:**

- ❖ Tissue Culture: Anther culture, production of haploids, embryo rescuing and its uses in crop improvement.
- ❖ Production of secondary metabolites, cell line isolation, hairy root culture with some important secondary metabolite production and use of bioreactors.
- ❖ Production of biotic and abiotic resistant plants using tissue culture.

##### **UNIT IV:**

- ❖ Transgenics: a) Methods of gene transfer and its expression
- ❖ b) Transgenic crops for biotic and abiotic stresses, nutritional quality improvement,
- ❖ c) Transgenic crops field testing and regulatory measures

**Paper XV (CCPR 405.3.3.): CYTOGENETICS AND PLANT BREEDING:  
PRACTICAL COURSE IV**

**Project work based on special papers.**

**Reference Books:**

- ❖ **Thimmaiah S. R.** 1999, Standard methods of biochemical analysis. Kalyani Publishers Ludhiana.
- ❖ **Mitra Sandhya** 1996, Genetic Engineering Macmillan India Ltd.
- ❖ **Lal R. and Lal S.** 1993, Genetic engineering of plants for crop improvement. CRC Press.
- ❖ **Winkler, U. Ruger W. and Wackernagel W.** 1979. Bacterial phage and molecular genetics. Narosa Publication New Delhi.
- ❖ **Chawala H. S.** 2000 Introduction to Plant Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd.
- ❖ **Vidhyashekaran P.** 1993 Molecular biology and tissue culture from crop pest and disease management. Daya Publishing House New Delhi.
- ❖ **Kumar U.** 2005 Methods in Plant Tissue culture Agrobios Jodhpur India.
- ❖ **Razdan M. K.** 2003 Introduction to plant tissue culture. Oxford and IBH publishing Co. Pvt. Ltd.
- ❖ **Gustafson J. P.** 1990 Gene manipulation in plant improvement I and II. Plenum Press London.
- ❖ **Old R. W. and Primrose S. B.** 1989 Principles of Gene Manipulation. Blackwell Scientific Publ Oxford UK.
- ❖ **Razdan M. K. and Cocking E.C.** 2000 Conservation of plant genetic recourses in vitro. Oxford and IBH publishing Co. Pvt. Ltd.
- ❖ **Razdan M. K. and Bhojwani S. S.** 1996, Plant tissue culture: Theory and practice a revised edition. Elsevier Science.
- ❖ **Gupta P. K.** 2010 Plant Biotechnology. Rastogi Publications Meerut.
- ❖ **Singh B. D.** 2003 Biotechnology Expanding Horizons. Kalyani publishers Ludhiana.
- ❖ **Trigiano R. N. and Gray D. J.** 2000 Plant tissue culture concepts and laboratory exercises. CRS press LLC.
- ❖ **Manibhushanrao K. and Mahadevan A.** 1996 Recent developments in biocontrol of plant pathogens. Today and Tomorrow's printers and publishers New Delhi.
- ❖ **Reinert J. and Bajaj Y. P. S.** 2000 Plant cell, Tissue and Organ culture. Springer – Verlag. New York,
- ❖ **Chrispeels M. J. and Sadava D. E.** 1994 Plants, Genes and Agriculture. Jones and Barlett Publishers Boston, USA.
- ❖ **Gustafson J. P.** 2000 Genomes. Kluwer Academic Plenum Publishers New York USA.
- ❖ **Brown T. A.** 1999 Genomes. John Wiley and Sons Pvt. Ltd. Singapore.
- ❖ **Liu Ben Hui** 1998 Statistical Genomics: Linkage Mapping and QTL Analysis. CRC Press LLC Florida USA.
- ❖ **Wennacker Ernst L.** 1987 From Genes to Clones; Introduction to Gene Technology VCH publishers Weinheim (Federal Republic of Germany)



- ❖ **Mount D. W.** 2001 Bioinformatics Sequence and Genome Analysis. Cold Spring Harbour Laboratory. New York.
- ❖ **Jagota A.** 2000 Data Analysis and Classification for Bioinformatics. Published by Bioinformatics by the bay Press. University of Michigan, USA
- ❖ **Durbin R, Sean R., Eddy, Anders Krogh, Graeme M.**1999 Biological Analysis- Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press.
- ❖ **Andreas Baxevanis, B. F. Francis Ouellette and B. F. Cuellette** 1998 Bioinformatics: A Practical Guide to the analysis of Genes and Proteins, Wiley Publishers, New York

**Journals:**

- ❖ Indian Journal of Biotechnology
- ❖ Indian Journal of Experimental Biology
- ❖ Journal of Experimental Botany
- ❖ Trends in Biotechnology (Elsevier)
- ❖ Trends in biochemical Sciences (Elsevier)
- ❖ Journal of Molecular Plant Pathology
- ❖ Journal of Plant Biotechnology
- ❖ International Journal of Food Science and Technology.

**M.Sc. II PART- II (SEMESTER IV)**  
**Paper XV (CCS 403.4): Energy, Ecology and Environment**  
**(SPECIAL PAPER IV) ENVIRONMENTAL ISSUES, ASSESSMENT AND**  
**RESTORATION**

**Total Lectures: 60**

**UNIT I:**

- ❖ **Air pollution:** Classification, Acidic precipitation, causes and consequences. Air pollution control measures monitoring devices. Environmental issues.
- ❖ **Water pollution:** Classification of water pollutants. Oxygen demanding pollutants and their activity. Pathogens, nutrients, salts, heat, heavy metals and pesticides. Radioactive and oil pollutants. Self-purification of natural streams. Oxygen sag analysis.

**UNIT II:**

- ❖ **Environmental issues:** Ozone – Positive and negative influence of ozone. Air quality loss, nuclear winter, vehicular and industrial gases, global climate change
- ❖ **Land degradation:** Loss of soil fertility, mining. Causes and control measures. Sustainable land-management.

**Unit III:**

- ❖ **Environmental impact assessment:** Concept, scope and objectives of EIA, Biological monitoring programme, Bio indicators and environmental monitoring, Remote sensing and GIS
- ❖ Environmental impact assessment, Methodology, Component of EIA, Environmental management, Indian environmental law.

**UNIT IV:**

- ❖ **Natural resources:** Types of resources, Conservation and management of resources Soil resources, Forest resources, ecological and economic significance.
- ❖ **Recycling of natural resources:** Waste management, Waste disposal.
- ❖ **Ecotourism and Eco-friendly measures:** Guideline, Sustainability of ecotourism.

## **Paper XV (CCPR 405.3.4): ECOLOGY PAPER XVI: PRACTICAL COURSE IV**

### **Project work based on special papers.**

#### **Reference Books:**

- ❖ **Adriano, D. C. and Johnson, A. H.** (1989): Acidic precipitation, vol. II. John Wiley *Publishers*.
- ❖ **Balkrishnan, M., Borgstrom, R. and Bie, S. W.** (1994): Tropical Ecosystems. Oxford and IBH *Publishing Co.*
- ❖ **Dash, M. C.** (1993): Fundamentals of Ecology. Tata Mc.Graw Hill *Publishing Company Ltd.* New Delhi.
- ❖ **De, A. K.** (1994): Environmental Chemistry. New Age international *publishers*.
- ❖ **Good, R. E. et al** (1978): Fresh water wetlands. Margraf *Publishers*.
- ❖ **Gregory S.** (1988): Recent climatic changes: A regional approach. Kluwer Academic *Publisher*.
- ❖ **Lal, J. B.** (1987): Environmental Conservation. *Publisher:* International Book Distributors.
- ❖ **Misra K. C.** (1989): Manual of plant ecology. Oxford and IBH Publishing Co., New Delhi.
- ❖ **Owen, M. and Black, J. M.** (1990): Waterfall Ecology. Blackie *Publishers*, Glasgow, Scotland.

**M. Sc. PART-II (SEMESTER IV)**  
**Paper XV (CCS 403.5): Angiosperm Taxonomy**  
**(SPECIAL PAPER IV) PHYLOGENY AND FLORAL BIOLOGY OF ANGIOSPERMS**  
**Total Lectures: 60**

**UNIT I:**

- ❖ **Origin of Angiosperms:** Pre-cretaceous and Cretaceous fossil angiosperms, time of origin of angiosperms, cradle of angiosperms, probable ancestors of angiosperms- *Isoetes*-monocotyledon theory, Coniferales-amentiferae theory, Gnetales-angiosperm theory, Anthostrobilus theory, Caytonian theory, Stachyosporo-phyllispermae theory, Pteridosperm theory, Pentoxylales theory and Durian theory, monophyletic versus polyphyletic origin of angiosperms.
- ❖ **Fossil Angiosperms of India:** A brief account of fossil angiosperms of India- Palmae: *Palmoxylon*, *Rhizopalmoxylon*, *Palmocarpon*; Cyclanthaceae: *Cyclanthodendron*, *Tricoccites*; Pandanaceae: *Viracarpon*; Musaceae: *Musa cardiospermum*; Gramineae: *Graminocarpon*; Sonneriaceae: *Sonnerioxylon*, *Sonneriorhizos*, *Sahnianthus*, *Enigmocarpon*; Guttiferae: *Indocarpa*, Myrtaceae: *Sahnipushpam*; Malvaceae: *Sahnioocarpon*, *Harissocarpon*, *Daberocarpon*, *Chitaleypushpam*. Fossil angiosperms and palaeoecology of India.

**UNIT II:**

- ❖ **Floral Biology-I:** Evolution of flower, evolution of floral biology in basal angiosperms, co-evolution of flowering plant and insects, sex in flowers, sex distribution in plants, types of pollination, chasmogamy and cleistogamy; biology of floral parts-calyx, corolla, androecium, pollen, style and stigma.

**UNIT-III**

- ❖ **Floral Biology-II:** Anemophily, hydrophily, ornithophily, cheiropterophily, entomophily- beetle, fly, bee, wasp, *Catasetum*, fig wasp, butterfly, moth, carpenter bee pollination; floral diversity and evolutionary steps toward asclepiad flowers.

**UNIT IV**

- ❖ **Morphological variations, systematic position, interrelationships, phylogeny and economic importance of following families:** ASTERIDS-Convulvaceae, Boraginaceae, Rubiaceae, Apocynaceae, Oleaceae, Scrophulariaceae, Bignoniaceae, Lentibulariaceae, Verbenaceae, Lamiaceae

## PAPER XV (CCPR 405.3.5): ANGIOSPERM TAXONOMY: PRACTICAL COURSE IV

### Project work based on special papers.

#### Reference Books:

- ❖ **Cronquist, A.** 1988. The Evolution and Classification of Flowering Plants (2nd ed.) Allen Press, U.S.A.
- ❖ **Cronquist, A.** 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York.
- ❖ **Davis, P. H. and V. H. Heywood.** 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi.
- ❖ **Manilal, K. S. and M. S. Muktesh Kumar [ed.].** 1998. A Handbook of Taxonomic Training. DST, New Delhi.
- ❖ **Naik, V. N.** 1984. Taxonomy of Angiosperms Tata McGraw-Hill Publication Co. Ltd. New Delhi.
- ❖ **Quicke, Donald, L. J.** 1993. Principles and Techniques of Contemporary Taxonomy. Blakie Academic & Professional, London.
- ❖ **Rao, R. R.** 1994. Biodiversity of India (Floristic Aspects). Bishen Singh Mahendra Pal Singh, Dehra-Dun.
- ❖ **Taylor, D. V. and L. J. Hickey.** 1997. Flowering Plants: Origin, Evolution and Phylogeny. CBS Publishers & Distributors, New Delhi.
- ❖ **Lawrence, G. H. M.** 1951. Taxonomy of Vascular Plants. Oxford and IBH Publ. Co. Pvt. Ltd. New Delhi .
- ❖ **Shivanna, K. R. and B. M. Johri.** 1985. The Angiosperm Pollen: structure and Function. Wiley Eastern limited, New Delhi.
- ❖ **Endress Peter, K.** 1994. Diversity and Evolutionary Biology of Tropical Flowers. Cambridge.
- ❖ **Richard, A. J.** 1997. Plant Breeding Systems. (2ed.) Chapman and Hall.
- ❖ **Nayar, M. P.** 1996. Hot Spots of Endemic Plants of India, Nepal and Bhutan. Tropical Botanic Gardens and Research Institute, Palode, Kerala
- ❖ **Ahmedullah, M. and M. P. Nayar.** 1987. Endemic Plants of the Indian Region Vol I. Botanical Survey of India.
- ❖ **Synge, Hugh (ed.).** 1980. The biological aspects of Rare Plant Conservation. John Wiley & Sons.
- ❖ **Judd Walter S., Campbell C. S., Kellogg, E. A., Stevens, P.F. and M. J. Donoghue.** 2008. Plant Systematics. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.
- ❖ **Percival, M. S.** 1965. Floral Biology. Pergamon Press, London.

**M. Sc. PART-II (SEMESTER IV)**  
(CCS403.6): Marine Botany  
**(SPECIAL PAPER IV) APPLIED MARINE BOTANY**

**Total Lectures: 60**

**UNIT I:**

- ❖ **Primary Production:** Overview, GPP and NPP, Oceanic Production, effect of light and nutrients, Biomass harvesting/ harvest method, litter fall, chlorophyll method, gas exchange technique. Standing crop, light and dark bottle method, ecological indices.
- ❖ **Methods of Mangrove Analysis:** Collection by field methods-Transect, Quadrat, Phytosurvey. Geological Methods-Location, Elevation, Use of remote sensing technique in mapping of vegetation, Use of GPS.

**UNIT II:**

- ❖ **Collection and Preservation of Marine Algae:** Methods of collection, chemical preservation, herbarium technique.
- ❖ **Seaweed Mariculture:** Commercial cultivation of economic seaweeds, Scientific bases for seaweed mariculture, Techniques of seaweed mariculture- *Porphyra*, *Laminaria*, *Undaria*, *Kappaphycus* *Gracilaria* etc Future prospects.

**UNIT III:**

- ❖ **Utilization of Seaweeds:** Human food, sea vegetables, fodder, fertilizer and manure, kelp industry, antibiotics and drugs, phycocolloids and their applications. Algal Products- Soda and Potash, Iodine, Trace elements. Use of algae as Bio fuel.
- ❖ **Laboratory Culture of Algae:** Use of natural and synthetic culture media, types of culture, requirements/conditions of growth, difficulties in getting axenic culture

**UNIT IV:**

- ❖ **Coastal Bioresources:** Bioresource profile. Wild bioresources - food, feed, fodder, fire wood, timber, medicinal products, potential genetic resources, ornamentals. Domestic bioresources - crops, cereals, pulses, oil crops, horticultural crops, livestock, aquaculture, apiculture.
- ❖ **Nursery Techniques in Mangroves:** Nursery practices-collection of seed/ propagule/seeding material, storage, sowing of seeds, shading, watering, disease control and transplantation.
- ❖ **Mangrove Plantation Techniques:** Direct and indirect methods, zonation, season, gap filling, soil condition etc.

## **Paper XV (CCPR 405.3.6): MARINE BOTANY: PRACTICAL COURSE IV**

### **Project work based on special papers.**

#### **Reference Books:**

- ❖ **Beck.** Biotechnology of Microalgae.
- ❖ **Bhosale, L. J.** (2005). Mangroves of Maharashtra. (Field Guide). Shivaji University, Kolhapur.
- ❖ **Chapman, V. J.** (1976). Coastal Vegetation. II nd edition Pergamon Press. New York.
- ❖ **Jackson. D. F.** (1972). Algae and Man. Plenum Press.
- ❖ **Kannupandi, T.** (1998). Coral Reefs of India. State of Art Report. ENVIS Publication Series 2/98.
- ❖ **Krishnamurthy, V.** (1985). Marine Plants. (A.G. Untawale, Asso. Editor), Seaweed Research and Utilization Association, Madras.
- ❖ **Santhanam, R., Ramnathan, N., Venkataramanjan K. & Jegathanam, G.** (1987). Phytoplankton of Indian Seas. & Aspects of Marine Botany. Daya Publication Home. Delhi.
- ❖ **Stein, J. R.** (1973) Handbook of Phycological Methods. Cambridge University Press.
- ❖ **Stoermer, E. F. & Smol, J. P.** The Diatoms. Applications for Environment and Earth Sciences
- ❖ **Swaminathan M. S.** Research foundation (2003). Bioresources Status in Selected Coastal Location. National Bioresource Development Board (Department of Biotechnology) Govt. of India.
- ❖ **Trainor, F. R.** Introductory Phycology.

**M. Sc. PART-II (SEMESTER IV)**  
**(CCS 403.7): Plant Biotechnology**  
**APPLICATION, REGULATION AND PATENTING BIOTECHNOLOGY**

**Total Lectures: 60**

**UNIT I:**

**Biotechnology in Agriculture:**

- ❖ Bioethical principles for agricultural biotechnology, ethical aspects and public acceptance.
- ❖ Biological Nitrogen Fixation: Mechanism of N<sub>2</sub> fixation, Symbiotic N<sub>2</sub> fixation, Mechanism of N<sub>2</sub> fixation in root nodules, Nod genes, Nif genes, Hup genes.
- ❖ Use of microbes in Industry and agriculture

**UNIT II:**

- ❖ Application of biotechnology in environmental protection: Pollution control, phytoremediation immobilized microbial cells, wastewater treatment, microbes in leaching of metals.
- ❖ Economic and legal issues of biotechnology

**UNIT III:**

- ❖ Regulating the use of biotechnology in recombinant DNA technology, food, food ingredients and GMO's – cost benefit analysis of GMO's.
- ❖ Global biotech scenario, public versus private enterprises, international organizations involved in biotechnological inventions, cooperative programmes.
- ❖ Biotechnological spotlights

**UNIT IV:**

- ❖ Intellectual property; Intellectual Property Rights (IPR) and its protection, IPR and Plant Genetic Resources, GATT and TRIPS
- ❖ Patent systems in India, sources of patent information: a case study
- ❖ Patenting biotechnological inventions: Patent of higher plants, patent of genes and DNA sequences, plant breeder's right and farmer's right



## **Paper XV (CCPR 405.3.7): PLANT BIOTECHNOLOGY: PRACTICAL COURSE IV**

### **Project work based on special papers.**

#### **Reference Books:**

- ❖ **Altman, A.** 1998. Agricultural Biotechnology. Marcel Dekker, New York.
- ❖ **Gupta, P. K.** 2000. Elements of Biotechnology. Rastogi Publisher, Meerut, India.
- ❖ **Glick, B. R. and Pasternak, J. J.** 1994. Molecular Biotechnology- Principles and applications of recombinant DNA. ASM Press, Washington.
- ❖ **Mitra, S.** 1996. Genetic Engineering- principles and practice. Mcmilan, India ltd. Technology information, forecasting and assessment council.
- ❖ **(TIFAC).** 2002. Sources of patent information and patent agents. Technology Bhavan, New Delhi. Technology information, forecasting and assessment council.
- ❖ **(TIFAC).** 2002. Lecture notes on patents. Technology Bhavan, New Delhi.

**M.Sc. PART- II (SEMESTER- IV)**  
**Paper-XVI (DSC 404): Plant Ecology and Evolution**

**Lectures: 60**

**Unit-I:**

- ❖ **Major Ecosystems:** types of biomes
- ❖ **Terrestrial biomes:** grassland, tropical rainforest, temperate deciduous forest.
- ❖ **Aquatic biomes:**
  1. Fresh water ecosystem – lotic and Lentic
  2. marine ecosystem – ocean, sea, estuary
- ❖ **Species interaction:** concept of allelopathy, parasitism, mutualism, commensalism, competition and predation.

**Unit-II:**

- ❖ **Population Ecology:** Characteristics of a population; population growth curves; population regulation, life history strategies (r and K selection).
- ❖ **Concept of metapopulation:** demes and dispersal, interdemec extinctions, age structured populations.
- ❖ **Community Ecology:** Nature of communities; community structure and attributes; level of species diversity and its measurement, edges and ecotones.

**Unit- III:**

- ❖ **Ecological Succession:** Types; mechanisms; changes involved in succession, concept of climax.
- ❖ **Emergence of evolutionary thoughts:** Lamarck; Darwin-concepts of variation,
- ❖ adaptation struggle, fitness and natural selection; Spontaneity of mutations; the evolutionary synthesis.

**Unit- IV:**

- ❖ **Origin of cells and unicellular evolution:** Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparane and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes Phytogeographical regions of India, Environmental educational programmes (UNESCO, MAB, Biosphere reserve, UNEP, WWF)

## Paper XVI (CC 404/ CCO 404): Plant Ecology and Evolution

### Practical Course

#### Unit 1:

- ❖ Study of Phytoplankton
- ❖ Evaluation of Abiotic components of Aquatic ecosystem (pH, temperature, Transparency).
- ❖ Determination of Phytomass.
- ❖ Study of species diversity index.
- ❖ Study of Population dynamics
- ❖ Determination of field capacity of Soil

#### Unit 2:

- ❖ Determination of residual chlorine from water sample.
- ❖ Determination of frequency, Density, Abundance, Dominance and IVI of the plant community.
- ❖ Estimation of DO and free CO<sub>2</sub>
- ❖ Study of morphological and anatomical characteristics of plants under pollution stages.
- ❖ Allelopathic analysis of the plants.
- ❖ Preparation of Ecological report

### References

- ❖ **Agarwal, S. K.** (1992): Fundamentals of Ecology. New Delhi: Ashish Publishing House.
- ❖ **Bradbury, I. K.** (1990): The Biosphere. Published by John Wiley & Sons, Chichester.
- ❖ **Das, S. M.** (1989): Handbook of Limnology and water pollution with practical Methodology. Published by South Asian Publishers, New Delhi.
- ❖ **Etherington, J. R.** (1975): Environment and plant ecology: aims and development. Publisher Wiley.
- ❖ **Freedman, H. I.** (1980): Deterministic mathematical models in population ecology. Marcel Dekker Inc., New York.
- ❖ **Greig Smith, P.** (1983): Quantitative Plant Ecology. *Publisher:* WILEYBLACKWELL
- ❖ **Grims, J. P. et al** (1988): Comparative Plant Ecology. Colvend, Dalbeattie, Kirkcudbrightshire [Scotland]: Castlepoint Press.
- ❖ **Hashimoto, Y. et al** (1990): Measurement techniques in plant sciences. San Diego, Calif.: Academic Press
- ❖ **Kershaw, K. A.** (1964): Quantitative and dynamic ecology. Publisher: Edward Arnold
- ❖ **Kormondy, E. J.** (1996): Concept of ecology. Publisher: Benjamin Cummings.
- ❖ **Krebs, C. J.** (1978): Ecology. Harper & Row., New York.

- ❖ **Lieth, H. F. *et al*** (1973): Patterns of primary production in the biosphere. Kluwer Academic Publishers-Plenum Publishers.
- ❖ **Misra, K. C.** (1989): Manual of plant ecology. Oxford and IBH Publishing Co., New Delhi.
- ❖ **Misra, R. and Das, R. R.** (1971): Proceedings of the school of plant ecology. Publisher: Calcutta Oxford & IBH Pub. Co.
- ❖ **Odum, E. P.** (1971): Ecology. Publisher: Saunders
- ❖ **Odum E. P.** (3rd ed. 1996): Fundamentals of Ecology. Natraj Publishers, Dehra Dun.
- ❖ **Pandeya S. C. *et al*** (1963): Research methods in plant ecology. Asia Publishing House.
- ❖ **Watt K. E. F.** (1973): Principles of Environment Sciences. Published by McGraw-Hill.
- ❖ **Sharma,P.D.** (2019): Ecology and Environment, Thirteenth edition.Rastogi publication.

**DEPARTMENT OF BOTANY**  
**(CHOICE BASED CREDIT SYSTEM) SEM I/ III**  
**Generic Elective Course Botany (GE 407)**  
Botany and Human Welfare

**Total Lectures:30**

**Unit-I: Plants, Human and Environment**

- ❖ Introduction to plants, plant resources and their importance in progress, prosperity and survival of human race.
- ❖ 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 plant products**

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

**References**

- ❖ **Jain, S. K.** 2004. A manual of ethnobotany. 2nd edition, Scientific publishers, India.
- ❖ **Ramanamurthy, G. V.** 1985. Advances in Oilseeds Production and Technology. ICAR, New Delhi
- ❖ **Gill, N. T. and K. C. Vear and D.J. Barnard.** 1980. Agricultural Botany. 3<sup>rd</sup> revised edition. Duckworth, London.
- ❖ **Jha, L.K. and P. K. Sarma.**1993. Agroforestry: Indian Perspective. Ashish Publishing House, New Delhi
- ❖ **Varghese, E.** 1996. Applied Ethnobotany: A case study among the Kharias of Central India. Deep Publications, New Delhi.
- ❖ **Chapman S. R. and Carter L.P.** 1976. Crop Production: Principles and Practices. Freeman and Company, San Francisco, USA.
- ❖ **EL Bassam, N.** 1998. Energy Plant Species: Their Use and Impact on Environment and Development. Routledge.
- ❖ **Aiyer, A. K.** 1966. Field crops of India. Bangalore Printing and Publishing Company, Bangalore.
- ❖ **Shiva Vandana, V. M. Meherhomji and N.D. Joryal.** 1992. Forest Resources- Crises and Management. Natraj Publishers, Dehradun.
- ❖ **Jha, L. K. and P. K. Sen Sarma.** 1994. Forestry for the People. Ashish Publishing House, New Delhi.
- ❖ **Dogra, P.D. and R C. Dhiman (eds.).** 1994. Forestry Research and Education in India. INSA, New Delhi.
- ❖ **Wickens, G.E, N. Haq, P.Day (eds.).** 1986. New Crops for Food and Industry. Chapman and Hall, New York.