SHIVAJI UNIVERSITY, KOLHAPUR.
DEPARTMENT OF BOTANY

Syllabus for the Semester System Examination (Academic Flexibility, Credit System) w.e.f. January 2008 for M.Sc. Part - I (Semester I & II) No. and for M.Sc. II (Semester III & IV) No. from January 2009.

M.Sc. BOTANY REVISED SYLLABUS (Academic Flexibility) (Credit System)

1. The entire course of M. Sc. (Botany) will be of four semesters spread over within two years.
2. There shall be four theory papers and four practicals (each based on one theory paper) in every semester. Each semester course shall comprise of four units per theory paper per week. One practical of two units per paper per week.
3. Every theory paper shall be having four units and every practical shall be having two units.
4. There shall be one elective paper and corresponding practical among the four papers per semester and the students from other departments can opt for this particular elective paper. The decision regarding admission of such other departmental students will be made by departmental committee of Botany Department.
5. Each unit in theory paper shall comprise of 15 lectures of 60 minutes duration and there shall be four lectures per paper per week. There shall be four practicals (each with not less than three hour duration) per week. Library (Reference) work/ Excursion/ Field Work/Seminar –Group Discussion/Project Work shall also be conducted in every week.
6. Among the four Theory papers there shall be one elective paper per semester.
7. There shall be at least two short tours per year for all students. For M.Sc. I students there shall be one long tour (in a year) out of the state to Botanical Regions, Research Institutes / Centers. All excursion tours, short and long, are obligatory to each student. Candidates shall require to produce, the following at the time of practical examination (at the end of each semester). :-
   i) A laboratory journal of practicals and field record book duly signed by the concerned teacher from time to time. A set of micro preparations (semi / permanent) of plant materials illustrating the subject matter of the relevant paper.

ii) At least 10-15 Herbarium specimens and preserved specimens (preferably of weeds) collected by the Candidate during the field work or excursion tour.

8. Various subject specializations intradepartment-elective are available at M. Sc. II (Sem. III and IV). The Department offers one of the following specializations to each student on the basis of his/ her merit and willingness and availability of seats. (Subject distribution centralized).
    - Plant Physiology
    - Mycology and Plant Pathology
    - Cytogenetics and Plant Breeding
    - Energy, Ecology and Environment
    - Angiosperm Taxonomy
    - Marine Botany
    - Plant Biotechnology
    - Palaeobotany (Presently Suspended).
9. The entire course of M. Sc. in Botany will be of 2500 marks. So every semester will be of 600 marks; 400 marks for theory papers (4) and 200 marks for practicals (4), along with 50 marks for project work in semester III and semester IV.
10. Each theory paper will be of 100 marks (80 marks theory paper + 20 marks internal). Each semester (usually at the mid of the semester) there will be an internal test of 20 marks (20 multiple choice questions) and theory examination of 80 marks per paper (of 2.5 h duration) at the end of semester.
11. Each practical performance will be of 50 marks (20 marks internal + 30 marks external). There will be a separate practical examination for every paper carrying 30 marks. (Four separate Practicals). Each practical examination will be of 3 h duration.
12. A Project / Assignment will be given to every student during III and IV semesters, and each student will be examined for his / her project for 50 marks every semester. (50 × 2 = 100 marks for project, submission and oral presentation).
13. In each theory question paper (carrying 80 marks) seven questions will be put, out of which the candidate shall have to attempt five questions (carrying 16 marks each). The weightage to different types of questions is as follows :-
    i) Descriptive or essay type questions 50 – 60 %
    ii) Short answer type questions (20- 30 %)

    The last (7^{th}) question of short answer type questions will be compulsory (based on entire syllabus).

M.Sc. Part I (Semester - I)

Theory Papers :

B O 1.1 : Prerequisite Course

B O 1.2 : Biology and Diversity of Algae, Fungi and Bryophytes

B O 1.3 : Plant Ecology

Elective I

B O 1.4 : Biology and Diversity of Pteridophytes, Gymnosperms and Palaeobotany

Practicals:

B O P 1.1 : Prerequisite Course

B O P 1.2 : Biology and Diversity of Algae, Fungi and Bryophytes

B O P 1.3 : Plant Ecology

B O P 1.4 : Biology and Diversity of Pteridophytes, Gymnosperms and Palaeobotany

M.Sc. Part I (Semister - II)

Theory Papers:

B O 2.1 : Cell and Molecular Biology

B O 2.2 : Angiosperm Systematics

B O 2.3 : Plant Pathology

Elective II

B O 2.4 : Plant Resource Utilization and conservation

Practicals:

B O P 2.1 : Cell and Molecular Biology

B O P 2.2 : Angiosperm Systematics

B O P 2.3 : Plant Pathology

B O P 2.4 : Plant Resource Utilization and conservation

M.Sc. Part II (Semister - III):

B O 3.1 : Cytogenetics and Crop Improvement

Elective III

B O 3.2 : Biotechnology and Genetic Engineering

Special paper I

B O 3.31 : Plant Physiology

B O 3.32 : Mycology and Plant Pathology

B O 3.33 : Cytogenetics and Plant Breeding

B O 3.34 : Energy, Ecology and Environment

B O 3.35 : Angiosperms

B O 3.36 : Marine Botany

B O 3.37 : Plant Biotechnology

Special paper II

B O 3.41 : Plant Physiology

B O 3.42 : Mycology and Plant Pathology

B O 3.43 : Cytogenetics and Plant Breeding

B O 3.44 : Energy, Ecology and Environment

B O 3.45 : Angiosperms

B O 3.46 : Marine Botany

B O 3.47 : Plant Biotechnology

Practicals :

B O P 3.1 : Cytogenetics and Crop Improvement

B O P 3.2 : Biotechnology and Genetic Engineering

B O P Special paper I

B O P Special paper II

Project Work:

B O 3.5 : Project work/Assignment work

M.Sc. Part II (Semister - IV) :

Theory Papers:

B O 4.1 : Plant Physiology and Metabolism

Elective IV

B O 4.2 : Plant Structure, Development and Reproduction

Special paper III

B O 4.31 : Plant Physiology

B O 4.32 : Mycology and Plant Pathology

B O 4.33 : Cytogenetics and Plant Breeding

B O 4.34 : Energy, Ecology and Environment

B O 4.35 : Angiosperms

B O 4.36 : Marine Botany

B O 4.37 : Plant Biotechnology

Special Paper IV

B O 4.41 : Plant Physiology

B O 4.42 : Mycology and Plant Pathology

B O 4.43 : Cytogenetics and Plant Breeding

B O 4.44 : Energy, Ecology and Environment

B O 4.45 : Angiosperms

B O 4.46 : Marine Botany

B O 4.47 : Plant Biotechnology

Practicals:

B O P 4.1 : Plant Physiology and Metabolism

B O P 4.2 : Plant Structure, Development and Reproduction

B O P : Special paper III

B O P : Special paper IV

Project Work:

B O 4.5 : Project work/Assignment work

B O 1.1

Pre-requisite Course

Total Lectures: 60

Unit: I

1. Biochemistry Laboratory : Laboratory, discipline, safety and care. Laboratory note book, experimental report. Standard units of expression. **4**
2. Biostatistics : Measures of Dispersion and Variability. The Variance, The Coefficient of variation **4**
3. Computers in Biology : Modern computers, Internet(www/http), Modem, Use nets, E-mail, Browsers, Search Engine, Biological Data Bases. **3**
4. Bioinformatics: Definition, importance, constituents, Applications in genomics, biomolecular structure, medical science etc. Useful sites **4**

Unit: II

5. Separation Techniques: Basic principles of centrifugation, low and high speed centrifuges ultracentrifuge. Density gradient separation Column chromatography. - Ultrafiltration Isoeletricfocussing, Ion exchange and Affinity chromatography Gel electrophoresis. **8**
6. Spectroscopic Techniques : Basic principles Nature of electromagnetic radiation, Beer-Lambert's law. UV-VIS, Fluorescence and Absorption spectrophotometry – Instrumentation and applications. NMR, MASS Spectrometry. **7**

Unit: III

7. Tracer Techniques : Isotopes is biochemistry / biology units of radioactivity, Measurement of radioactivity – Geiger-Muller, Liquid Scintillation Counting. Applications of radioisotopes. **8**
8. Electrochemical Techniques : Principles, pH-electrode, oxygen electrode, Ion-selective electrodes, Biosensors. **5**
9. X-ray Diffraction : Brief idea with principle **2**

Unit: IV

10. Culture Technique : Principles, types (bacteria, fungi, algae, plant) media preparation, sterilization, inoculation, Equipments – Laminar air flow, thermobath, shaker, stirrer, hot air oven, centrifuge Electricautoclaves **8**
11. Palaeobotanical Techniques : Peel technique Palaeopalynological studies. **3**
12. Collection and Preservation of plant material. Cryopreservation **4**

Practicals :

UNIT : I (Any Four practicals)

1. Preparation of standard solutions, M, N, ppm , etc.
2. ANOVA use of computer.
3. Determination of Correlation coefficient.
4. Accessing biological data bases, / E-mail operations
5. Use of search engine for literature / reference work / Searching biochemical literature
6. Verification of Beer and Lambert's law

Units: II (Any Four practicals)

7. pH – measurement and preparation of buffers.
8. Peel technique for fossil studies
9. Separation of proteins by gel electrophoresis
10. Study of instruments / equipments.-Radioactive counetrs, photomicrography, Flame photometer, R.C. X-Ray diffraction.
11. Density gradient centrifugation – A separation technique

List of Books :

1. Practical cytology, applied genetics and Bio-statistics Goswami H. K. and R. Goswami, Himalayan Publ. House, Bombay (1993)
2. Methods in plant molecular biology – M. A. Schwer and Zeclinskin publ. Academic Press New York (1989)
3. Plant histochemistry – Jensen.
4. Photosynthesis and production in a changing environment. A field and laboratory manual- Hall, Scurlik, Bolhar Nordenkampt, Leagood and Long Chapman and Hall Publ. (1993)
5. Experimental plant physiology – J. Arditti and Dunn, Publ. Academic Press (1970).
6. Techniques in Bioproductivity and photosynthesis by – Coombs, Hall, Long and Sourlock, Pergamon press Oxford (1985)
7. Methods in enzymology- Colowick and Kaplan Academic Press.
8. Handbook of field and herbarium techniques S. K. Jain and R. R. Rao.
9. Practical Biochemistry : Principles and Techniques. Ed. E. Wilson and J. Walker (2000) Cambridge Publ.
10. Studies in Paleobotany-Andrews, H. N. (1961)
11. Modern Experimental Biochemistry-Boyer, R.(2005). Pearsa, Education, Singapore.
12. Methods in Experimental Biology.-Ralph, R. (1975). Blakie, London
13. An Introduction to Biometry- Mungikar, A. M. (1997), Saraswati Printing Press Aurangabad.

B O 1.2
Biology and Diversity of Fungi, Algae and Bryophytes

Total Lectures : 60

Fungi

Unit: I (15)

1. General Characters of Fungi. **1**
2. Classification of Fungi by Alexopoulos and Mims (1979) **1**
3. Taxonomical groups to understand life cycle patterns, growth, development and phylogeny with respect to the following major classes up to the level of orders **13**

Classes	Orders
Acrasiomycetes	Dictysteliales
Myxomycetes	Stemonitales
Chytridiomycetes	Chytridiales
Plasmadiophoromycetes	Plasmadiophoromycetales
Oomycetes	Perenosporales
Zygomycetes	Mucorales
Hemiascomycetes	Taphrinales
Plectomycetes	Eurotiales

Unit : II (15)

4. Taxonomical groups to understand life cycle patterns, growth, development and phylogeny with respect to the following major classes up to the level of orders **13**

Pyrenomycetes	Clavicipitales
Discomycetes	Pezizales
Loculoascomycetes	Dothidiales
Teliomycetes	Uredinales, Ustilaginales
Hymenomycetes	Agaricales, Aphyllophorales
Gastomycetes	Nidulariales
Hyphomycetes	Hyphomycetales
Coelomycetes	Melanconiales, Spheropsidales

5. Role of fungi in industries with reference to the production of alcohol, organic acids, antibiotics and enzymes. **2**

Algae

Unit: III (15)

- Classification in Algae **2**
- Culture, Cultivation and methods of preservation. **2**
- Role of Algae in human welfare **2**
- Structure, Reproduction, Phylogeny and interrelationship of following classes with reference to the forms mentioned against the classes **9**

  Cyanophyceae : *Gloeoecapsa, Oscillatoria, Scytonema, Spirulina*

  Chlorophyceae : *Mougeotia, Pithophora, Cladophora, Fritchella*, *Coleochaete, Draparnaldia, Ulva*.

  Xanthophyceae : *Vaucheria, Botrydium.*

  Bacillariophyceae : *Pinnularia*.

  Phaeophyceae : *Dictyota, Padiana*.

  Rhodophyceae : *Gracillaria*.

Bryophytes

Unit: IV (15)

- Trends in classification of Bryophytes. **2**
- Origin of Bryophytes **2**
- Distribution, habit, morphology, reproduction, phylogeny, and inter relationship of following orders **8**

  Sphaerocarpales, Takakiales, Jungermanniales,Sphagnales, Buxbaumiales
- Economic importance of Bryophytes. **2**
- Bryophytes as indicators of pollution. **1**

Practicals Unit: I (15)

- **Fungi**
  1) Isolation of fungi from soil, air, water and host, their inoculation on culture media. **1**
  2) Detailed study of following types from each of the following orders. **5**

Class	**Order**	**Types**
Myxomycetes	Stemonitales	Stemonitis
Chytridiomycetes	Chytridiales	Physoderma, Synchytrium

Plasmodiophoromycetes	Plasmodiophorales	Plasmodiophora (Slide)
Oomycetes	Perenosporales	Plasmopara, Bremia, Albugo.
Zygomycetes	Mucorales	Mucor,Rhizopus
Plectomycets	Eurotiales	Penicillium, Aspergillus
Pyrenomycetes	Clavicipitales	Claviceps
Discomycetes	Pezizales	Peziza
Loculoascomycetes	Dothidiales	Capnodium, Asterina
Teliomycetes	Uredinales	Melampsora, Uromyces.
Hymenomycetes	Agaricales	Agaricus.
	Aphyllophorales	Polyporus.
Gasteromycetes	Nidulariales	Cyathus
Deuteromycetes	Hypomycetales	Alternaria.
	Melanconiales	Colletotrichum

Unit :II (15)

- **Algae**

  Study of Algae: Types mentioned against each class in theory paper (available specimens / slides)

- **Bryophytes**

  Morphological, anatomical and reproductive studies of the following members (available specimens / slides)

Marchantiales	:	Asterella, Targionia, Cyathodium
Jungermanniales	:	Fossombronia, Porella
Anthocerotales	:	Notothyllus
Polytrichales	:	Polytrichum

Reference Books and Journals.

Algae

1. Kumar, H.D. and H. N. Singh (1971) Textbook of Algae
2. Sharma, O.P. (1986) Textbook of Algae
3. Pandey, B. P. (1994) Textbook of Botany – Algae
4. Vashista, B. R. (1995) Botany for degree students-Algae
5. Gangulee, H.C. and A. K. Kar (1992) College Botany Vol. III
6. Desikachary, T.V. (1972) Taxonomy and Biology of Blue - green algae

7. Fritsch, F. E. (1965) Structure and Reproduction of Algae
8. Venkataraman et al. (1974) Algae-Form and Function
9. Chapman, V.J. and D. J. Chapman (1965) The Algae

Journals

1. Phykos.
2. Phycologia
3. Seaweed Research.
4. Mahasagar
5. Indian Journal of Marine Biology

Fungi.

1. Alexopoulos, C.J. and C. W. Mims (1979) : Introductory Mycology
2. Sharma, O.O. (1989) : Textbook of Fungi
3. Ainsworth, G. G. and A.S. Sussman : The Fungi Vols. I, II, III, IV- A and IV-B
4. Bessey, E. A. (1967) : Morphology and Taxonomy of Fungi
5. Gangulee, H.S. and A. K. Kar (1992) : College Botany Vol. I
6. Thind K. S. (1977) : The Myxomycetes of India
7. Subramanan, C. V. (1971) : Hyphomycetes
8. Mundkur B.B. and M.J.Trimukchar (1952) : Ustihlaginales of India
9. Sparrdo F.K. (1960) : Aquatic phycomycetes
10. Dayal (1995) : Aquatic Fungi of India

Bryophytes

1. Cavers, R. (1964) : Inter-relationship of Bryophytes
2. Kashyap, S. R. (1929) : Liverworts of Western Himalayas and the Punjab Plains Part I and II
3. Parihar, N. S. (1959) : An introduction to Embryophyta. Bol. I – Bryophyta
4. Ram Udar (1976) : Bryology in India
5. Smith, G. M. (1955) : Cryptogamic Botany Bol. II
6. Watson, E.V, (1964) : The Structure and life of Bryopytes
7. Watson, E.V, (1963) : British Mosses and Liverworts
8. Vashista, B.R. (1996) : Botany for degree students -Brtophyta
9. Chopra, R. N. and P. K. Kumra (1988) : Biology of Bryophytes.

B O 1.3
Plant Ecology

Total Lectures: 60

Unit: I

1. Habital Ecology : Fresh Water and Marine water ecology (ecosystems) **8**
2. Succession : Allogenic and Autogenic Succession, Climatic Climax, Models of plant Succession **7**

Unit: II

3. Wetlands and their Characteristics – Classification of Wetlands & Examples **8**
4. Environmental Education Programmes : WWF, IUCN, MAB, Biosphere Reserve **7**

Unit: III

5. Population growth and structure: Concept and attribrutes, Biotic potential and Natality, Mortality, Survivorship curves. Life table and age structure. Law of population growth curves. **15**

Unit: IV

6. Introduction of Remote Sensing technique and Geographical Information system (GIS) **8**
7. Global sinks and pollution cycle **7**

Practicals: (2 Units, Any 8)

Unit: I (15)

1. Study of phytoplankton
2. Evaluation of abiotic components of aquatic ecosystem (P^H, Temperature and Transparency)
3. Determination of phytomass
4. Study of Species diversity index
5. Study of satellite imagery and vegetation Analysis

Unit: II (15)

6. Determination of field capacity of Soil.
7. Estimation of primary productivity of an aquatic ecosystem
8. Determination of hardness of Water
9. Determination of residual Chlorine from Water sample.
10. Ecological reports based on tour and / or analysis.

List of Books :

1. Plant Ecology – R. S. Ambsht, 1990.
2. Environmental Impact Assessment, Technology Assessment. - V. T. Covel, 1985
3. Environmental Impact Assessment of Govordhan, 1993, Theridam
4. Ecology workbook – R. Misra
5. Environmental management of mining operations – B. B. Dhot 1990
6. Progress of Plant Ecology in India – R. Misra, 1973
7. Ecology : The experimental analysis of distribution and abundance – C. J. Krens, Horper and Row (1978)
8. Ecology of halophytes – R. J. Reimold and W. H. Queens, 1974
9. Structure and functioning – A.W.J. Freysen and T. W. Wedendrop, 1978
10. Air pollution and forests – W. H. Smith, 1981
11. Plant pollution ecology – A. J. Dary et. Al. 1988.
12. Plant succession and indicators – F. E. Clements
13. Plant Ecology – Weaver and Clemests
14. The Plant community – Hanson and Churchil, 1961
15. Principles of environmental Biology – P.K. Nair, 1979
16. Fundamentals of Ecology – E.P. Odum, 1996
17. Ecology – E. P. Odum.
18. Progress of Plant Ecology Ed. I – Ed. R. Misra, dt. Al. 1973
19. Quantitative and dynamic ecology – K. A. Kershaw
20. Patterns of primary production in the biosphere H.F.W. Lieth. 1978
21. Taxonomy and Ecology - V. H. Heywood
22. Plant strategies and vegetation process 0 J. P. Grime
23. An Introduction to Air Pollution (1995) – R. K. Trivedy
24. Concept of Ecology (1996) – Edward J. Kormond, Prentice – Hall of India, New Delhi
25. Practical Methods in Ecology and Environmental Science - R. K. Trivedy, P. K. Goel. Enviro Media Publ. Karad
26. Ecology and Environment – P. D. Sharma, Rastogi publications, Meerut
27. Concept of Ecology (Environmental Biology) - P. S. Verma, V. K. Agarwal, S. Chand and Company Ltd. New Delhi.

B O 1.4 (Elective I)
Biology and Diversity of Pteridophytes, Gymnosperms and Paleobotany

Total Lectures: 60

Pteridophytes

UNIT I (15)

1) Classification of Pteridophytes **2**
2) Current trends of research in Pteridophytes **3**
3) Comparative morphology, reproduction and phylogeny of following orders with reference to the forms mentioned against each. **10**

Psilotales, Lycopodiales, Filicales,Marattiales, Salviniales

Gymnosperms

UNIT II (15)

- Recent trends in Classification **5**
- Evolution in Reproductive structures of Cycadales **5**
- Woods of Coniferales **5**

UNIT III (15)

- Study of morphology, anatomy, reproductive organs and affinities of extant members of following orders. Ginkgoales, Taxales, Ephedrales, Welwitschiales **10**
- Applied aspects of Gymnosperms **5**

Paleobotany

UNIT IV (15)

- Study of morphology, anatomy and evolutionary trends of following groups of plants. **8**

Lepidodendrales - Sigillariales
Sphenophyllates -
Psilophytales.
Marattiales -
Filicales -

Pteridospermales : Medullosales
Bennettitales - Williamsonials
Cycalales -
Cordiaitales -
Coniferales -

- Indian fossil flora – Glossopteris flora, Rajamahal Hill flora, Deccan Intertrappean flora **5**
- Paleopalynological techniques – Coal maceration, Lignite maceration **2**

Practicals -

UNIT I (15)

Morphological, anatomical and reproductive studies of the following members (available specimens / slides)

Psilotales	:	Tmesipteris
Lycopodiales	:	Lycopodium, Selaginella, Isoetes
Filicales	:	Gleichenia, Microsorium, Pteris
Marattiales	:	Angiopteris
Salviniales	:	Salvinia

UNIT II (15)

- Study of the morphology and anatomy of the vegetative and reproductive parts of
- Araucaria, Cupressus, Podocarpus, Ginkgo, Taxus, and Ephedra from available specimens / slides.

Study of following specimens :

- Sigillariales	:	Sigillaria Stem
- Sphenophyllales	:	Sphenophyllum Stem
- Marattiales	:	Psaronius stem
- Filicales	:	Rodeites, Gleichenites
- Medullosales	:	Medullosa, stem, Pachytesta
- Coniferales	:	Elatocladus, Brachyphyllum
- Cycadaless	:	Ptilophyllum, Dictyozarrites
- Angiosperms	:	Palmoxylon, Enigmocarpon, Sahnianthus Glossopteris, Gangmopteris, Scutellum

Reference Books :

Trivedi, A. N. (2002) - Advances in Pteridology

Bierhorst, D.W.(1971) - Morphology of Vascular plants

Eames, A. J. and E. M. Giffard (1950) - Comparative morphology of vascular plants

Rashid, A. (1978) - An introduction ot Peridophytes

Spome, K.R. (1966) - Morphology of Ptseridophytes

Bower, F. O. (1963) - The Ferns

Jermy, A. G. (1973) - The Phylogeny and Classification of ferns.

Vashishta, B.R. (1996) - Botany for degree students – Pteridophytes

Parihar, N.S. (1959) - An Introduction to Pteridophyta

Arnold, C.A. (1972) - An introduction to paleobotany

Darroh, W.C. (1968) - Principles of paleobotany

Surange, K.R. (1968) - Indian Fossil Pteridophytes

Journals –

American Fern Journal

International Journal of plant sciences.

Bierhorst, D.W. (1971) – Morphology of vascular plants

Chamberlein, C.J. (1966) - Gymnosperms, Structure and Evolution

Coulter and Chumberlein, J. M. - Morphology of Gymnosperms

Foster, A. S. and Gifford, E. M. (1959)- Comparative morphology of vascular plants

Ramanujan, C.G.K. (1979) - Indian Gymnosperms in Time and Space

Spome, K.R. (1967) - Morphology of Gymosperms

Vashistha, P.C. (1976) - The Gymnosperms

Bhatnagar, S.P. and Moitra Alok (1996)- The Gymnosperms.

Arnold, C. A. (1972) - An Introduction to Pateobotany

Andrews, H.N. (1961) - Studies in Pateobotany

Darroh, W.C. (1960) - Principles of Paleobotany

Surange, K. R. (1968) - Indian Fossil Pteridophyles

Shukla, A.C. and Mishra, S.D. (1975)- Essentiales of Paleobotany

Bhatnagar, S.P. and Moitra Alok (1975) - The Gymnosperms

Stewart, W. N. (1983) - Paleobotany and the evolution of plants, Cambridge U.S.

Semester - II

B O 2.1Cell and Molecular Biology of Plants

Total Lectures: 60

UNIT: I (15)

1. Dynamic cell:
   General account of plant cell structure specialized plant cell types **4**
2. Plasma membrane : Structure, models and functions, sites for ATP ion carriers, channels and pumps, receptors, transport **4**
3. Plasmodesmata : structure, role in movement of molecules, comparison with gap junctions **7**

UNIT: II (15)

4. Organization and expression of chloroplast and mitochondrial genomes, Nucleo- organelle interactions **5**
5. Plant vacuole – Tonoplast membrane ATP ases, Transporters, as storage organelle **3**
6. Nucleus : Structure, nuclear pores, nucleosome organization. **2**
7. Cell shape and motility : The cytoskeleton, organization and role of microtubules and microfilaments, motor movements implications in flagellar and other movements **5**

UNIT: III (15)

8. Cell cycle and apoptosis : control mechanisms, role of cyclins and cyclin dependent Kinases : Cell plate formation . **4**
   Mechanism of programmed cell death
9. Nucleic acids : Structural pecularities of DNA and RNA
   Law of DNA constancy and C – value paradox, DNA polymorphism, DNA damage and repair **4**
10. Protein sorting : targeting of proteins to organelles, **7**

UNIT: IV (15)

11. Protein Biosynthesis : Concepts of central dogma, reverse transcription, mechanism of transcription, RNA polymerase and its role, RNA processing (capping, *polyadenylation,* splicing), Gene concept, split genes, genetic code, deciphering the code, concept of degeneracy and Wobble hypothesis, mechanism of protein synthesis. **10**
12. Techniques in cell biology : In Situ hybridization to locate transcripts incell types, FISH, GISH, confocal microscopy **5**

Practicals :

UNIT I

1. Isolation of chloroplasts
2. Separation of chloroplast proteins
3. Isolation and Estimation at DNA from various plants
4. Restriction digestion of DNA, its separation by agarose gel electrophoresis
5. Study of cell types – Guard cells, heterocysts, Sclereids, Storage cells.

UNIT II

6. Study of vacuoles from different plants
7. Preparation of feulgen stained chromosome in root iip cells.
8. Effect of colchicine on chromosome movements during mitosis.
9. Use of fluorescent dye to visualize cell components.

Reference Books :

1. Johnson Lewys – 2004 : Cell Biology ; sarup and sons, New Delhi
2. E.J. Dupraw – 1970 : Cell and Molecular Biology; Academic Press, London
3. De Robertis and De Robertis – 1997 : Cell and Molecular Biology (VIII); B.I. Waverly Pvt. Ltd., New Delhi
4. C. P. Swanson, T. Merz, and W.J. Young – 1982 : Cytogenetics ; Prentice – Hall of India Pvt. Ltd., New Delhi
5. P.C.L. John (Ed.) – 1981 : The cell cycle; Cambridge University press
6. Benjamin Lewin : Genes – VI, VII and VIII ; Oxford Press.
7. R. A. Chapoldi 1977 : Membrane proteins and their interactions with lipids; Marcel Dekker, inc. N. York
8. A. N. Mortonosi (Ed.) – 1985 : The enzymes of Biological Membrames Vol. I, II and III; Plenum press, New York
9. Watson and others – 2004 : Molecular Biology of the gene (V); pearses Educatias, Inc India
10. P.C. Turner and others – 2002 : Molecular Biology (II); Viva Books, Pvt. Ltd., New Delhi.
11. W. Ream and K. G. Field – 1999 : Molecular Biology Techniques ; Academic Press, London.
12. Brace Alberts etal – 1983 : Molecular Biology of the cell ; Garland Publ. Inc., New Yorsk.
13. Charlothe J. Avers – 1986 : Molecular cell Biology ; Addision. Wesley Publ. Company
14. Sandhya Mitra – 1988 : Elements of Molecular Biology ; McMillan India Ltd., N. Delhi
15. C. B. Powar – 1992 : Cell Biology; Himalaya Publishing House.

Current and Back Volumes of following Periodicals :

1. Annual review of plant Biology
2. Cell
3. Cytologia
4. Journal of Genetics
5. The Journal of cytology and Genetics
6. Journal of Experimental Biology
7. The journal of Biochemistry
8. Indian journal of Biochemistry and Biophysics.
9. Trends in Biotechnology

B O 2.2
ANGIOSPERM SYSTEMATICS

Total Lectures : 60

Unit: I

Systematics: A Key science, Importance, Relevance to conservation, Sustainable utilization of bio-resources and ecosystem research **3**

Taxonomic Structure: Taxonomic hierarchy, The species concept, Categories and ranks

Evolutionary Concepts : Origin of intra-population variation, population and environment General biological Principle, Transference of Function, Adaptive radiations **5**

Plant Speciation: Allopathic / Abrupt / Sympatric / Hybrid / Apomictic speciation, Isolating mechanisms. **7**

Unit: II

Biosystematics: Steps in biosystematics, Biosystematic categories, Importance of Biosystematic studies **5**

International Code of Botanical Nomenclature : Salient features-Principles, Important Rules and Recommendations, Provisions for the governance of the Code, Appendices **10**

Unit: III

Taxonomic tools : Herbarium, floras, Botanical gardens, Computers, GPS, GIS **7**

Systems of Angiosperm Classification : Phenetic versus phylogenetic systems. Cladestics in taxonomy, Angiosperm phylogeny group (APG) **8**

Unit: IV

Phytogeography : Phytogeographic regions of India, Endemism, hotspots and hottest hotspots. Endemism in Western Ghats, Plant explorations, invasions and introductions. Biodiversity, magnitude, assessment, importance, conservation, utilization. **15**

PRACTICALS:

Unit: I

(1-6) Study of at least 20 locally available families of flowering plants

Unit: II

(7-8) Identification of genus and species of locally available wild plants

(9) Preparation of botanical keys

(10) Field trips within and around the University Campus, compilation of field notes and preparation of herbarium sheets of such plants.

(11-12) Knowledge of at least 25 plant species from each of the following categories :

a) Medicinal Plants. B) Endemic plants. C) Exotic weeds.

Botanical excursion of about one week duration to any botanically rich location preferable outside the State.

BOOKS :

Davis, P. H. and V. H. Heywood 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi

Grnquist, A. 1981. An Integrated system of Classifications of flowering plants. Columbia University Press, New York

Gurcharan Singh. 2004. Plant Systematics : Theory and practice Oxford and YBH Publishing Co. Pvt. Ltd., New Delhi.

Hulchikson, J. 1959. Families of flowering plants

Lawrence George H. M. 1951. Taxonomy of vasadar plants Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi

Manilal, K. S. and M. S. Muktesh Kumar (ed.) 1998. A Hand book of Taxonomy Training, DST, New Delhi

Naik, V. N. 1984. Taxonomy of Angiosperms Tata McGrow-Hill Publication Com. Ltd., New Delhi

Primak, R. B. 2004. A Primer of Conservation Biology. Sinauer Associales, Inc. Publishers

Quicke, Donald, L. J. 1993. Principles and Techniques of Commemoratory Taxonomy. Blakie Academic and Professional, London

Stace, C. A. 1989. Plaul. Taxonomy and Biosystematics Etwaed Arnold, London.

Stuessy T. F. 2002. Plant taxonomy . The systematic Evaluation of comparative data. Biseu Sigh Mahendra Pal Sign Pehra Duk.

Taylor, D. V. and L. J. Hickey 1997. Flowering plaub : Origin, evolution and phylogeny CBS Publishers a Distributors New Delhi.

B O 2.3
Plant Pathology

Total Lectures : 60

Unit: I

1. **History of plant diseases:** Beginnings of modern plant pathology, conformation of Provost's work Anton De Bary, Khun period, plant pathology in 20th century. Contribution of Woronin, S. D. Garrett, J. C. Horsefall, K.C. Mehta, S. T. Sadavasivan, M. J. Trimulachari. **3**
2. **Symptomology and Epidemiology :** Disease identification based on symptoms, (external and internal,) epidemiology (Slow and rapid,) epiphytotics, disease forecasting. **6**
3. **Methods of Studying plant diseases and their diagnosis :** Field observation, collection of samples, laboratory studies, culturing of pathogenic organisms (fungi, bacteria, mycoplasma etc) **,** Koch's postulates. **6**

Unit: II

1. **Introductory Virology :** Nomenclature and classification of plant viruses, ultrastructure of TMV, TYMV, and Bacteriophage. Chemistry of plant viruses, isolation and purification of plant viruses. Economic importance of viruses. **5**
2. **MLO :** Classification, morphology and characteristics of MLO's Identification techniques of MLO's **3**
3. **Stages of disease development :** Pre penetration, Penetration, post penetration and colonization. **3**
4. **Defense mechanism in host :** Structural, physiological, genetical and chemical. **2**
5. **Role of environmental factors in disease development.** **2**

Unit:III

1. **History, symptomology, causal organism, etiology and management of diseases of :** Rice, Sugarcane, Jowar, Wheat, Bajra, , Pigeonpea, Rajmah, Tomato, Cabbage, Bhendi, Brinjal, Cucurbits, Chilly, Onion, Potato, Ginger, Turmeric. **15**

Unit: IV

1. **History, symptomology, causal organism, etiology and management of diseases of:** Banana, Grapes, Coconut, Papaya, Citrus, Tobacco, Gerbera, Roses, Coffee, Cotton, Sunflower, Groundnut, Soybean, Sesamum, Teak, Dalbergia, Bamboo. **15**

Practicals :

Unit: I

1-4. Fungal Diseases : Club root, Damping off, White rust, Early and late Blight, Downy mildew, Powdery mildew, Smut, Rust, Bunt, Blast, leaf sopt, Tikka, Anthracnose, Rot, Wilt.

5. Bacterial Diseases : Citrus canker, Blight and Leaf Spot.

Unit: II

6. Mycoplasmal Diseases : Grassy shoot disease and Little leaf

7. Viral Disease : TMV, PMV and YVMV.

8. Nematode Disease : Root knot

9. Phanerogamic plant Diseases : Total and Partial root and stem parasites

10-12 Estimation of chlorophylls sugars and polyphenols fro healthy and infected leaves.

Reference Books :

Agrios, G. N. 1978 : Plant Pathology

Aneja, K. R. 1993. : Experiments in Microbiology, plant pathology and Tissue culture

Cooke, A. A. 1981. Diseases of Tropical and Subtropical field, Fiber and oil plants

Gangopadhyay , S. 2004: Clinical Plant Pathology

Kuijit, J. 1969: The Biology of parasitic flowering plants.

Mahadevan, A. and R. Shridhar, 1982. Methods in physiological plant pathology

Mehrotra, R. S. 1980: Plant Pathology

Nyvall, R. F. 1979 : Field Crop Diseases Handbook

Paul Khurama, S. M. 1998: Pathological Problems of Economic crop plants and their management

Planke, J. E. ander, 1968 : Disease Resistence in plants.

Planke, J. E. Vander. 1963 : Plant Diseases Epidemics and control

Rangaswami, G. 1979 : Diseases of crop plants in India

Singh, R. S. 1998 : Plant Diseases

Current and back – Volumes of following periodicals :

1. Journal of phytopathology
2. Indian journal of phytopathology
3. Journal of Mycology and plant pathology
4. Annual review of plant pathology

B O 2.4 (Elective II)
Plant Resource Utilization and Conservation

Total Lectures: 60

Unit: I

1. Economic importance of microbes **5**

2. Economic importance and utilization of Lower Plant Groups **5**

3. Role of fungi in industries with reference to the production of alcohol, organic acids, antibiotics and enzymes. **5**

Unit: II

1. Green revolution: Benefits and adverse consequences **2**

2. Important fire wood and timber yielding plants and non-wood forest products (NWFPs) such as bamboos, raw-materials for papermaking, gums, tannins and dyes, resins and fruits. **6**

3. Origin, evolution, botany and uses of food crop (rice and pigeonpea), Fibre crop (Agave), Medicinal and Aromatic plants (Curcma longa; Artimesia), Vegetable oil yielding crop (Safflower, Sunflower) Sugar and biomass crop (Sugarcane) **7**

Unit: III

1. A brief account of major spices, condiments, narcotics, mastigatories and funmitories and beverages **2**
2. General account of petrocrop **2**
3. Plants used in Sericulture **2**
4. Ethnobotany : basic principles and scope **4**
5. Ornamental plants **2**
6. Plants used as avenue trees for shade, pollution control and esthetics **3**

Unit: IV

1. Principles of conservation, extinction, environmental status of plants based on International Strategies for conservation – ***in situ*** conservation : International efforts and Indian initiatives; protected areas in India – sanctuaries national parks, biosphere reserves, Wetlands, mangroves and coralreefs for conservation of wild biodiversity **5**

2. Strategies for conservation: ***ex situ*** conservation: Principles and practices; botanical gardens, field gene banks, seed banks, in vitro repositories, cryobanks, general account of the activities of Botanical Survey of India (BSI), National Bureau of Plant Genetic Resources (NBPGR), Indian Council of Agricultural Research (ICAR), Council of Scientific and Industrial Research (CSIR) and the Department of Biotechnology (DBT) for conservation, non-formal conservation efforts. **10**

Practicals :

Unit: I

1. Study of food crops : Wheat, Maize, Chickpea, Sugarcane
   Morphology, anatomy, microchemical tests for stored food materials.
2. Forage / fodder crops : Study of important crops of the locality (Sorghum, Bajra.) 1) Estimation of proteins
3. & 4. Plant fibres
   a) Textile fibres : Cotton, Agare
   b) Cordage fibres : Coir
   c) Fibres for stufting : Silk cotton / Kapok

   Morphology, anatomy, microscopic study of fibre using appropriate staining procedure.
5. & 6. Medicinal and aromatic plants : Depending upon the geographical location select any five from campus / wild / crop field *Catharanthus roseus, Adhatoda zeylanica (*Syn*, A vasica) Jasminum, Mentha, Cymbopogon sp.*

Unit: II

7. and 8. Vegetable oils :Mustard, Safflower, soybean Morphology, microscopic structure of oil-yielding tissues, tests for oils and iodine number.
9. Petro and Sericultural crops.
10. Gums, resins, tannins, dyes : Perform simple tests for gums and resins. Prepare a wet extract of vegetable tannins (Acaeia, Terminalia, Mangroves) Dyes (Turmeric , Bixa, Butea, Lawsonia)
11. Economically important lower plants – two from each group.
12. Field survey and submission of report and scientific visits

Books :

A manual of ethnobotany Ed., S. K. Jain, Eciatific publications Jodhpur

A New moral Economy to India's forests ? – Roger Feffery and Nandini Sundar (1999). Sage Pub., New Delhi.

Advances in Oilseeds Production and Technology, G. V. Ramanamurthy. ICAR New Delhi (1985)

Agricultural Botany. N. T. Gill and K. C. Vear. Garal Duekworth and Co. Ltd. London (1969)

Agrofrestry India Perspeetive. L.K. Jha and P. K. Sengupta. Ashish Publishing House., New Delhi

Allen and Unwin Ltd., London (1954)

Applied Ethnobotany – E.Varghesee S-VD
Complete Gardening of India. K. S. Gopalaswaniengar, Rengedhy G. Parthasarathy and P. Mukadam. Pupl. By G. Partha ocrruthy Bengalore (1991)
Crop Protection Principles and Pratices, S.R. Chapmen and L.P. Carter. Publ. W. H. Freeman and Company Son Fran (1976)
Deep Aublicatins, New Delhi (1996)
Economic Botany, B. B. Simpson and M-Conner
Economic Botany, Hill A. Mcgrow Hill Book Company (1962)
Energy Plant Species. Their use and inpact on environment and development. N. El. Bassam. Publ. Jemes and Jemes (Science Publichers) U. K. (2005)
Field crops of India by A.K. Aiyer. Banglore Printing and Publishing Company Bangalore (1966)
Forest Management (1996). P. R. Trivedy and K.M. Sudarshan. Discovery publishing House, New Delhi.
Forest Resources – Crises and Management Natraj Publishers, Dehradun. Vandana Shiva, V. M. Meherhomji and N.D. Joryal (1992)
Forestry and the People (1994) L. K. Jha and P. K. Sen Sharma . Ashish Pub. House, New Delhi.
Forestry Handbook Ed. R. D. Forbes Publ. The Ronald Press Company New York (1955)
Foristry Research and Education in India. P.D. Dogra and R C. Dhiman (edt.) 1994. A Diamond Jubilee Publication by INSA, New Delhi.
Frrest Wealth of India Inaccesible to impoverished. R. A. Jaji. Day Publishing House New Delhi (1997)
Handbook of Agriculture, ICAR New Delhi (1969)
Handbook of Sericultural Technologies. S. B. Donlin, Jayant Jaiswal and K. Giridhar. Publ. Central silk Board, Ministry of Textiles, Govt. of India. Bengalore (2001)
Herbal Medicines for human health. Chaudhary R.R. (1994) CBS Publishers New Delhi
Contributions to Ethnobotany of India. S. K. Jain
Indian Agriculture, 19996, Vikas Singhal Indian Economic. Data Res. Center. New Delhi.
Introduction to Spices, Plantation crops medicinal and arremats Plants. N. Kumar, A. Khader, P. Rangaswami, I. Iralappan
Management of Minor forest produce for sustainability M. P .Shiva, R. B. Mathur (1996). Orford and IBH publishing Co. Pvt. Ltd., New Delhi
Modern General Science and Technology by Y. Pomeranz VCH Publ. Inc. (1987)

New Crops for Food and Industry. Ed. G. E. Wickens. N. Hag, P.Day, Chapmen and Hall Publi. London

Ogorzaly, McGraw Hill Intenational Edition (1986)

Oxfod- IBM publ. New Delhi (1997)

Plants For Man., R-M. Schery, George

Scientific Publishers Jodhpur 1996. The Useful Plants of India. K. Rmachandran (1986) CSIR New Delhi.

The biological aspects of rate plants conservation Syrge Hugh (ed.) John Wiley and Sons. 1980.

The Purpose of forests – Jack Westoby (1987). Basil Blackwell Inc. New York

Tropical – Pulses by J. Smartt – Lengman Group Ltd., Great Pritan (1976)

Tropical forest Resources FAC Forestry Paper (1962)

Wealth of India - Old and New Series CSIR Publication

SEMESTER III
BO 3.1: CYTOGENETICS AND CROP IMPROVEMENT

Total Lectures: 60

Theory (4 Units, 60 Lectures)

Unit 1: 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, Banding patterns, Karyotype evolution **15**

Unit 2: a) **Genetics of Prokaryotes and Eukaryotes:** Mapping of prokaryotic and eukaryotic genome, Mobile genetic elements and their significance, Gene families, Genetics of chloroplasts and mitochondria, Cytoplasmic male sterility **7**

b) **Crop Genetic Resources:** Centers 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 **8**

Unit 3: Population and Evolutionary Genetics: Evolutionary theory and population genetics, Theory of allele frequencies, Changes in genetic structure of populations (Mutation, Genetic drift, Migration, Natural selection), Genetic variations in natural populations (Protein variation and variation with RFLP and DNA sequences) **15**

Unit 4: Classical and modern methods of crop breeding and improvement: Genetic variability in crop plants, Heterosis, Methods of breeding in self and cross pollinated crops, Molecular plant breeding, Molecular marker systems, Importance of molecular marker assisted breeding, Applications of computer in plant breeding **15**

Practical (2 Units, Any 8)

1. Visit to National Research Institute/ NBPGR centers/ Seed Company and submission of field diary.
2. Determination of mitotic index.
3. Karyotype analysis in any two plant species.
4. Isolation of plasmid from *E. coli*.
5. Orcein banding
6. Isolation of DNA and quantification by spectrophotometer.
7. Smear preparation of *Allium cepa, A. sativum, Vicia faba, Aloe vera, Chlorophytum species, Rhoeo discolor* or any other ideal plants **2**
8. Study of floral biology of crop plants **2**
11. Genetic problems on gene mapping in higher plants
12. Centers of origin of crop plants.

Suggested readings:

Avers, C. J. Genetics. Van No Strand Reinhold.

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. Molecular cell biology. Scientific American Books.

Gardner, E. J. Principles of genetics. John Wiley and sons, New York.

Jahier, J. Techniques of plant cytogenetics. Oxford and IBH Publishing.

Lewin, B. Genes IV, V, VI. Oxford University Press,

Mandal, A. K., Ganguli, P. K. and Banarjee, S. P. Advances in plant breeding Vol. I and II.

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. Principles and practice of plant breeding. Tata McGrow 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.

Strickberger, M. W. 1968. Genetics. The Macmillan Company, New York.

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:

1. Indian Journal of Genetics and Plant Breeding.
2. Journal of Genetics
3. Journal of Cytology and Genetics
4. Cytologia
5. Caryologia
6. International Journal of Food Science and Technology

SEMESTER III

BO 3.2: BIOTECHNOLOGY & GENETIC ENGINEERING

Total Lectures: 60

Theory (4 Units, 60 Lectures)

Unit 1: a) Biotechnology: Concept, scope and importance **4**

b) Applications of plant tissue culture **4**

c) Techniques of enzyme and cell immobilization, its application in industry **7**

Unit 2: a) Bacterial Biotechnology: Bacterial nutrition and culture, scope and application of bacteria in agriculture with reference to biological nitrogen fixation, biogas generation, biological control and recycling of waste **7**

b) Microbial products: production of microbial biomass, primary and secondary metabolites and enzymes. Bacterial transformation and genetic improvement of microbes, fermentation technology **8**

Unit 3: a) Recombinant DNA technology: Gene cloning, principles and techniques, construction of genomic and cDNA libraries and vectors **8**

b) Genetic engineering of plants: Aims, strategies for development of transgenic, Agrobacterium Mediated gene transfer, selection **7**

Unit 4: a) Hybridoma technology and stem cells **4**

b) Introduction to genomics, proteomics and bioinformatics **4**

c) Introduction to environmental biotechnology **4**

d) IPR: Concept, importance, ecological risks and ethical concerns **3**

Practical (2 Units, Any 8)

1. Isolation of root nodule bacteria.
2. Isolation and culture of bacteria.
3. Production of alcohol by microbes.
4. Estimation of alcohol.
5. Effect of biofertilizers on growth of plant.
6. Seed dressing and inoculation with *Rhizobia*
7. Enzyme / cell immobilization.
8. Study of phyto-remedation
9. Study of bacterial growth pattern.
10. Study of *Agrobacterium* mediated transformation.

Suggested readings:

A Text Book of Biotech by R.C.Dubey.

Aneja K.P.: Experiments in Microbiology, Plant pathology tissue culture and mushroom cultivation. Weshwa Prakashan, New Delhi, 1996, 2nd Ed.

Boyce, C.O.L. : Novo's Handbook of Practical Biotechnology. Novo Industry, A/S, 1986.

Dodds, J.H.and L. W. Roberts: Experiments in plant tissue culture, Cambridge Univ.Press, Cambridge, 1985.

Gamborg, O.L.,G.C.Phillips : Plant Cell, Tissue and organ culture, Fundamental Methods. Narosa Pub.House, New Delhi, 1995.

General Microbiology by S.B. Sullia and S Shantharam.Oxford & IBH, Pub.Co.2005

Kumar H.D.: Molecular Biology and Biotechnology, Vikas Pb. New Delhi, 1993.

Molecular Biotechnology, Principles and Applications of Recombinant DNA- Bernard and Glick and J.J Pasternals.-Ason Press Washington 1984.

Razdan, M.K.: An Introduction to plant tissue culture oxford & IBH Pbl.Ltd., New Delhi, 1994.

Reinhert,J. and Y.P.S. Bajaj.: Applied and fundamental aspects plant cell, tissue and organ culture, Springer Verlag, Berlin, 1977.

Tauro, P.Kapoor, K.K.and K.S.Yadav: An Introduction to Microbiology, Wiley Estern Ltd., New Delhi 1996.

Trehan K. Biotechnology, Wiley Eastern Ltd., New Delhi 1994.

Trends in Biotechnology.

Semester –III
PLANT PHYSIOLOGY`(Special Paper – I)
B O – 3.31 Advanced Plant physiology and plant Biochemistry

Total Lectures-60

Unit –I

1.**Respiration** – whole plant 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. **15**

Unit –II

2.**Photosynthesis**-A brief outline of chlorophyll biosynthesis and the pigment organization in thyllakoid membrane. Regulation of PCR Cycle and C4 Pathway, RUBISCO and PEP Case, C3 – C4 intermediates. **15**

Unit –III

3.**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. **10**

4. **Organic acid metabolism** –Metabolism and roles of oxalic acid, ascorbic acid and malic acid . **5**

Unit –IV

5. **Secondary metabolites** –Shikimate Pathway and its role in biosynthesis of Secondary Metabolites. **8**

6.**Phosphorus nutrition** – Forms of phosphorus in soil. Phosphorus uptake, factors controlling 'P' uptake, 'P' fractions in plants. Role of Pyrophosphate in plant metabolism. **7**

Practicals :–

Unit –I
1. To study the effect of potassium on glycolytic enzyme pyruvate kinase .
2. Estimation of starch.
3. Study of Oxalic acid accumulation in leaf tissue.
4. Estimation of Ascorbic acid.
5. Estimation of Polyphenols.
6. Estimation of Cellulose.

Unit –II
7. Study of Phosphorus distribution in different plant parts.
8. Study of enzyme inorganic pyrophosphatase.
9. Study of effect of light on chlorophyll biosynthesis.
10. Study of enzyme polygalacturonase.
11. Study of enzyme phenylalanine ammonia lyase.

Suggested readings:-

Bidwell, R. C. S. (1979): Plant Physiology.

Bonner, J. and Varner, E. (1976): Plant Biochemistry.

Edwards, G., Walker, D. W. (1983): C3- C4 mechanism and cellular environmental regulation of photosynthesis.

Govindjee, H. (1982): Photosynthesis Vol. I & II.

Hopkins, W. C. (1995): Introduction to Plant Physiology.

Krishnamurthy, H.N. (1992): Physiology of Plant Growth and Development.

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

Miller, P (9173) : Phytochemistry Vol.I, II and III.

Moore, T.C. (1974): Research experience in Plant Physiology, a laboratory manual.

Mukharjee, S.P. and Ghosh A.N. (1996): Plant Physiology.

Noggle, G.R. and Fritz, G. J. (1976): Introductory Plant Physiology.

Randhir Singh and Sawhney, S. K. (1988): Advances in frontier Areas of Plant Biochemistry.

Sadashivam and Manikam (1996): Plant Biochemical methods.

Salisbury, F. B. and Ross, C.W.(1992): Plant Physiology IV ed.

Sinha S.K., Sane P.V., Bhargava S.C. and Agarwal P.K. (1990): Proceeding of International Congress of Plant Physiology Vol. I & II.

Smith, H. (1975): Phytochrome and Photomorphogenesis.

Steward F.C. (1976): Growth and Organization in plant.

Stump, P.K. and Conn, E. (1980) : Biochemistry of Plants. A Comprehensive Treatise.

Taiz, L. and Ziegler, F. (1998): The Plant Physiology.

Pessarkli, M. (2004): Handbook of Plant and Crop Physiology, Marcel Dekkar Inc. NY.

Pessarkli, M. (2005): Handbook of Photosynthesis.

Wilkins, M. B. (1976): Physiology of Plant Growth and Development.

Annual reviews of Plant Physiology and Molecular Biology.

Indian Journal of Plant Physiology.

Journal of Experimental Botany.

Physiologia Plantarum Sweden.

Plant Physiology (Bethedsa, USA).

The Plant Cell.

Semester III
MYCOLOGY & PLANT PATHOLOGY
B O 3.32- Taxonomy of Fungi (Special paper I)

Total Lectures – 60

UNIT -I

1. General features of fungi. **04**
2. Various systems of classification of fungi. a. Ainsworth (1973) and b. Webstor (1980). **04**
3. Micrometry : Study of micrometry and its significance in fungal taxonomy. **04**
4. Culture : Types of culture media and their preparation, special culture media. **03**

UNIT -II

5. Criteria used in the classification of fungi. **15**
   a. Morphology : External and Internal.
   b. Vegetative and Reproductive.
   c. Cytological and Genetics.

UNIT –III **15**

   d. Serological and Nutritional.
   e. Physiological and Biochemical.
   f. Host specificity.
   g. Ultrastructural and cultural.

UNIT –IV

6. Microtomy : Types of microtomes, Techniques of microtomy, stains and fixatives used. **11**
7. Status of fungi and research in Mycology and Plant Pathology in India: An overview. **04**

Practicals (2 Units, Any 8)

UNIT-I 1. Measurement of fungal dimensions.

2,3 & 4.Measurement of spore size, determination of standard deviation and Frequency distribution, histogram and polygon.

5 & 6. Preparation of culture media, PDA, Czapeks Dox Agar and Richard's medium.

UNIT-II 7,8,9. Microtomy of fungal specimen.

10,11,12. Isolation of fungi from soil, water, air and host plant, their identification and Classification.

REFERENCE BOOKS:

Ainsworth, G.E.,Sparrow,F.K.and A.S.Sussman (1973): The Fungi,Vol. I,II, III ,

Alexopoulous, C.J.and C.W.Mims(1979) : Introductory Mycology.

Aneja K.R.(1993) : Experiments in Microbiology,Plant Pathology and Tissue

Barnett, H.L. (1960): Illustrated genera of imperfect fungi.

Bessey, E.A. (1967): Morphology and Taxonomy of fungi

Buller,A.H.R.(1909-50):Researches on Fungi Vol.I-VIII.

Gangopadhyay S. (1994): Clinical Plant Pathology.

Gangulee, H. S. and A.K.Kar (1992):College Botany Vol. II. IV-A and IV-B.

Johanson, D.A.(1940): Plant Microtechniques.

Kendrick,W.B. (1979): Taxonomy of fungi imperfecti.

Pandey,B.P.(1994): A Text Book of Botany: Fungi.

Rangaswamy G. (1975): Diseases of crop plants in India.

Raychudhary , S.R.et al.(1975): Advances in Mycology and Plant Pathology.

Sharma,O.P.(1989): Text Book of Fungi.

Journals

Annual Review of Plant Pathology.

Indian Journal of Plant Pathology.

Canadian Journal of Botany.

Mycologia.

SEMESTER III

CYTOGENETICS AND PLANT BREEDING (SPECIAL PAPER- I)

B O 3.33: CYTOGENETICS

Total Lectures – 60

Unit 1: a) Introduction to cytogenetics. Mitotic and meiotic cell division **5**

b) Meiosis: modes of meiosis, chromosome disjunction. Genetic control of meiosis, mechanism and theories of crossing over, Recombination models, Synaptonymal complex **10**

Unit 2: a) Structural variations in chromosomes, their cytological consequences, Gene mapping and other uses, Structural hybrids, B-chromosome its origin and consequences **8**

b) Numerical variation in chromosomes, sources and consequences, euploidy and aneuploidy, classification, natural and induced polyploids **7**

Unit 3: a) Genome analysis in crop plants: Wheat, Cotton, Tobacco, Triticale **8**

b) Alien genetic resources in crop improvement: Align addition and substitution lines, transfer of segment from align chromosome, possibilities and limitations **7**

Unit 4: a) Apomixis; types of apomixes in higher plants, significance in plant breeding **7**

b) *Drosophila* genetics: Life cycle, special type of chromosome, genetic regulation of development in *Drosophila* **8**

Practical (2 Units, Any 8)

1. Smear preparations in *Allium cepa, Zea mays, Delphinium malbaricum, Coix lacriamajobi.* (2)
2. Meiotic analysis in plants (Stages, chisma, chisma terminalization by using photographs) Pachytene analysis.
3. Meiotic studies in structural hybrids (*Rhoeo, Setcreatia Cynotis*). (02)
4. Study of aneuploidy and chromosome mapping in barely. (03)
5. Study of B chromosome in *Maize/ Drimia.*
6. Induction of polyploidy using Colchicine.
7. Cytological analysis of polyploidy in plants.
8. Genome analysis in wheat/ *Gossypium.*
9. Study of life cycle in *Drosophila melanogaste.r*
10. Special type of chromosome in *Drosophila melanogaster.*
11. Study of Apomictic Chromosome.

Suggested readings:

Special Paper- I

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

SEMESTER III

(Special Paper – I) ENERGY, ECOLOGY & ENVIRONMENT

BO 3.34 ENVIRONMENT AND ITS ASPECTS

Total lectures: 60 **Total Practicals: 11**

UNIT 1:

1. Abiotic Environment: Leibigs Law of minimum, Law of limiting factors. **(5)**

2. Environment in Terrestrial Ecosystems: **(5)**

Atmosphere

Climate- Classification of climate climographs. **(5)**

UNIT 2:

3. Environment in Aquatic Ecosystem:

i. Marine Environment- light, waves, currents, winds, tides. **(9)**

ii. Fresh water Environment – Wind- currents. **(6)**

UNIT 3:

4. Soils: formation, composition, soil profile, soil types of India. **(15)**

UNIT 4:

5. Land use classification, planning and management. **(7)**

6. Water: Resources and Management. **(8)**

Practicals: (2 Units any 8)

UNIT 5:

1. Analysis of water samples from polluted and non-polluted lakes for DO.
2. Field visits to Industrial area.
3. Study of effect of effluents on plant growth.
4. Determination of BOD at R.T.
5. Study of wilting coefficient.

UNIT 6:

6. Determination of quality of water by physical parameters (colour, EC, pH, TSS, TDS and TS).
7. Study of MPN as hydrobiological character.
8. Study of EC and pH of the soil.
9. Study of soil profile.
10. Determination of organic matter from soil.
11. Some ecological instruments used in air and water pollution studies.

Suggested readings:-

- Agarwal S. K. (1992) : Fundamentals of Ecology.
- Bradbury I. K. (1990) :The Biosphere.
- Das S. M. (1989) :Handbook of Limnology and water pollution with practical Methodology.
- Etherington J.R. (1975) : Environment and plant ecology : aims and development.
- Freedman H. I. (1980) : Deterministic mathematical models in population ecology.
- Greig Smith P. (1983) : Quantitative Plant Ecology.
- Grims J. P. et al (1988) : Comparative Plant Ecology.
- Hashimoto Y et al (1990) : Measurement techniques in plant sciences.
- Kershaw K. A. (1964) : Quantitative and dynamic ecology.
- Kormondy E. J. (1996) : Concept of ecology.
- Krebs C. J. (1978) : Ecology.
- Lieth H. F. et al (1973) : Patterns of primary production in the biosphere.
- Misra K. C. (1989) : Manual of plant ecology.
- Misra R. and Das R. R. (1971) : Proceedings of the school of plant ecology.
- Odum E. P. (1971) : Ecology.
- Odum E. P. (3rd ed. 1996) : Fundamentals of Ecology.
- Pandeya S. C. et al (1963) : Research methods in plant ecology.
- Watt K. E. F. (1973) : Principles of Environment Sciences.

SEMESTER III

B O-3.35 ANGIOSPERM TAXONOMY

(Special Paper-I)

Unit-I	**1**	**PRINCIPLES AND PRACTICES IN PLANT TAXONOMY:** Definitions and concepts, importance of taxonomy and need for classification, hierarchical classification, general and special purpose classifications, Alpha and Omega taxonomy, taxonomy as synthetic discipline.	**4**
	2	**THE NEW GLOBAL TAXONOMY INITIATIVES:** Systematic agenda-2000, systematic knowledge and value of biodiversity, the missions of systematic agenda-2000. Taxonomy and conservation of biodiversity.	**4**
	3	**A BRIEF HISTORY OF PRE-DARWINIAN CLASSIFICATIONS:** i) Systems based on habit: Theophastus, Albert Magnus, Otto Brunfels, Jerome Bock, Andrea Cesalpino, Jean Bauhin, Joseph Pitton *de* Turnfort, John Ray; ii)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.	**7**
Unit-II	**4**	**A BRIEF HISTORY OF POST DARWINIAN CLASSIFICATIONS:** The evolutionary theory by Darwin and Wallace, i) Systems based on phylogeny:The Englarian School of thoughts: August Wilhelm Eichler, Adoph Engler, Alfred Rndle, Karl Christian MezAugust A. Pulle, Carl Skottberg, B. Hayata; the Ranalian School of thoughts: Richard von Wettstein,Charles E. Bessey, Hans Hallier, John Hutchinson, Oswald Tippo, Karl Mez, G. Gunderson, Lyman Benson.	**10**
	5	**RECENT SYSTEMS OF CLASSIFICATIONS:** By Armen L. Takhtajan, Authur Cronquist, R. M. T. Dahlgren and Robert F. Thorne.	**5**
Unit-III	**6**	**GENERAL EVOLUTIONARY TRENDS IN FLOWERING PLANTS:** With reference to habit and habitat, leaf structure, nodal anatomy, xylem and phloem, inflorescence, flower, androecium, pollen grains, gynoecium, placentation, ovules, seeds, seedlings and fruits.	**5**

	7	**TAXONOMIC HIERARCHY:** Ranks of Taxa, Forms of scientific names; major categories: division, class, order, family; minor categories: genus, species and infraspecific categories.	**3**
	8	**NOMENCLATURE:** A brief history of International Code of Botanical Nomenclature [ICBN]; Divisions; Principles; Nomenclatural terminology-Type method (typification)-holotype, isotype, syntype, lectotype, paratype, neotype; Effective and Valid publication; Priority; Scientific names-Correct name, Autonym, Basionym, Homonym, Synonym, Tautonym; alternative, ambiguous, illegitimate, naked, rejected and superfluous names.	**7**
Unit-IV	**9**	**MORPHOLOGICAL VARIATIONS, SYSTEMATIC POSITION, INTERELATIONSHIPS, PHYLOGENY AND ECONOMIC IMPORTANCE OF FOLLOWING FAMILIES:** Magnoliaceae, Lauraceae, Piperaceae, Aristolochiaceae, Nymphaeaceae, Moraceae, Urticaeae, Casuarinaceae, Alismataceae, Hydrocharitaceae, Najadaceae, Aponogetonaceae.	**15**
Unit-I		**PRACTICALS/LABORATORY EXCERCISES** • Exercises on nomenclature problems: Author citation, principle of priority, transfer of taxa, effective and valid publication etc • Describing new taxon, deposition of type, Latin diagnosis and abbreviations used in citations. • Phytography: preparation of scientific botanical description of a plant specimen • Study of morphology and general evolutionary trends in flowers, stamens and carpels of primitive families viz. Magnoliaceae, Ranunculaceae, Papaveraceae, Dilleniaceae, Alismataceae, Aponogetonaceae, Nymphaeaceae, Nelumbonaceae, Lauraceae, Hydatellaceae	**15**
Unit-II		• Study of different types of ovules, placentations and evolutionary trends therein. • Descriptions, Sketching, classification and identification of families: Magnoliaceae, Lauraceae, Piperaceae, Aristolochiaceae, Nymphaeaceae, Moraceae, Urticaeae, Casuarinaceae,	**15**

		Alismataceae, Hydrocharitaceae, Najadaceae, Aponogetonaceae and identification of wild and cultivated plant species using regional and national floras. Any additional practical/s based on theory syllabus will be added whenever necessary.	

Reference books and Journals:

- 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 Tommorow 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 Com. Ltd. 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 & Distributers, New Delhi.
- Lawrence George H. M. 1951. ***Taxonomy of Vascular Plants***. Oxford and IBH Publ. Co. Pvt. Ltd. New Delhi .
- Takhtajan, A. 1962. ***Flowering plants- Origin and Dispersal.***
- Hutchinson, J. 1959. ***Families of Flowering plants***.
- Judd Walter S., Cmpbell C. S., Kollogg, E. A., Stevens P.F. and M. J. Donoghue 2008. Plant Systematics. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.

M. Sc. PART II (SEMESTER III)

MARINE BOTANY (SPECIAL PAPER I)

BO – 3.36 GENERAL MARINE BOTANY

Total Lectures: 60

UNIT 1: MARINE PLANT GROUPS AND ORGANISMS: Introduction and classification, Brief idea of Plankton, Nekton, Benthos. Marine phytoplankton- dinoflagellates. nanoplankton, ultraplankton, coccoliths. **6**

MARINE FUNGI, ACTINOMYCETES, LICHENS. AND BACTERIA: Brief idea. **5**

CORALS, FOSSIL MANGROVES: Brief introduction. **4**

UNIT 2: MICRO AND MACROALGAE: Taxonomy, cytology, ultrastructure, salient features of Myxophyceae (Cyanophyceae), Bacillariophyceae, Chlorophyceae, Rhodophyceae and Phaeophyceae. Life histories of a few important species **.** **15**

UNIT 3: BIODIVERSITY OF MANGROVES: Brief idea of Creek, Estuary, Lagoon and Delta. Definition of the term 'mangrove', Distribution –biogeography of Indian mangroves, East and West coast mangroves, Mangrove shores and forests. Salient features of important mangrove families such as Rhizophoraceae , Sonneratiaceae Avicenniaceae, Myrsinaceae, Acanthaceae etc. **15**

UNIT 4: SALT MARSHES: Taxonomy, Distribution, Morphological and anatomical adaptations. **5**

SEA GRASSES: Taxonomy, distribution, adaptations, morphology, anatomical features. **5**

SAND DUNE VEGETATION: Formation of coastal sand dunes. Dune vegetation, Restoration and protection of dune ecosystem. **5**

PRACTICAL COURSE I

UNIT 5: a) Study of characteristic features of Chlorophyceae Ex. ***Enteromorpha,Chaetomorpha*, *Ulva ,Caulerpa, Bryopsis*** etc.

b) Study of characteristic features of Phaeophyceae Ex. ***Padina, Dictyota, Sargassum*** etc.

c) Study of characteristic features of Rhodophyceae Ex. ***Gracilaria, Gelidium , Hypnea*** etc.

d) Sampling and identification of phytoplankton.

e) Demonstration of phytoplankton / algal culture technique.

UNIT 6: a) Study of mangrove associates and /or halophytes(***Aeluropus,Halophila*** etc.)

b) Type study of mangroves from Rhizophoraceae.

c) Type study of mangroves from Avicenniaceae and Sonneratiaceae.

d) Type study of mangroves from Myrsinaceae and Acanthaceae.

e) Study of sand dune plants (***Spinifex,Ipomoea*** etc.).

SUGGESTED READINGS :-

1. Chapman,V. J. (1976). Costal Vegetation. II nd edition Pergamon Press. New York.
2. Desikachary, T. V. (1975). Marine Plants. N. C. E. R. T. New Delhi.
3. Kumar H.D. Introduction to Phycology.
4. Kumar H.D. and H.N.Sing (1990). Algae. Affiliated East West Press pvt. Ltd. publ. New Delhi.
5. McConnaughey,B. H (1974). Introduction to Marine Biology.
6. Ranade, D. R. & Gadre, R. V. (1988). Microbial Aspects of Anaerobic Digestion. Laboratory Manual., M.A.C.S. Pune.
7. Sambamurthy,A.V.S.S.(2005). A Text Book of Algae.
8. Santhanam, R.; Ramnathan,N.; Venkataramanjan K. & Jegathanam,G. (1987) . Phytoplankton of Indian Seas. & Aspects of Marine Botany.Daya Publication Home. Delhi.
9. Sen Neera and Kumudranjan Naskar, (2003). Algal Flora of Sundarbans. Mangal Daya
10. Stein, J. R. (1973) Handbook of Phycological Methods. Cambridge University Press.
11. Trainor,F. R. Introductory Phycology.
12. Vashishta, B. R. (1995). Algae S. Chand and co. Ltd., new Delhi.

SEMESTER III
PLANT BIOTECHNOLOGY (SPECIAL PAPER- I)

B 0 3. 37 : PLANT TISSUE CULTURE- I

Theory (4 Units, 60 Lectures)

Unit 1:

a) **Plant tissue culture**: Objective and goals of Plant tissue culture, laboratory design and development, operation and management **(3);** b) **Plant tissue Nutrition**: Basic principles of in vitro culture, factors influencing morphogenesis, Physiological significance of tissue nutrition **(7);** c) **Media preparation**: Media preparation and handling, sterilization technique, equipment and apparatus, procedure of media preparation and stock solution **(5).**

Unit 2: a) **Types of Culture:** Explant culture, Callus formation and its culture, Callus desiccation, organogenesis, meristem culture, axillary bud culture – protocols and schedules of observation **(10);** b) Somaclonal variation; selection **(5).**

Unit 3: a) Organ culture anther/ovary culture, embryo rescuing, synseed **(4);** b) Hardening of tissue cultured plants **(2);** c) Cell suspension culture, cell line isolation **(5);** d) Hairy root culture **(4).**

Unit 4: a) Green house technology; conservation, operation, maintenance, management **(10);** b) Cryopreservation, its importance and future prospects **(5).**

Practical (2 Units, Any 8)

1&2.	Media preparation	(2)
3.	Sterilization techniques	(1)
4&5.	Callus culture	(2)
6&7.	Organogenesis	(2)
8&9.	Cell suspension culture	(2)
10.	Techniques of hardening	(1)
11.	Visit to commercial R&D green houses, agro based industries	(1)

Suggested readings:

Special Paper- I

1. Bhojwani, S.S.and Razdan, N. K. 1983.plant tissue culture, theory and practice. Elsevier Publ.
2. Dixon, R.A. 1985. Plant cell culture- a practical approach. Oril Press Oxford.
3. Doddas, J.H.and Roverts, L.W.1985. Experiments in plant tissue culture. Cambridge Uni. press.
4. Evans *et al* 1983. Hand book of plant cell culture vol. I, II, III. McMillan Publ. Co., New York.
5. Gamborg, O.L.and Phillips, G.C.1966.Plant, tissue and organ culture fundamental Methods.Narosa Publishing House.
6. Narayanswamy, S. 1997.Plant cell and tissue culture.Tata McGraw Hill Publishers, New Delhi.
7. Nelson, P.V.1973.Greenhouse operation and management.Reston Publishing Co.Inc.
8. Old, R.W.and Primerose, S.B.2002.Principles of gene manipulation.Blackwell, Oxford, England.
9. Raghavan, V.1997.Molecular embryology of flower plants. Cambridge Uni. Press.
10. 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.
11. Reddy, S.M., Srivastava, H.P., Purohit, D.K., and Reddy, S.R.1997.Microbial biotechnology. Scientific Publishers, Jodhpur, India.
12. Reinsert, J.and Bajaj, Y.P.S.1976.Plant cell, tissue and organ culture. Springer Verlag, Berlin, Heidelberg, New York.
13. Street H.E. 1974. Tissue culture.Academic Press, New York.
14. Thorpe, T.A.1981. Plant tissue culture.Academic Press, New York
15. Vasil, I.K.1984.Cell culture and somatic cell genetics of plants (I).Laboratory procedures and their applications. Academic Press Inc.

Semester –III
PLANT PHYSIOLOGY
B O 3.41 Plant Growth and Development
(Special Paper II)

Total Lectures-60

Unit –I

1.**Growth and Morphogenesis**-Meristems in plant development. A brief idea about development of plant organs: root, stem, leaf and flower. **Photomorphogenesis** ; History and discovery of phytochromes and cryptochromes and their photochemical and biochemical properties . A brief idea about phytochrome biosynthesis, cellular localization, roles , mechanism of action of photomorphogenetic receptors. **11**

2. **Plant movements** – Phototropism, geotropism and nastic movements. **04**

Unit –II

3. **Pollen germination** –Physiology of pollen germination and pollen stigma interaction. **04**

4. **Senescence and PCD**- Biochemical changes during senescence of leaves and petals and regulation of senescence. Programmed Cell Death. **06**

5. **Seed Development** –Biochemical changes during development of seeds.

Unit –III

6. **Post harvest Physiology** –Ripening of fruit and its regulation. Metabolism of leafy vegetables during storage. **06**

7. A brief idea about role of tissue culture, and mutants in physiological studies. **03**

Unit –IV

8. **Plant Growth Regulators** – A brief idea about discovery, role and possible mechanism of action of a)Triacontanol, b)Brassins, c)Salicylic acid, d)Jasmonates e)Polyamines . A brief idea about role of plant growth retardants a)CCC, b)Maleic hydrazide, c)Trizoles d)TIBA. **15**

Practicals:-

Unit –I
1, 2. Hormonal regulation of leaf and petal senescence.
3, 4. Study of changes in RNA and Proteins during senescence.
5. Study of changes in starch / protein content during seed development.
6. Study of enzyme acid phosphatase during ripening of fruits.

Unit –II
7. Study of changes in respiration rate during ripening of fruits.
8. Study of lipid accumulation during development of oil seeds.
9. Effect of chemical compounds on pollen germination.
10. To study the effect of different PGRs on seedling growth

Suggested readings:-

Bidwell, R. C. S. (1979): Plant Physiology.

Bonner, J. and Varner, E. (1976): Plant Biochemistry.

Edwards, G., Walker, D. W. (1983): C3- C4 mechanism and cellular environmental regulation of photosynthesis.

Govindjee, H. (1982): Photosynthesis Vol. I & II.

Hopkins, W. C. (1995): Introduction to Plant Physiology.

Krishnamurthy, H.N. (1992): Physiology of Plant Growth and Development.

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

Miller, P (9173) : Phytochemistry Vol.I, II and III.

Moore, T.C. (1974): Research experience in Plant Physiology, a laboratory manual.

Mukharjee, S.P. and Ghosh A.N. (1996): Plant Physiology.

Noggle, G.R. and Fritz, G. J. (1976): Introductory Plant Physiology.

Randhir Singh and Sawhney, S. K. (1988): Advances in frontier Areas of Plant Biochemistry.

Sadashivam and Manikam (1996): Plant Biochemical methods.

Salisbury, F. B. and Ross, C.W.(1992): Plant Physiology IV ed.

Sinha S.K., Sane P.V., Bhargava S.C. and Agarwal P.K. (1990): Proceeding of International Congress of Plant Physiology Vol. I & II.

Smith, H. (1975): Phytochrome and Photomorphogenesis.

Steward F.C. (1976): Growth and Organization in plant.

Stump, P.K. and Conn, E. (1980) : Biochemistry of Plants. A Comprehensive Treatise.

Taiz, L. and Ziegler, F. (1998): The Plant Physiology.

Pessarkli, M. (2004): Handbook of Plant and Crop Physiology, Marcel Dekkar Inc. NY.

Pessarkli, M. (2005): Handbook of Photosynthesis.

Wilkins, M. B. (1976): Physiology of Plant Growth and Development.

Annual reviews of Plant Physiology and Molecular Biology.

Indian Journal of Plant Physiology.

Journal of Experimental Botany.

Physiologia Plantarum Sweden.

Plant Physiology (Bethedsa, USA).

The Plant Cell.

Semester III
MYCOLOGY AND PLANT PATHOLOGY
B O 3.42 Integrated Disease Management (Special paper II)
(Concepts and Application I)

Total Lectures – 60

UNIT –I

1. Principles of Plant Pathology: History, Classification of crop diseases: Viral, Bacterial, Fungal and Nematode. Deficiency of micronutrients. **05**
2. Seed Pathology : Methods of detection of internal and external seed borne Fungi, Bacteria and Viruses, biodeterioration and mycotoxins. **10**

UNIT-II

3. Role of enzymes and toxins in disease development. Cell wall degrading enzymes ; Cellulolytic , Pectolytic, Proteolytic and Lipolytic. Toxins lycomarsmine, alternic Acid, Fusaric acids, Piricularin, Victorin, aflatoxins. **15**

UNIT-III

4. Physiology and Biochemistry of host pathogen interaction, Respiration, Photosynthesis, Proteins, Nucleic acids, phenol metabolism and plant growth regulators. **15**

UNIT-IV

5. Genetics of host pathogen interaction, gene for gene hypothesis, protein for protein hypothesis, antigen and antibody reaction. Immunoglobulines, application of immunological techniques, physiological specializations. **15**

Practicals (2 Units, Any 8)

UNIT-I 1,2 & 3.Production of Pectolytic, Cellulolytic, Amylolytic enzymes.
4. Estimations of nucleic acids from healthy and infected plants.
5. Use of Biocontrol agents against plant pathogens.
6. Extraction and detection of aflatoxins from fungi.

UNIT- II 7. Estimation of protein from healthy and infected plants.
8 & 9.Study of external and internal seed mycoflora.
10. Immunological techniques-purification and fragmentation of immunoglobulins.
11 & 12. Study of symptomology and histo-pathology of diseases mentioned in the theory.

REFERENCE BOOKS:

Agrios, G.N.(2006):Plant Pathology (5th Edition).

Aneja K.R.(1993) : Experiments in Microbiology,Plant Pathology and Tissue

Cooke, A.A.(1981):Diseases of Tropical and Subtropical Field, Fiber and Oilplants.

Gangopadhyay S. (1994): Clinic

al Plant Pathology.

Gangulee, H. S. and A.K.Kar (1992):College Botany Vol. II.

Kuijit, J. (1969): The Biology of parasitic flowering plants. Uni. Of California Press,U.S.A.

Mahadevan, A. and R. Sridhar (1982): Methods in Physiological Plant

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

Ny vall, R.F.(1979): Field Crop Diseases Handbook.

Padoley, S.K. and P.B.Mistry: A manual of Plant Pathology.

Paul Khurana, S.M.(1998):Pathological problems of Economic Crop Plants and their Management.

Plank J.E.Van der (1963): Plant Diseases, Epidemics and Control.

Plank,J.E.Van der (1968): Disease Resistance in Plants.A.P.London and New York.

Rangaswamy G. (1975): Diseases of crop plants in India.

Singh, R.S.(1963): Plant Diseases.

SEMESTER III

CYTOGENETICS AND PLANT BREEDING (SPECIAL PAPER – II)

B O 3.43: PLANT BREEDING

Theory (4 Units, 60 Lectures)

Unit 1: a) Objectives of Plant Breeding **(1);** b) Domestication, Selection under domestication; Introduction, Quarantine; and Acclimatization of plants **(2);** c) Germplasm: Gene pool concept, Genetic erosion, Exploration and collection of germplasm, conservation and utilization **(2);** d) Mechanism of pollination control: self-incompatibility and male sterility **(10).**

Unit 2: a) Inheritance of qualitative and quantitative characters **(8);** b) Biometrical techniques in plant breeding: Introduction, Assessment of variability, Components of variance, Genetic diversity **(7).**

Unit 3: a) Aids to Selection: Correlation coefficient analysis, Path analysis and Discriminant functions **(5);** b) Choice of parents and breeding procedures: Diallele, partial diallele, Triallele, Line tester, Generation mean analysis, Biparental cross analysis with various designs and Varietal adaptation **(10).**

Unit 4: a) Breeding for biotic and abiotic stresses: Disease and Insect resistance; Drought, Salinity, Heat and cold resistance **(10);** b) Mutation breeding **(5).**

Practical (2 Units, Any 8)

1. To study the effect of mutagens on germination, seedling growth and on mitosis **(02).**
2. To study crossability between cultivars and their wild relatives **(02).**
3. Germplasm collection, cataloging, data storage and retrieval **(02).**
4. Study of pollen germination and demonstration of incompatibility.
5. Study of Cytoplasmic male sterility.
6. Estimation of heritability **(02).**
7. Designing field experiments **(02)**
8. Metroglif analysis.
9. D^2 analysis.
10. Screening of germplasm for biotic and abiotic stresses **(03)**

Special Paper- II

1. Singh, B. D. 2000. Plant breeding- Principles and methods. Kalyani Publishers, Ludhiana.
2. Sharma, J. R. Principles and practice of plant breeding. Tata McGrow Hill Publ. Co. Ltd., New Delhi.
3. Siddiqui B. A. and Khna S. 1999 Breeding in crop plants. Mutation and In vitro mutation breeding . Kalyani Publishers New Delhi
4. IAEA 1995 Induced mutations and Molecular techniques for crop improvement. Proc FAO/IAEA Symposium Vienna
5. IAEA 1991 Plant Mutation Breeding crop improvement Proc. FAO/IAEA Symposium (Vol 1&2)Vienna
6. Micke A. 1991 Induced Mutation for crop improvement. Gamma Field Symposia No.30 Institute of Radiation Breeding Pullman USA.
7. Allard R. W. 1960 Principles of Plant Breeding John Wiley and Sons New York.
8. Hays H. K. , Immer F.R. and Smith D.C. 1955 Methods of Plant Breeding. McGraw Hill Book Company Inc New York.
9. Fehr W. R. 1987 Principles of Cultivar Development (2 Volumes) MacMillan Publishing Co. New York.
10. Poehlman J.M. 1986 Breeding Field Crops AVI Publishing Company Connecticut.
11. Sharma J. R. 1998 Statistical and Biometrical techniques in Plant Breeding New Age International Publishers New Delhi.
12. Singh R. K. and Singh B. D. 1997 Biometrical Methods in Quantitative genetic Analysis. Kalyani Publishers, New Delhi.
13. Vijendra Das L. D. 2000 Problems Facing Plant Breding CBS Publishers New Delhi
14. Rosielle A. A. and Hamblin J. 1981 Theoretical aspects of selection for yield in stress and non- stress environments Crop Sci, 21: 932-946.
15. Levitt J. 1980 Response of Plants to Environmental Stress: Water, Salt and Other stresses. Academic Press, New York.
16. Bulm A. 1988 Plant Breeding for stress Environments. CRC Press Florida.
17. Chopra V. L. 1989 Plant Breeding .oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
18. Roy Darbeshwar 2000, Plant breeding analysis and exploitation of variance. Narosa Publishers New Delhi.

Journals:

1. Indian Journal of Genetics and Plant Breeding.
2. Journal of Genetics
3. Journal of Cytology and Genetics
4. Cytologia
5. Caryologia
6. International Journal of Food Science and Technology
7. Mutation Breeding Newsletter
8. International Journal of Plant Breeding

SEMESTER III

(SPECIAL PAPER II) – ENERGY, ECOLOGY & ENVIRONMENT

BO-3.44 POPULATION AND COMMUNITY ECOLOGY

Total lectures: 60 **Total Practicals: 11**

UNIT 1:

1) **Population Ecology**: Population Regulation, Density dependant and Independent Regulation- Role of Different factors, Genecology-Ecads, Ecotypes, etc. Human Population Dynamics and predication. **(15)**

UNIT 2:

1) Community Ecology:

A) Community as a unit: Clementsian unit of vegetation. **(4)**

B) Community nature: Individualistic and organismic nature of communities, community stratification. **(11)**

UNIT 3:

C) Functional Aspects of community: Community Metabolism, Community Periodism. **(6)**

D) Community Stability: Maturation of Communities, Regulation of communities, community stability- Ecotone and Edge effect. **(6)**

E) Community as Indicator. **(3)**

UNIT 4:

F) Biodiversity: Levels, Global biodiversity, Biodiversity in India, Hot spots- Global and Indian, Threats to Biodiversity, Conservation of Biodiversity. Indian Biodiversity **(15)**

Practicals: (2 Units Amy 8)

UNIT 5:

1. Study of the Litter production.
2. Determination of similarity index.
3. Determination of association index.
4. Study of stratification and physiognomy.
5. Study of population dynamics.

UNIT 6:

6. Study of Vegetation by transect method.
7. Study of community bisects.Community function – Biomass production measurement, Biomass profile for the community.
8. Determination of IVI.
9. Estimation of phytoplankton biomass in terms of chlorophyll.
10. Visit to local protected or conserved area.

Suggested readings:-

- Abe, T., Levin, S. A. and Higashi, M. (1997) (ed.): Biodiversity an Ecological Perspective.
- Bradbury I.K.1990) : The Biosphere.
- Brij Gopal and Bhardwaj, N. (1979): Elements of Ecology.
- Galston, K. J. (1996): Biodiversity: A biology of numbers and differences.
- Greig Smith P. (1983) : Quantitative Plant Ecology.
- Hamdan, H. C. and Churchill, E. D. (1961): The Plant Community.
- Hashimoto Y *et al* (1990) : Measurement techniques in plant sciences.
- Kormondy E. J. (1996) (4th ed.): Concept of ecology.
- Krattiger, A. I. *et al* (1994): Widening Perspectives on Biodiversity.
- Krebs C. J. (1978) : Ecology.
- Misra K. C. (1989) : Manual of plant ecology.
- Nair, P. K. G. (1990): Principles of Environmental Biology.
- Odum E. P. (3rd ed. 1996) : Fundamentals of Ecology.
- Pandeya S. C., Puri, G. S. and Singh, J. S. (1968) : Research methods in plant ecology.
- Shukla, R. S. and Chandel, P. S. (1983): Plant Ecology.
- Walter, H. (1979); Vegetation of the Earth and Ecological Systems of Geobiosphere.
- Weaver, J. E. and Clements, F. S. (1938): Plant Ecology.
- Willis, A. J. (1973): Introduction to Plant Ecology.
- Yadav, P. S. and Singh, J. S. (1997): Progress in Ecology vol. II.

Semester III
ANGIOSPERM TAXONOMY(Special Paper-II)

B O-3.45 MODERN TRENDS IN ANGIOSPERM TAXONOMY

Unit-I	**1**	**EMBRYOLOGY IN RELATION TO TAXONOMY:** Embryological characters of taxonomic importance, utilisation of embryological data in solving taxonomic problems at different levels.	**5**
	2	**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.	**5**
	3	**PALYNOTAXONOMY:** Pollen morphology-Polarity, symmetry, NPC of pollen, exine stratification, excrescences, L/O pattern, palynogram; pollen characters of taxonomic importance.	**5**
Unit-II	**4**	**PHYTOGEOGRAPHY, ECOLOGY, GENETICS AND TAXONOMY:** Phytogeography and speciation; adaptations, ecological variations, genetic variations and plant systematics.	**3**
	5	**NUMERICAL TAXONOMY:** Phenetic methods in taxonomy [Taxometrics]: principles, construction of taxonomic groups, OUTs, unit characters, character coding, measurement of resemblances, cluster analysis, phenons and ranks, discrimination, nomenclature and numerical taxonomy, applications, merits and demerits. Cladastics and cladogram, parsimony analysis, cladastics and classification.	**5**
	6	**CYTOTAXONOMY:** Chromosome number, Basic chromosome number, polyploidy, aneuploidy, chromosome morphology, karyotype, chromosome banding, meiotic analysis and plant systematics, scope and limitations**.**	**7**
Unit-III	**7**	**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, chemical protein analysis procedures, analysis of aminoacid sequence and its significance in systematics; serology and taxonomy: history, precipitation reaction, techniques, antigen, antisera antibody, application of serological data in systematics.	**7**

	8	**ULTRASTRUCTURAL SYSTEMATICS:** SEM and TEM studies and plant systematics; SEM and plant surface stucture, TEM and dilated cisterneae of endoplasmic reticulum and sieve element plastids, applications of data in the classification of higher taxa.
	9	**MOLECULAR SYSTEMATICS:** Molecular diagnostic tools, restriction fragment length polymorphism (RFLP's), Random amplified polymorphic DNA (RAPD), Polymerage chain reaction (PCR) analysis, specific applications of RAPD in molecular systematics. Molecular data and systematic position of Hydatellaceae.
Unit-IV	**10**	MORPHOLOGICAL, VARIATIONS, SYSTEMATIC POSITION, INTERELATIONSHIPS, PHYLOGENY AND ECONOMIC IMPORTANCE OF FOLLOWING FAMILIES: Gentianaceae, Cuscutaceae, Boraginaceae, Plantaginaceae, Lentibulariaceae, Lobeliaceae, Asteraceae, Costaceae, Pontederiaceae, Dioscoriaceae, Burmanniaceae, Orchidaceae.
Unit-I		**PRACTICALS/LABORATORY EXCERCISES** • Microtome technique for study of embryological characters • Study of wood character, vessels, storied and nonstoried wood • Semipermanent pollen preparations by acetolysis method and study of different pollen morphotypes. • Study of chomosomes, chromosome banding and Karyotype analysis • Interpretation of flavonoid data for taxonomy using PC/TLC / protein profile analysis

Unit-II		• Practical based on numerical taxonomy • 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 • Descriptions, Sketching, classification and identification of families: Gentianaceae, Cuscutaceae, Boraginaceae, Plantaginaceae, Lentibulariaceae, Lobeliaceae, Asteraceae, Costaceae, Pontederiaceae, Dioscoriaceae, Burmanniaceae, Orchidaceae and identification of wild and cultivated plants represented in local flora.. Any additional practical/s based on theory syllabus will be added whenever necessary.

(Atleast 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.)

Selected readings:

- 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 Tommorow Publications, New Delhi.
- Erdtman, G. 1952. ***Pollen Morphology and Plant Taxonomy. Angiosperms.*** Almquist and Wiksell. Stockholm.
- Fahn. 1979. ***Plant Anatomy***.
- 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 Publication Com. Ltd. 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 & Distributers, New Delhi.

- Lawrence George 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 Arunkumar and Archana Sharm. 1980***. Chromosome Technique: Theory and Practices*** (3rd ed.) Butterworths, London.
- Judd Walter S., Cmpbell C. S., Kollogg, E. A., Stevens P.F. and M. J. Donoghue 2008. Plant Systematics. Sinauer Associates, INC,Publishers.Sunderland, Massachusetts, USA.

M. Sc. PART II (SEMESTER III)

MARINE BOTANY PAPER XII (SPECIAL PAPER II) BO-3.46

BO-3.46 PHYSIOLOGY AND BIOCHEMISTRY OF MARINE PLANTS

Total Lectures: 60

UNIT 1:

PHOTOSYNTHESIS IN MARINE ALGAE: Fine structure and properties of Algal plastids, Photosynthetic pigments in different algal groups, Photosynthetic carbon fixation, Photosynthesis in marine macroalgae- light absorption, effect of low light condition, photosynthetic rate.C_3 versus C_4 characteristics in marine algae**.** **8**

STORAGE AND STRUCTURAL COMPONENTS IN ALGAE: Seaweed polysaccharides- Chemical structure, properties and extraction of Agar, Carrageenan and Alginic acid, Low molecular weight compounds in algae. **7**

UNIT 2: PHOTOSYNTHESIS IN MANGROVES: Stomatal behaviour, Carbon fixation Initial products of photosynthesis, Photosynthetic enzymes, Role of aspartate, Accumulation of free amino acids, Photorespiration**.** **7**

BIOACTIVE COMPOUNDS IN MANGROVES: A brief idea of occurrence and importance of these compounds**.** **5**

Effect of flooding on growth of halophytes. **3**

UNIT 3: MINERAL NUTRITION : Nutrient requirement- Essential elements, vitamins for growth of algae. Availability in sea water, Uptake, Factors affecting, Metabolic role of essential nutrients**,** **5**

SALT REGULATION IN HALOPHYTES: Salt glands and salt secretion. Ultrastructure of salt glands, Salt glands in mangroves, Significance of vivipary. Leaf succulence, selective ion absorption**.** **5**

SALINITY AND METABOLISM: Influence of salinity on photosynthesis of halophytes. Induction of CAM. Membrane transport under salinity. Effect of salinity on growth and phytohormones**.** **5**

UNIT 4: **REGENERATION IN MANGROVES:** Methods of natural and artificial regeneration in mangroves**.** **5**

MARINE ALGAL RESEARCH IN INDIA: Important Research centers in India and their work. **5**

MANGROVE RESEARCH IN INDIA: Measure research centers in India and their contribution.

PRACTICAL COURSE II

UNIT 5:

a) Estimation of pigments from marine algae. chlorophyll a, b ,c, d, carotenoids, phycobilins etc.

b) Isolation of agar agar from algal material.

c) Extraction and Estimation of alginic acid and carrageenan from marine algae.

d) Estimation of total carbohydrates from marine algae.

e) Determination of organic matter content from sediment.

UNIT 6:

a) Determination of TAN of succulent marine plants (Ex ***Sesuvium,Lumnitzera*** etc.)

b) Regeneration study in some mangrove species.

c) Determination of free amino acid content in saline and nonsaline plants.

d) Estimation of proline from saline and nonsaline plants.

e) Estimation of tannins from bark/ stems of different mangroves.

Suggested Readings :-

1. Chapman, V. J. (1976) : Costal Vegetation. IInd edition Pergamon Press. New York.
2. Ring M. (1982) : The Biology of Marine Plants. Edward Arnold Publishers, London.
3. Gerald, E. Ecophysiology of Economic Plants in Arid and Semiarid Land.
4. Jackson D. F. (1972) : Algae and Man. Plenum Press.
5. Lobban, C. S. & Harrison, P. J. (1985) : Seaweed Ecology and Physiology. Cambridge University Press.
6. Sambamurthy, A. V. S. S. (2005) : A Text Book of Algae.
7. Stein, J. R. (1973) : Handbook of Phycological & Biochemistry.
8. Stewart, W. D. (1974) : Algal Physiology & Biochemistry.
9. Waisel Y. (1972) : Biology of Halophytes Academic Press, London and New York.

SEMESTER III

(SPECIAL PAPER- II) PLANT BIOTECHNOLOGY

B O 3.47: MOLECULAR BIOTECHNOLOGY AND GENETIC ENGINEERING.

Theory (4 Units, 60 Lectures)

Unit 1: a) Fundamentals of molecular biotechnology **(2);** b) Vectors in gene cloning and their selection **(6);** c) Molecular research procedure; Gene amplification, basic PCR, its modification, application, DNA polymorphism **(7).**

Unit 2: a) Use of various enzymes in recombinant DNA technology **(6);** b) 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 jumping **(9).**

Unit 3: a) Isolation, sequencing and synthesis of genes: Isolation of genes, DNA sequencing, synthesis, gene synthesis machines **(10);** b) Plant genetic engineering: gene transfer techniques, protoplast technology **(5).**

Unit 4: a) Genomics, Proteomics and Bioinformatics **(10);** b) Immunology **(5).**

Practical (2 Units, Any 8)

1.	Isolation of genomic DNA	(1)
2&3.	DNA detection and purification by gel- electrophoresis	(2)
4.	DNA estimation	(1)
5.	Isolation of proteins	(1)
6.	Isolation of plasmid DNA	(1)
7&8.	2D electrophoresis of protein	(2)
9&10	Bacterial transformation	(2)
11.	*Agrobacterium* mediated gene transfer technique.	(2)
12.	Isolation of protoplast	(1)
13.	Restriction digestion of DNA	(1)

Special Paper II:

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

Semester –IV

PLANT PHYSIOLGY

BO 4.1- Plant Physiology and Metabolism

Total Lectures-60

Unit -I

1. Membrane transport and translocation of water and solutes:
   Mechanism of xylem and phloem transport, phloem loading and unloading, passive and active solute transport, membrane transport of proteins. Root microbe interactions in facilitating nutrient uptake. **(06)**
2. Photochemistry and Photosynthesis:
   General concepts and historical background, evolution of photosynthetic apparatus, photosynthetic pigments and light harvesting complexes, photooxidation of water, mechanism of electron and proton transport, carbon assimilation- the Calvin cycle, Rubisco, significance of photorespiration. Sub classification of C4 plants, ecological significance and modification of CAM. Biosynthesis of starch and sucrose. (09)

Unit -II

3. Respiration and lipid Metabolism:
   Overview of plant respiration, Anaerobic respiration, modern concept of electron transport and ATP synthesis. Inhibitor of respiration, glyoxylate cycle, synthesis of membrane lipids, structural lipids and storage lipids and their catabolism, gluconeogenesis. **(09)**

4. Phytohormones:
   Biosynthesis and mechanism of action of Phytohormones: auxin, gibberellin, cytokinin, ethylene and ABA. **(06)**

Unit -III

5. Nitrogen and Sulphur Metabolism:
   Nitrogen fixation, Nitrogenase, “nif” genes, regulation of nitrogen fixation, products of nitrogen fixation and their transport, mechanism of nitrate uptake and reduction, transamination, nitrogen metabolism in relation to photosynthesis and respiration, Sulphate uptake, transport, reduction and assimilation. **(09)**

6. The flowering process:

   Photoperiodism and its significance, endogenous clock and its regulation, floral induction and development- genetic and molecular analysis, role of vernalization.

   (06)

Unit –IV

7. Stress Physiology:

   A brief idea of plant responses to water deficit, salinity, metal ion stress, freezing and heat stress, oxidative stress and drought resistance mechanism.

   (09)

8. Signal Transduction: --

   Overviews, receptors and G- proteins, phospholipids signaling, role of cyclic nucleotides, Calcium-Calmodulin cascade, protein kinases and phosphatases, specific signaling mechanisms. e.g. two component sensor – regulator system in bacteria and plants. (06)

Practicals :-

Unit –I

1) Study of enzyme ATPase
2) Sugar and amino acids analysis of phloem sap, with paper chromatography.
3) Determination of Chlorophyll a / b ratio of C3 and C4 plants.
4) Determination of rate of respiration in germinating seeds under aerobic and anaerobic conditions.
5) Study of enzyme lipase.

Unit –II

6) Effect of red and far red light on seed germination and study of photomorphogenesis.
7) Estimation of nitrate in different plant parts.
8) Study of enzyme glutamate oxaloacetate transaminase.
9) Study of nitrate reductase in plants.

   Study of effect of PEG induced water stress on seed germination

Reference Books-

1. Miller, P (1973) : Phytochemistry Vol.I, II and III.
2. Epstein, E (1972) : Mineral nutrition of plants : Principals and prespectives.
3. Bonner, J. and Varner, E. (1976): Plant Biochemistry.
4. Gregory, P (1976) : Biochemistry of Photosynthesis.
5. Devlin, R.M. and Witham (1975): Plant Physiology.
6. Beevers, H (1976): Nitrogen Metabolism in plants.
7. Stump, F.A. and Conn, E.E. (1981) : Biochemistry of Plants. A Comprehensive Treatise Vol. II, III, IV, IX and XII.
8. Mukharjee S.P. and ghosh A.N. (1996) Plant Physiology.
9. Wilkins, M.B. (1976): Physiology of Plant Growth and Development.
10. Noggle, G.R. and Fritz, G. J. (1976): Introductory Plant Physiology.
11. Marschner, H. W. (1986): Mineral nutrition of Higher Plants.
12. Salisburry, F.B. (1971): The biology of Flowering.
13. Krishnamurthy, H.N. (1992): Physiology of Plant Growth and Development.
14. Salisbury, G.B. and Ross, F.V.(1990): Plant Physiology.
15. Levitt, J. (1969, 1980): Responses of Plants to Environmental Stress.
16. Taiz L. and Zeiger F. (2004): Plant Physiology.
17. Pessarkli M. (2005): Handbook of Photosynthesis. II nd Edition.

SEMESTER IV

COMMON PAPER IV Elective IV

BO 4.2 PAPER XIV: PLANT STRUCTURE, DEVELOPMENT & REPRODUCTION

Total Lectures 60

Unit -I

Embryology :

1. Gametophyte in Angiosperms: outline of development of male and female gametophyte.**(04)**
2. Ultrastructure of gametophyte: Vegetative cell, generative cell, pollen wall, pollen tube, abnormal male gametophyte and their function. **(06)**
3. Ultrastructure of female gametophyte: Synergids, Eggs, antipodal, central wall. **(05)**
4. Pollen: Structure of stigma and style, Chemotropism, Pollen wall proteins, Stigma surface proteins, Post fertilization events. **(04)**

Unit –II

5. Experimental Embryology: Techniques for anther, ovary, nucellus, endosperms, embryo culture and their significance. **(04)**
6. Types of apomixis: Dilpospory, apospory. Causes, consequences and significances of apomixis. **(04)**
7. Polyembryony: Classification, causes, experimental induction and partial importance. **(03)**

Unit -III

Anatomy: (15)

1. Shoots development :- Organisation of shoots apical meristem (SAM) cytological and molecular aspects of SAM; Control of cell division and cell to cell communication; Control of tissue differentiation especially xylem and phloem **(04)**
2. Leaf growth and Differentiation :- Determination, control and leaf forms : Differentiation of epidermis (with special Suggested readings:- to stomata and trichomes) and mesophylls. **(04)**
3. Root development:-
   Organisation of root apical meristem(RAM) , Vesscular tissue differentiation , Lateral roots , root hairs, root- microbes interaction.
4. Application:-
   Utility in systematics, archaeology climatic studies and crime detection.

Palynology : **10**

Palynology :Scope and branches with special Suggested readings:-s to (01)

Palynotaxonomy : Pollen morphology and plant taxonomy with Suggested readings:- to Gymnosperms and Angiosperms. (01)

Paleopalynology : Principles, microfossil recovery theory and techniques, microfossil groups and oil exploration. (02)

Aeropalynology: Principles, techniques, pollen analysis, pollen and spore allergy, allergic properties of pollen, pollen calendar and importance. (02)

Melittopalynology: Bee colony,foraging behaviour of bees , unifloral multifloral honey, application in crop productivity. (02)

Agropalynology: Pollen viability, pollen germination, pollen storage and their significance. (02)

PRACTICALS:

Embryology:

1. Study of ultrastructure of male gametophyte with the help of slides and microphotographs.
2. Study of ultrastructure of female gametophyte with the help of slides and microphotographs.
3. Culture of any one organ: anther / ovary / endosperm / nucellus / embryo.
4. Study of few apomicts with the help of any suitable material.
5. Study of polyembryonic seeds. (Mango, Citrus)

Anatomy:

1. Study of living shoots apices by dissection using aquatic plants such as *Ceratophyllum* and *Hydrilla*.
2. Study of cytohistological zonation in the shootapical meristem (SAM) in sectioned and doubled stained permanent slides of suitable plant such as Coleus Kolanchoe, Tabacco.
3. Examine of shoot apices in a monocotyledons in both T.S. and L.S. to show the origin and arrangement of leaf primordial.
4. Study of whole roots in monocots and dicots
5. Examine of L.S. of root from a permanent preparation to understand the organization of root apical meristem & it's derivatives (use maize, aerial roots of banyan , *Pistia, Jussieua* etc.) origin of lateral roots .
6. Study of leguminous roots with different types of nodules.
7. Study of leaf anatomy – structure, stomata, trichomes, types of stomata .

Palynology:

1 Study of pollen morphotypes (by at least 6 examples)
2 Acetolysis (Honey Analysis)
3 Study of aerospora , aerospora analysis by Tilak Air Sampler and Gravity slide method.
4 Study of allergic plants and their pollen.
5 Study of fertility by TTC (Acetocarmine methods etc.)

SUGGESTED READINGS:-

Embryology:

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

Anatomy:

Barnova, M A. 1987: Historical developments of the present classification of morphological types of stomata. Bot.Res.53:53-79.
Cutter, E G 1971 Plant Anatomy
Dilcher, D D 1974: Approaches to the identification of angiosperms leaf remains. Bot.Rev. 40:2-157
Emmes, E J. and M C Danials, 1947: An introduction to plant anatomy.
Easau, K. 1962: Plant anatomy –anatomy of seed plants.
Fahn, A.1969: Secretary Tissue system
Foster, A S 1942: Practical plant anatomy
Haberland, G.1965: Physiological
Masueth, J D. 1936 : Plant anatomy
Metcalfe, C R and L Chalk, 1950: Anatomy of the dicotyledons
Solender, H. 1908 : Systematics anatomy of the dicots
Tomlinson, P S 1961: Anatomy of the monocotyledons.

Palynology

Cunningham, D D 1873 : Microscopic examination of air.

Fageri, K and J Inversen, 1964: Text book of pollen analysis.

Nair, P K K 1964 : Advances in Palynology.

Nair, P K K 1966 : Essentials of Palynology.

Heslop-Harrison, Y. 1971: Pollen development and physiology.

Gregory, P H, 1973: Microbiology of atmosphere.

Erdtman, G.1988 : Pollen morphology and plant taxonomy.

Tilak, S T. 1989 : Airborne pollen and fungal spores.

Shivanna K R and N S Rangaswami 1992 : Pollen Biology, A Laboratory manual.

Bhattacharya, K. , M R Majumdar and S G Bhattacharya 2006: A Text book of Palynology.

Shivanna K R and B M Johari,1985: The Angiosperm Pollen, structure and function.

Pandey and Chadha, 1992: Plant Anatomy and Embryology .

Journals:

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

Semester-IV

PLANT PHYSIOLOGY(Special Paper-III)

B O- 4.31 Stress Physiology of Plants

Total Lectures- 60

Unit –I

1. **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. **(08)**
2. **Flooding stress** - Nature of waterlogging stress. Effect of flooding stress on physiological processes in plants. Wetland and non wetland species. Mechanism of waterlogging tolerance. **(07)**

Unit –II

3. **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. **(09)**

4. **Ionic stress** - Effect of ion toxicity (iron, zinc), heavy metals toxicity and aluminum toxicity in plants, Phytoremediation, Mechanism of aluminium tolerance, Transgenic approaches. (06)

Unit –III

5. **Thermal stresses** - Effect of high and low temperatures on plant metabolism, Mechanisms of high and low temperatures tolerance, Cold hardening, Role of HSP. **(05)**
6. **Radiation stress** - Influence of high light intensity on photosynthesis, Photoprotection mechanisms, Effect of UV radiations on plants, Mechanism of UV tolerance. **(05)**

7. **Oxidative stress** - Generation of reactive oxygen species, Effect of ROS on metabolism, ROX detoxification mechanisms in plants, Transgenic approaches. **(05)**

Unit –IV

8. **Gaseous stress** - Effect of elevated CO_2 concentration on plant metabolism, Effect of air pollutant SO_2 and O_3 on plants. **(06)**
9. **Biotic stress** – Effect of fungal infection on plant metabolism, Biochemical mechanism of disease resistance, Allelopathy. **(09)**

Practicals:-

Unit –I

1) Measurement of RWC and Osmotic potential
2) Determination of chlorophyll stability index.
3) Estimation of chlorides in leaves of halophytes and non halophytes.
4) Study of protein/ amino acid profile in plants under stress.
5) Study of effect of fungal infection on peroxidase activity.

Unit –II

6) Study of phenolics in scales of onion varieties differing in disease resistance.

7 & 8) Study of free radicals scavenging enzymes, Catalase and super oxide dismutase.

9) Study of free prolein accumulation in plants under stress.

10) Study of seed germination under stress condition.

Suggested readings:-

1. Cherry, J.H (1989): Environmental stresses in plants. Biochemical and Physiological mechanisms.
2. Evans, L.T.(1972): Crop Physiology.
3. Fageria, N. K.(1992): Maximizing crop yield.
4. Fertilizer association of India (1974): Fertilizer handbook of Usage.
5. Fitter, A. H. and Hay, R. K. M. S. (1987): Environmental Plant Physiology.
6. Gupta, U. S. (1972): Crop Physiology.
7. Gupta, U. S. (1975): Physiological aspects of dryland farming.
8. Hale, M.C. and Orcutt, D.M. (1987): The Physiology of Plants Under Stress.
9. ICAR handbook of Fertilizers.
10. Kozlowski, T. T. (1984): Flooding and Plant Growth.

11. Levitt, J. (1969, 1980): Responses of Plants to Environmental Stress.
12. Mansfield, C.A. (1976): Effect of air pollutant on plants.
13. Marschner, H. W. (1986): Mineral nutrition of Higher Plants.
14. McLaren, J.S. (1985): Chemical manipulation of crop growth and Development.
15. Mehrotra, R.S. (1980): Plant Pathology.
16. Paleg, L.G. and Aspinal, D.(1982): The Physiology and Biochemistry of Drought resistant in Plants.
17. Pojakoff Mayber A. and Gale, J. (1975): Plants in saline environment.
18. Rice, E. L. (1982): Allelopathy (Physiological Ecology).
19. Sharma, S. K. and Gupta, I. S. (1986): Physiological aspects of dryland farming.
20. Sinha S.K., Sane P.V., Bhargava S.C. and Agarwal P.K. (1990): Proceeding of International Congress of Plant Physiology Vol. I & II.
21. Srivastava, Y. N. Environmental pollution.
22. Turner, N. C. and Cramer, P.J.(1980): Adaptation of plants to water and high temperature stress.
23. Upeke, L. K. (1982): Tropical tree crops.
24. Yawalkar and Agarwal, Manures and fertilizers.
25. Pessarkli, M. (2004): Handbook of Plant and Crop Physiology, Marcel Dekkar Inc. NY.
26. Pessarkli, M. (2005): Handbook of Photosynthesis.
27. Nickell, L.G. (1986): Plant growth regulators in Agriculture.
28. Asana, R.D. and Sarin M.N. (1968): Crop Physiology in India IARI Publ.
29. Taiz L. and Zeiger F. (2002): The Plant Physiology

Journals

- Annual reviews of Plant Physiology and Molecular Biology.
- Indian Journal of Plant Physiology.
- Journal of Experimental Botany.
- Physiologia Plantarum Sweden.
- Plant Physiology (USA).
- Everymans Science.

Semester- IV

MYCOLOGY & PLANT PATHOLOGY

B O 4.32 Industrial Mycology (Special Paper-III)

Total Lectures – 60

UNIT- I

1. Role of fungi in industrial mycology :scope and their utility. **05**
2. Commercial fungal strain : selection,improvement,development and their maintenance. **05**
3. Fermentation: Methods and types of fermentation of alcohol and organic acid by using fungi as microorganisms. **05**

UNIT-II

4. Secondary metabolites : use of fungi in production of secondary metabolites. 15

UNIT- III

5. Antibiotics of fungal origin and their production. **06**
6. Production of Ergot alkaloids. **03**
7. Enzymes of fungal origin and their importance in industry. **15**

UNIT-IV

8. Edible fungi, their nutritional value and role in cottage industry. Large and small scale cultivation technique of *Agaricus bisporus, Pleurotus spp.,Volvarialla volavacea* and their preservation, diseases and their control, cost benefit analysis. **15**

Practicals (2 Units, Any 8)

UNIT-I

1. Study of strain maintenance using different methods.
2. Production of alcohol by fermentation technique.
3. Detection of citric acid from mycelial biomass using circular chromatography.
4. Study of antibiotics of fungal origins.

5 & 6. Production of Ergot alkaloid by using fungal elicitor.

UNIT-II

7 & 8. Preparation of spawn: Grain, Perlite and manure spawn.

9 & 10. Cultivation of mushroom.

11 & 12.Study of some enzymes of fungal origin.

REFERNCE BOOKS:

1. Casida, L.E.Jr. (1964): Industrial Microbiology.
2. Whipps, J.M. and R.D.Lumsden (1989): Biotechnology of fungi for improving plant growth.
3. Turner (1971): Fungal metabolism.
4. Atal (1978): Indian Mushroom Science-I.
5. Kannaiyan (1980): A hand book of edible mushrooms.
6. Purkhyastt (1976): Indian edible mushrooms.
7. Smith,J.F. and Barry,D.R.:The filamentous fungi Vol.I Industrial Mycology Vol.II and III.
8. Dodge, C.W.(1935):Industrial Mycology.
9. Prescott, S.G. and Dunn,C.D.(1959): Industrial Microbiology.
10. Christensen,C.M. (1975): Mould, Mushrooms and Mycotoxins.
11. Rose, A.H.(1961): Industrial Microbiology.
12. Singer, R.(1961): Mushrooms and Truffles cultivation and utilization.
13. Rhodes, A. and Fletcher, D.L.(1966): Principles of industrial microbiology.
14. Gray, W.D.(1970): The use of fungi as food and food processing.
15. Lodder, J.(1970): The Yeast.
16. Chang,S.T. and Hays, W.A.(1978): The biology and cultivation of edible mushrooms.
17. Aneja K.R.(1993) : Experiments in Microbiology,Plant Pathology and Tissue Culture.
18. Onions, A.H.S.D. Allsopp and H.O.W.Eggins (1981): Smith's Introduction to Industrial Mycology.
19. Barger, G. (1931): Ergot and Ergotism.
20. Fletcher, J.T.,White,P.F.and Gaze, R.H.(1989): Mushrooms: Pest and Disease Control.

SEMESTER IV

CYTOGENETICS AND PLANT BREEDING (SPECIAL PAPER- III)

B O 4.33: MOLECULAR GENETICS

Theory (4 Units, 60 Lectures)

Unit 1:

Microbial Genetics: Genetic studies in microorganisms with special Suggested readings: to *E. coli* and *Agrobacterium*. Genetic exchange in bacteria- an overview (Mutants, Transformation, conjugation and Transduction, Para sexuality and its significance in bacteria) **(15).**

Unit 2: a) The Genetics of Viruses: The structure and life cycle of bacterial virus, Mapping the bacterio-phage genome (Phage phenotypes, genetic recombination in phage, fine structure and deletion mapping), T_4 genetic map, bacterio-phage X 174 **(8),** b) Molecular analysis of DNA, RNA and Proteins using blotting techniques and Micro arrays **(7).**

Unit 3: The Techniques in Molecular Genetics: Basic techniques (Restriction digestion, production of recombinant DNA molecules, amplification using vectors, construction of genomic libraries, cDNA libraries and screening DNA libraries for genes of interest); The manipulation of cloned DNA sequences: *in vitro,* using phagemid vectors; *In vitro* site specific mutagenesis **(15).**

Unit 4: a) Molecular analysis of Genes and Chromosomes: PCR, Physical maps of DNA molecules based on RFLP and Fine structure maps **(8),** b) Genetics of C_4 and CAM pathways, Genes from plastids and nuclei, Regulation of expression (Transcriptional, Post transcriptional, translational, post translational and compartment specific control) **(7).**

Practical (2 Units, Any 8)

1. Media preparation for microbial cultures.
2. Isolation, culturing and growing *E. coli.*
3. Study of bacterial conjugation (02).
5. Study of bacterial transduction (02).
7. Study of transformation (02).
9. Study of *Agrobacterium* mediated transformation.
10. Study of restriction digestion analysis by gel electrophoresis (02).
12. Study of southern blotting (02).

Suggested readings:

Special Paper- III

1. Twyman R. M. 1998 Advanced molecular Biology. Viva Books Pvt. Ltd. New Delhi.
2. Wolfe S. L. 1993 Molecular and cellular biology. Wadwith Publishing Co. California USA.
3. Lewin, B. 2000 Genes IV, V, VI. Oxford University Press, New York.
4. Brown T. A. 1998 Genomes. John Wiley and sons Singapore.
5. Alberts B. et al 1994 Molecular biology of the cell 3rd Edition Garland Publishing, New York.
6. Singh B. D. 1990 Fundamentals of Genetics. Kalyani Publishers Ludhiana.
7. Latchman D. S. 1990 Gene regulation an eukaryotic perspective. Unwin Hyman Publication London.
8. Klug W. S. and Cummings M. R. 1983 Concepts of Genetics. Charles E. Merrill Publishing Company London.
9. Jain H. K. 1999 Genetics Principles, Concepts and Implications. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
10. Gupta P. K. 1985 Genetics Rastogi Publications Meerut.
11. 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.
12. Stickeberger M. W. 1996 Genetics 3rd Edition MacMillan Publishing Co. New Delhi.

Journals:

1. Annual review of Microbiology
2. Journal of Cytology and Genetics
3. Cytologia
4. Caryologia
5. Indian Journal of Experimental Biology
6. Journal of Experimental Botany
7. Trends in Biotechnology (Elsevier)

Trends in biochemical

SEMESTER IV

ENERGY, ECOLOGY AND ENVIRONMENT - SPECIAL PAPER-III

BO-4.34 EXPERIMENTAL ECOLOGY AND ENERGY STUDIES

Total lectures: 60 **Total Practicals: 11**

EXPERIMENTAL ECOLOGY:

UNIT 1:

1. Methods in autecological study: Systematic position, geographic distribution, seed germination, species environment (microclimate), physical anatomy, leaf area index (LAI). **(5)**
2. Methods of Community study: Quadrats and its types, Transects, Bisects. **(3)**
3. Methods of primary productivity measurements, Global primary productivity patterns. **(7)**

UNIT 2:

4. Systems Ecology: Introduction and Elements of system ecology. **(5)**
5. Ecosystem modeling- Conceptual model, Working model. Auxiliary variables and Foresters diagram. **(5)**
6. Remote sensing techniques and its applications. **(5)**

UNIT 3:

ENERGY STUDIES:

7. Source of energy: Conventional and non-conventional sources, Biological methods, Hydrogen fuel. **(8)**
8. Biomass production by the species, techniques of producing biomass energy plants, fuel wood species and petrocrops and their potential, other energy yielding crops (Sweet sorghum). **(7)**

UNIT 4:

9. Energy from wastes. **(8)**
10. Conservation of energy **(7)**

Practicals. (2 Units Any 8)

UNIT 5:

1. Seed germination under various treatments for tree species.
2. Study of seed output and reproductive capacity.
3. Study of petro crops and other energy plants.
4. Determination of calorific value of wood.
5. Study of effect of natural light intensity on primary productivity of an aquatic ecosystem.

UNIT 6:

6. Setting up an ecological model.
7. Use of ecological model in the field study.
8. Study of Leaf Area Index.
9. Study of rooting of the cuttings.
10. Ecological data collection for computer use.
11. Study of population growth curve.

Suggested readings:-

- Agarwal S.K. (1992) : Fundamentals of Ecology.
- Bradbury I.K.1990) : The Biosphere.
- Das S.M. (1989) : Handbook of Limnology and water pollution with practical methodology.
- Etherington J. R. (1975) : Environment and plant ecology : aims and development.
- Freedman H. I. (1980) : Deterministic mathematical models in population ecology.
- Greig Smith P. (1983) : Quantitative Plant Ecology.
- Grims J.P. *et al* (1988) : Comparative Plant Ecology.
- Hashimoto Y *et al* (1990) : Measurement techniques in plant sciences.
- Kershaw K. A. (1964) : Quantitative and dynamic ecology.
- Kormondy E. J. (1996) : Concept of ecology.
- Krebs C. J. (1978) : Ecology.
- Lieth H. F. *et al* (1973) : Patterns of primary production in the biosphere.
- Misra K. C. (1989) : Manual of plant ecology.
- Misra R. and Das R. R. (1971) : Proceedings of the school of plant ecology.
- Odum E. P. (1971) : Ecology.
- Odum E. P. (3rd ed. 1996) : Fundamentals of Ecology.
- Pandeya S. C. *et al* (1963) : Research methods in plant ecology.
- Watt K. E. F. (1973): Principles of Environment Sciences.

Semester IV

B O-4.35 ANGIOSPERM TAXONOMY FLORISTICS AND BIOSYSTEMATICS

(Special Paper-III)

Unit-I	**1**	**FLORISTICS**: Need and significance of floristic studies, methodology, analysis and data presentation.	**3**
	2	**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, color charts, outstanding botanical libraries.	**7**
	3	**HERBARIUM AND BOTANICAL GARDENS:** Herbarium as a store house of plants and plant information, its role in research and teaching; Botanical and experimental gardens and their role in teaching, training and conservation of plants. Important Herbaria and Botanical Gardens of the world and India.	**5**
Unit-II	**4**	**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.	**5**
	5	**HISTORY OF BOTANICAL EXPLORATION IN INDIA:** Beginning of botany in India, contributions made in earlier phase by Garcia d'Orta, C. acosta, Van Rheede, John Burman, John Koenig, Robert kid, Buchnan, Roxbugh, N. Wallich, William Griffith, Robert Wight, Thomas Thomson, J. D. Hooker and recent phase by Collet, Brandis, T. Cooke, Duthie, Fyson, Gamble, Haines, Parkinson, Prain, Santapau, and present works with special emphasis on Maharashtra. Botanical Survey of India (BSI).	**10**
Unit-III	**6**	**BIOSYSTEMATICS:** Aims, concepts of species, steps in biosystematic study, biosystematic categories- ecotype, ecospecies, cenospecies, camparium, methods in biosystematic studies, ecotypic variations and taxonomy, scope and limitations.	**5**
	7	**SPECIES CONCEPT:** Concept of taxa, concept of species- Nominalistic, Typological, Biological and alternative species concepts; concept of genus and family.	**5**

	8	**SPECIATION:** Kinds of speciation- quantum, Mayrean, catastrophic, local ecological, geographic, phyletic; speciation and evolution of species.	5
Unit-IV	9	**MORPHOLOGICAL VARIATIONS, SYSTEMATIC POSITION, INTERELATIONSHIPS, PHYLOGENY AND ECONOMIC IMPORTANCE OF FOLLOWING FAMILIES:** Dilleniaceae, Clusiaceae, Tiliaceae, Lecythidaceae, Bigoniaceae, Passifloraceae, Caricaeae, Salicaeae, Arecaeae, Pandanaceae, Araceae, Lemnaceae.	15
Unit-I		**PRACTICALS/LABORATORY EXCERCISES** • Study of materials and methods of preparation of herbarium • Preparation of Botanical keys • Study of ecotypes/ variations in population of species • To know using computer • To identify family with the help of computerized Key • Study of Exotic plants (weeds) found in the region	
Unit-II		• Study of Endemic plants of India in light of IUCN Red List Categories. • Study of medicinal plants of the region • Descriptions, Sketching, classification and identification of families: Dilleniaceae, Clusiaceae, Tiliaceae, Lecythidaceae, Bigoniaceae, Passifloraceae, Caricaeae, Salicaeae, Arecaeae, Pandanaceae, Araceae, Lemnaceae and identification of wild and cultivated plants represented in local flora. Any additional practical/s based on theory syllabus will be added whenever necessary.	

Selected Readings

- 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 Tommorow Publications, New Delhi.
- Naik, V. N. 1984. ***Taxonomy of Angiosperms*** Tata McGraw-Hill Publication Com. Ltd. 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 & Distributers, New Delhi.
- Lawrence George 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.
- Rao, R. R. 1994. ***Biodiversity of India (Floristic Aspects).*** Bishen Singh Mahendra Pal Singh, Dehra-Dun.
- Judd Walter S., Cmpbell C. S., Kollogg, E. A., Stevens P.F. and M. J. Donoghue 2008. Plant Systematics. Sinauer Associates, INC,Publishers.Sunderland, Massachusetts, USA.

M. Sc. PART II (SEMESTER IV)

BO-4.36 MARINE BOTANY PAPER XV (SPECIAL PAPER III)

MARINE ECOLOGY

Total Lectures : 60

UNIT 1:

MARINE ENVIRONMENT : , Oceans. Sea as an environment. Abiotic factors - Chemical (salinity, O_2, CO_2, nutrients) Physical (light, temperature, wind, tidal action, waves, etc) and Geological (oceans, ocean floor)factors. Biotic factors - floral and faunal components. Types of Coasts, Estuaries. **10**

PRIMARY PRODUCTIVITY OF ESTUARINE ECOSYSTEM: An over view, factors affecting, Role of phytoplankton, Water blooms and red tide phenomenon**.** **5**

UNIT 2:

ECOLOGY OF MARINE ALGAE: Zonation pattern and seasonality**.** **5**

ECOLOGY OF MANGROVES: Occurrence, diversity, distribution, zonation structure in mangrove ecosystem. Ecological significance. Anatomical, physiological, morphological adaptations in mangroves, Vivipary and its role in mangroves**.** **10**

UNIT 3:

MICROBIAL ECOLOGY OF COASTAL ECOSYSTEM: Mycorrhizal relations, Coastal vegetation and nitrogen fixation, Detritus based food chain**.** **6**

CORAL REEFS: Occurrence, distribution and types. Calcification, reef algae, Natural and anthropogenic stress ,Restoration and conservation of coral ecosystem, Concept of Marine Park**.** **9**

UNIT 4: MARINE POLLUTION: Types, sources and impact. Toxic metal pollution, Oil, sewage, pesticide, radioactive pollution and effect of waste disposal on marine ecosystem, Biomagnification**.** **10**

CONSERVATION OF MANGROVE ECOSYSTEM: Need for conservation, Human impact, Threats and conservation measures. Restoration and management-
Role of Global institutions and NGOs in India **.** **5**

PRACTICAL COURSE III

UNIT 5: a) Determination of EC, pH, salinity, and chlorinity of seawater .

b) Determination of nitrate from seawater.

c) Determination of BOD of polluted water.

d) Determination of oil and grease / hydrocarbon content of polluted sea water.

e) Determination of phosphate from seawater.

UNIT 6: a) Study of zonation pattern in algae and mangroves

b) Study of vivipary in mangroves.

c) Study of salts glands, trichomes, sclerides in mangroves .

d) Study of phenological events in different mangroves species.

e) Microbe analysis of sediments (Sulphur bacteria) from estuaries.

Suggested Readings :-

- Chapman,V. J. (1976). Costal Vegetation. II nd 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 Tomarrow. 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
- Round Ecology.
- Saenger, P. (2002). Mangrove Ecology, Silviculture and Conservation. Springer.
- Soepadmo,E. A.N. Rao and D.J. Macintosh (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 . Publi,. New Delhi.

SEMESTER IV
PLANT BIOTECHNOLOGY (SPECIAL PAPER- III)
B O 4.37: PLANT TISSUE CULTURE- II: APPLICATIONS AND PROSPECTS.

Theory (4 Units, 60 Lectures)

Unit 1:

a) Application of Biotechnology in conservation of plant generic resources, Gene banks **(5),** b) Application of tissue culture in Agriculture: Plant improvement through tissue culture technology; production of resistant lines to biotic and abiotic stresses **(10).**

Unit 2: a) Applications of tissue culture in horticulture: micropropagation of some tree species like *Morus, Ficus* etc. **(5),** b) Application of tissue culture in forestry: *In vitro* establishment of Mycorrhiza forest species, orchids, and other related improvements in forest species Eg. *Tectona, Pinus* etc. **(8),** c) Prospects in plant tissue culture industry in India; Applications in public sector **(2).**

Unit 3: a) Secondary metabolite production- Secondary metabolites from callus, cell cultures, cell suspension, biotransformation. Procedure for process design and product recovery from cultured plant cells. Factors affecting product yield. Secondary metabolites from immobilized plant cell **(15).**

Unit 4: a) Transgenic plants for crop improvement **(5),** b) Marker genes and their use in transformed plants, selectable markers, reporter genes **(4),** c) Molecular farming, Bioreactor, edible vaccines, edible antibodies **(6).**

Practical (2 Units, Any 8)

1.	Cell suspension culture.
2&3.	Hairy root culture.
4.	Anther, embryo culture.
5.	Somatic embryogenesis.
6.	Study of synseeds.
7.	Study of transgenic plants.
8&9.	Isolation and culture of any two industrially important microorganisms.
10.	Preparation of biofertilizers.
11.	Study of Nitrate reductase activity.

Suggested readings :

1. Altman, A. 1998. Agricultural Biotechnology. Marcel Dekker, New York.
2. Chavala, H.S. 1998. Biotechnology in crop improvement. International Book Distributing Co. New Delhi.
3. Glick, B.R. and Pasternak, J.J.1994.Molecular Biotechnology- Principles and applications of recombinant DNA. ASM Press, Washington.
4. Gupta, P.K. 2000. Elements of Biotechnology. Rastogi Publisher, Meerut, India.
5. Kakralya, B.I.and Ahuja, I.2001. Transgenic Plants-Promise or Danger.Agrobios, India.
6. 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.
7. Reddy, S.M., Srivastava, H.P., Purohit, D.K., and Reddy, S.R.1997.Microbial biotechnology. Scientific Publishers, Jodhpur, India.
8. Schlegel, H.G.1995. General microbiology. Cambridge University Press.
9. Trehan, K.1994.Biotechnology.Wiley Eastern Ltd. New Delhi.

Semester-IV

B O – 4.41 Applied Plant Physiology

(Special Paper –IV)

Total Lectures-60

Unit –I

1) Crop growth and its regulation- Growth analysis of crop plants and its significance. Factors controlling crop productivity, Harvest index, water use efficiency and N use efficiency. **(06)**
2) Nutriophysiology - Physicochemical properties of soil. Classification of mineral nutrients according to function. Factors influencing mineral uptake. Foliar diagnosis of critical nutrient status. Physicochemical properties of soil, lime and gypsum as soil additives. Role of chelates in mineral utilization. Foliar applications of mineral elements. Biofertilizers, CO_2 as a fertilizer. **(09)**

Unit –II

3) Source Sink relationship in crop plants and its significance. **(06)**
4) Reproductive physiology:- Photoperiodism and vernalization. Role of PGRs in flowering, sex determination and fruit development. Ethylene and post harvest physiology. **(09)**

Unit –III

5) Plant growth regulators in Agriculture and Horticulture**.** **(15)**

Mode of applications of PGRs

i) Pre sowing soaking treatment
ii) Foliar application
iii) Other modes

Roles:

a) auxins and synthetic auxins
b) gibberellins
c) cytokinins
d) ethylene and ethylene generating compounds
e) long chain alcohols
f) brassinosteroids
g) Plant growth retardants
h) Amino acid mixtures and other commercial products. Biotonics.

Unit –IV

6) Crop weed interaction, weedicides and their mode of actions, Invading weeds. **(08)**

7) Physiological aspects of transgenic crops. **(04)**

8) A brief idea of crop physiological research in India. **(03)**

Practicals:-

Unit –I

1, 2) Growth analysis of any two crop plants (RGR, NAR, LAR, LAI, etc.)

3,4) Determination of N, P & K status of soil and crops

5) Study of effect of source manipulation on sink capacity in any crop plant.

6) Study of effect of weedicides on some aspects of weed metabolism (chlorophylls, nitrate reductase)

Unit –II

7) Effect of pre sowing-soaking treatments of PGRs on crop growth.

8) Determination of Harvest index of different crops (Wheat, chickpea and applications)

9) Effect of foliar applications of some commercial PGRs and biotonics on crop productivity parameters (carbohydrate status).

10) Effect of soil conditioners & Biofertilizers on crop growth.

Suggested readings:-

25. Cherry, J.H (1989): Environmental stresses in plants. Biochemical and Physiological mechanisms.
26. Evans, L.T.(1972): Crop Physiology.
27. Fageria, N. K.(1992): Maximizing crop yield.
28. Fertilizer association of India (1974): Fertilizer handbook of Usage.
29. Fitter, A. H. and Hay, R. K. M. S. (1987): Environmental Plant Physiology.
30. Gupta, U. S. (1972): Crop Physiology.
31. Gupta, U. S. (1975): Physiological aspects of dryland farming.
32. Hale, M.C. and Orcutt, D.M. (1987): The Physiology of Plants Under Stress.
33. ICAR handbook of Fertilizers.
34. Kozlowski, T. T. (1984): Flooding and Plant Growth.

35. Levitt, J. (1969, 1980): Responses of Plants to Environmental Stress.
36. Mansfield, C.A. (1976): Effect of air pollutant on plants.
37. Marschner, H. W. (1986): Mineral nutrition of Higher Plants.
38. McLaren, J.S. (1985): Chemical manipulation of crop growth and Development.
39. Mehrotra, R.S. (1980): Plant Pathology.
40. Paleg, L.G. and Aspinal, D.(1982): The Physiology and Biochemistry of Drought resistant in Plants.
41. Pojakoff Mayber A. and Gale, J. (1975): Plants in saline environment.
42. Rice, E. L. (1982): Allelopathy (Physiological Ecology).
43. Sharma, S. K. and Gupta, I. S. (1986): Physiological aspects of dryland farming.
44. Sinha S.K., Sane P.V., Bhargava S.C. and Agarwal P.K. (1990): Proceeding of International Congress of Plant Physiology Vol. I & II.
45. Srivastava, Y. N. Environmental pollution.
46. Turner, N. C. and Cramer, P.J.(1980): Adaptation of plants to water and high temperature stress.
47. Upeke, L. K. (1982): Tropical tree crops.
48. Yawalkar and Agarwal, Manures and fertilizers.
25.Pessarkli, M. (2004): Handbook of Plant and Crop Physiology, Marcel Dekkar Inc. NY.
26. Pessarkli, M. (2005): Handbook of Photosynthesis.
27. Nickell, L.G. (1986): Plant growth regulators in Agriculture.
28. Asana, R.D. and Sarin M.N. (1968): Crop Physiology in India IARI Publ.
29. Taiz L. and Zeiger F. (2002): The Plant Physiology

Journals

- Annual reviews of Plant Physiology and Molecular Biology.
- Indian Journal of Plant Physiology.
- Journal of Experimental Botany.
- Physiologia Plantarum Sweden.
- Plant Physiology (USA).
- Everymans Science.

Semester IV

MYCOLOGY & PLANT PATHOLOGY

B O 4.42 Integrated Disease Management (Special Paper- IV)

(Concepts and Application II)

Total Lectures – 60

UNIT –I

1. Methods of disease diagnosis, field observation, isolation and identification of Pathogens. **05**
2. 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. **10**

UNIT-II

3. 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 plants, pathogens and their management, Antibiotics and biological control of plant pathogenic fungi. Biological control Agents, VA-Mycorrhiza, *Trichoderma viride, T.harzianum, Pseudomonas flurescans, Glomus.* Use of Botanicals and other biopesticides. **15**

UNIT-III

4 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).

15

UNIT-IV

5. 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).

15

Practicals (2 Units, Any 8)

UNIT-I

1. Study of air borne fungi using air sampler.

2 & 3. Spore germination of pathogenic fungi in two different media.

4 & 5. Evaluation of fungicides and antibiotics against pathogen by spore germination by food poisoning technique.

UNIT-II

5, 6 & 7. Synergistic effect of Agrochemicals in the management of crop Diseases.

8,9 & 10. Symptomology, histopathology of the disease mentioned in the theory.

11 & 12. Collection and preservation of plant diseases.

REFERENCES BOOKS

1. D. Lalithakumari (2000): Fungal Protoplast: A Biotechnological Tool: Oxford and IBH Publishing Co. Pvt.Ltd.
2. R.E.F. Mathews (1970) : Plant Virology.
3. S.T.Tilak (1998): Aerobiology.
4. Kenneth M. Smith (1968): Plant Viruses.
5. F.C.Bawden (1964): Plant Viruses and Virus Diseases.
6. Mehrotra R.S.(1980): Plant Pathology
7. Agrios, G.N.(2006): Plant Pathology (5^{th} Edition).
8. Ny Vall, R.F.(1979): Field Crop Diseases Handbook.
9. Singh, R.S.(1963): Plant Diseases.
10. Padoley, S.K. and P.B.Mistry: A manual of Plant pathology.
11. Gangopadhyay, S.(1984): Clinical Plant Pathology.

SEMESTER IV
CYTOGENETICS AND PLANT BREEDING (SPECIAL PAPER – IV)
B O 4.43: SPECIAL APPROACHES IN GENETIC IMPROVEMENT OF CROP PLANTS

Theory (4 Units, 60 Lectures)

Unit 1:

a) General introduction to concepts of genetic engineering **(2),** b) Vectors in gene cloning: Plasmids, Bacteriophages, Shuttle vectors, Ti- plasmid, expression vectors, constructing chimeric DNA **(7),** c) Isolation of the desired gene, insertion of gene in vector, transformation, selection of the transformed host cells, cloned gene expression **(6).**

Unit 2: a) Engineering plants for the production of insect resistance, herbicide resistance, resistance against plant viral diseases; Improvement of the nutritional quality of the crop **(10),** b) Transgenics, terminator technology and their ecological risks **(5).**

Unit 3: a) Genetics of Nitrogen fixation: Types of nitrogen fixation, organization and molecular analysis of *nif* genes in *Klebsiella*, structures of host gene, *Hup* gene and regulation of nitrogen fixation **(5),** b) Tissue Culture: Somaclonal variation, somatic embryogenesis, production of secondary metabolites, cell line isolation, hairy root culture **(5),** c) Greenhouse Technology: Construction, operation, maintenance and management **(5).**

Unit 4: a) Protoplast isolation and genetic engineering: Isolation of protoplast, cellular hybridization, gene transfer and protoplast modification in plant improvement, somatic hybrids for Cytoplasmic male sterility **(5),** b) Genomics- an overview: Mapping, Sequencing and functional analysis of genome; Human genome project; Bacterial, Yeast, *Drosophila, Arabidopsis* and Rice genomes **(7),** c) Proteomics and Bioinformatics **(3).**

Practical (2Units, Any 8)

1. Isolation of genomic DNA.	2. Cell line culture
3. Cloning vectors.	4. Hairy root culture
5. Induction of enzyme Nitrate reductase.	6. Gene cloning using PCR
7. Protoplast fusion and culture.	8. Study of DNA markers using RAPD
9. Somatic embryogenesis	
10. Detection and estimation of protease inhibitors from pulse seeds	
11. Isolation of protoplast by mechanical and enzymatic methods.	
12. Visit to commercial Greenhouse and submission of report.	

Special Paper- IV

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

22. Wennacker Ernst L. 1987 From Genes to Clones; Introduction to Gene Technology VCH publishers Weinheim (Federal Republic of Germany)
23. Mount D. W. 2001 Bioinformatics Sequence and Genome Analysis. Cold Spring Harbour Laboratory.
24. Jagota A. 2000 Data Analysis and Classification for Bioinformatics. Published by Bioinformatics by the bay Press.
25. Durbin R, Sean R., Eddy, Anders Krogh, Graeme M.1999 Biological Analysis-Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press.
26. Andreas Bazevanis, B. F. Francis Ouellette and B. F. Cuellette 1998 Bioinformatics : A Practical Guide to the analysis of Genes and Proteins

Journals:

1. Indian Journal of Biotechnology
2. Indian Journal of Experimental Biology
3. Journal of Experimental Botany
4. Trends in Biotechnology (Elsevier)
5. Trends in biochemical Sciences (Elsevier)
6. Journal of Molecular Plant Pathology
7. Journal of Plant Biotechnology
8. International Journal of Food Science and Technology.

SEMESTER IV-

ENERGY, ECOLOGY & ENVIRONMENT - SPECIAL PAPER-II

BO-4.44 PAPER- XVI: ENVIRONMENTAL ISSUES, ASSESSMENT AND RESTORATION

Total lectures: 60 **Total Practicals : 10**

UNIT 1:

1) Pollution of Environment:

A) Air Pollution: Acidic precipitation, causes and consequences. Air pollution monitoring devices. **(6)**

B) Water Pollution: Classification of water pollutants: A brief account. Oxygen demanding pollutants and their activity. Pathogens, Nutrients, salts, heat, heavy metals, pesticides. Radioactive pollutants and oil pollutants. Self purification of natural streams. Oxygen sag analysis. **(9)**

UNIT 2:

2) Environmental Issues:

Ozone – Positive and negative influence of ozone. **(2)**

Air quality loss. **(2)**

Nuclear winter. **(2)**

Vehicular and Industrial gases. **(2)**

Carbon and world climates. **(2)**

3) Land Degradation: Loss of soil fertility, Mining. **(5)**

UNIT 3:

4) Impact Assessment – EIA:

EIA – Global Scenario, In India, Methodology. **(8)**

Environmental Auditing and Monitoring- Role of plants and microbes. **(7)**

UNIT 4:

5) Ecology and Human Welfare:

Natural resources- Conservation and management. **(3)**

Recycling of resources. **(3)**

Waste management. **(3)**

Vermitechnology. **(3)**

Ecotourism and ecofriendly measures **(3)**

Practicals.

UNIT 5:

1. Study of Biological Indicators.
2. Study of IUCN Red list categories.
3. Study of wetland macrophytes.
4. Effect of effluents on soil microflora.
5. Study of garbage.

UNIT 6:

6. Measurement of vehicular pollution.
7. EIA study-I.
8. EIA study-II.
9. Comparison of plant communities from polluted and non-polluted areas.
10. Measurement of dust fall.

Suggested readings:-

- Adriano, D. C. and Johnson, A. H. (1989): Acidic precipitation, vol. II
- Balkrishnan, M., Borgstrom, R. and Bie, S. W. (1994): Tropical Ecosystems.
- Dash,M. C. (1993): Fundamentals of Ecology.
- De, A. K. (1994): Environmental Chemistry.
- Good, R. E. *et al* (1978): Fresh water wetlands.
- Gregory S. (1988): Recent climatic changes: A regional approach.
- Lal, J. B. (1987): Environmental Conservation.
- Misra K. C. (1989) : Manual of plant ecology.
- Oowen, M. and Black, J. M. (1990): Waterfall Ecology.

Semester IV

ANGIOSERM TAXONOMY (Special Paper- IV)

B O-4.45 BPHYLOGENY AND FLORAL BIOLOGY OF ANGIOSPERMS

Unit-I	**1**	**ORIGIN OF ANGIOSPERMS:** Pre-cretaceous and Cretaceus 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, stachyospory-phyllospermae theory, pteridosperm theory, pentoxylales theory and durian theory; monophyletic verses polyphyletic origin of angiosperms.	**9**
Unit-II	**2**	**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;* Sonnertiaceae: *Sonnertioxylon, Sonnertiorhizos, Sahnianthus, Enigmocarpon;* Guttiferae: *Indocarpa,* Myrtaceae: *Sahnipushpam;* Malvaceae: *Sahniocarpon, Harissocarpon, Daberocarpon, Chitaleypushpam.* Fossil angiosperms and palaeoecology of India.	**6**
Unit-III		**PHYTOGEOGRAPHY:** Geological time scale, geographical history, Continental Drift, Land Bridges, shifting of poles, theories of differentiation and natural selection, types and areas of natural distribution, centre of origin, theory of tolerance, phytogeographic regions of the world, Botanical provinces of India and their characteristic vegetation with emphasis on Vegetation and Phytogeography of the Western Ghats.	**5**
	7	**CONSERVATION BIOLOGY:** Biodiversity, its importance, assessment, loss and conservation, ethical principles of conservation biology, World organisation for conservation of biodiversity, Red List categories of IUCN, means and ways for conservation**.**	**5**
	8	**ENDEMISM:** Concept of endemism, categories, biodiversity of India, megacentres of endemism in India; Keystone and flagship species, endemic plants of India with special reference to Western ghats and Maharashtra, sacred grooves and their importance.	**5**

Unit-III		**FLORAL BIOLOGY:** Sex in flowers, sex distribution in plants, types of pollination, chasmogamy and cleistogamy; biology of floral parts-calyx, corolla, androecium, pollen, style and stigma; anemophily; hydrophily; ornithophily; cheiropterophily; entemophily-bee. carpenter bee, fly, moth, butterfly and wasps flowers; floral diversity and evolutionary steps toward asclepiad flowers. Co-evolution of angiosperms, insects and fungi.	**15**
Unit-IV	**9**	**MORPHOLOGICAL VARIATIONS, SYSTEMATIC POSITION, INTERELATIONSHIPS, PHYLOGENY AND ECONOMIC IMPORTANCE OF FOLLOWING FAMILIES:** Podostemonaceae, Rhizophoraceae, Santalaceae, Loranthaceae, Viscaceae, Polygalaceae, Sapindaceae, Apiaceae, Xyridaceae, Eriocaulaceae, Hydatellaceae, Typhaceae.	**15**
Unit-I		**PRACTICALS/LABORATORY EXCERCISES** • Study of characters of anemophilous flowers. • Study of characters of hydrophilous flowers. • Study of characters of cheiropterophilous flowers. • Study of characters of flowers entemophilous: bee. Carpenter bee, fly, moth, butterfly and wasps flowers.	**15**
Unit-II		• Study of fossil angiosperms of India with the help of slides and specimens • Practical based on Theory of Continental Drift • Descriptions, Sketching, classification and identification of families: Podostemonaceae, Rhizophoraceae, Santalaceae, Loranthaceae, Viscaceae, Polygalaceae, Sapindaceae, Apiaceae, Xyridaceae, Eriocaulaceae, Hydatellaceae, Typhaceae. and identification of wild and cultivated plants represented in local flora. Any additional practical/s based on theory syllabus will be added whenever necessary.	**15**

(In second term of IV Semester, at least two local tours and an excursion of about one week duration has to be conducted for students opting for, 'Taxonomy of Angiosperms' as their specialization to study vegetation, pollination mechanism, ecology and flowering plant species of suitable region.
Student has to submit herbarium specimens (50), permanent or semi permanent slides (5) preserved plant specimens, tour report, laboratory work-book and project work report(if any) at the time of practical examination.)

Selected Readings:

- 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 Tommorow 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 Com. 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 & Distributers, New Delhi.
- Lawrence George 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 BotanicaGardens 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., Cmpbell C. S., Kollogg, E. A., Stevens P.F. and M. J. Donoghue 2008. Plant Systematics. Sinauer Associates, INC,Publishers.Sunderland, Massachusetts, USA.

M. Sc. PART II (SEMESTER IV)

MYCOLOGY & PLANT PATHOLOGY

BO-4.46 MARINE BOTANY PAPER XVI (SPECIAL PAPER IV)

APPLIED MARINE BOTANY

Total Lectures: 60

UNIT 1:

METHODS OF ANALYSIS: Primary productivity measurement (biomass harvesting, litter fall, gas exchange, modelling technique).Standing crop, Species diversity index, Similarity index etc. **8**

MANGROVE SURVEY BY REMOTE SENSING APPLICATION: Use of remote sensing technique in mapping of mangrove vegetation, Use of GPS. **7**

UNIT 2:

METHODS OF COLLECTION AND PRESERVATION OF MARINE ALGAE: Collection, Chemical preservation, Herbarium technique, Storage of specimen**.** **5**

COMMERCIAL CULTIVATION OF SEAWEEDS: Traditional and recent methods. Mariculture of ***Porphyra ,Laminaria, Undaria ,Gracilaria*** etc**.** **8**

DIATOMS: Application and uses**.** **2**

UNIT 3:

UTILIZATION OF SEAWEEDS: Species used as food and fodder, application to soil as a fertilizer or manure, Medicinal uses, Source of iodine. Industrial applications of seaweeds**.** **10**

LABORATORY CULTURE AND CULTIVATION OF ALGAE : Use of natural and synthetic culture media, difficulties in getting axenic culture. **5**

UNIT 4:

COASTAL BIORESOURCES: Bioresource Profile. Wild bioresources - food , feed, fodder, fire wood, timber, medicinal products, potential genetic resources, ornamentals. **8**

Domestic bioresources - crops, cereals, pulses, oil crops, horticultural crops, live stock, aquaculture, apiculture**.** **7**

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PRACTICAL COURSE IV

UNIT 5: a) Determination of primary productivity of estuarine ecosystem.

b) Study of herbarium technique in marine algae.

c) Study of diatoms (cleaning, preparation and observation)

d) Demonstration of phytoplankton / algal culture technique.

e) Determination of total ash/mineral content from seaweeds.

UNIT 6: a) Effect of seaweed concentrate on seed germination and plant growth.

b) Study of economically important mangrove species (used for food / fodder / timber / medicines etc).

c) Study of major faunal components from mangrove ecosystem.

d) Determination of S.D.I. and similarity index of mangroves.

e) Detection of bioactive compounds in some mangrove species by TLC.

SUGGESTED READINGS:-

- Beck. Biotechnology of Microalgae.
- Bhosale,L.J.(2005). Mangroves of Maharashtra. (Field Guide). Shivaji University,Kolhapur.
- Chapman,V. J. (1976). Costal 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 Costal Location. National Bioresource Development Board (Department of Biotechnology) Govt. of India.
- Trainor,F. R. Introductory Phycology.

SEMESTER IV: PLANT BIOTECHNOLOGY (SPECIAL PAPER- IV)

B O 4.47: APPLICATION, REGULATION AND PATENTING BIOTECHNOLOGY

Theory (4 Units, 60 Lectures)

Unit 1: a) Biotechnology in Agriculture: Ethical aspects and public acceptance; Bioethical principles for agricultural biotechnology **(5),** b) Biological Nitrogen Fixation: Mechanism of N_2 fixation, Symbiotic N_2 fixation, Mechanism of N_2 fixation in root nodules, Nod genes, Nif genes, Hup genes **(5),** c) Use of microbes in Industry and agriculture **(5).**

Unit 2: a) Application of Biotechnology in Environmental protection: Pollution control, Phytoremediation immobilized microbial cells, wastewater treatment, microbes in leaching of metals **(10),** b) Economic and legal issues of biotechnology **(5).**

Unit 3: a) Regulating the use of Biotechnology in recombinant DNA technology, Food, food ingredients and GMO's – cost benefit analysis of GMO's **(6),** b) Global biotech scenario, public verses private enterprises, International organizations involved in biotechnological inventions, cooperative programmes **(5),** c) Biotechnological spotlights **(4).**

Unit 4: a) Intellectual property; IPR: Intellectual Property Rights, Intellectual Property protection, IPR and Plant Genetic Resources GATT and TRIPS **(5),** b) Patent systems in India, Sources of patent information; a case study **(5),** c) Patenting biotechnological inventions: Patent of higher plants, Patent of genes and DNA sequences, Plant breeders rights and farmer's right **(5).**

Practical (2 Units, Any 8)

1&2.	Collection, Identification and conservation of land races of crop plants.
3.	Preparation of questionnaire for acceptance of Biotech products.
4&5.	Culture of *Thiobacillus* and its use in bioleaching.
6&7.	Use of bioscavengers in water and soil treatment.
8.	Study of GMOs.
9&10.	Formulation of patent proposal.
11.	Visit to Biotech firms, Agro biotech fields.

Suggested readings:

Special Paper- III

1. Altman, A. 1998. Agricultural Biotechnology. Marcel Dekker, New York.
2. Chavala, H.S. 1998. Biotechnology in crop improvement. International Book Distributing Co. New Delhi.
3. Glick, B.R. and Pasternak, J.J.1994.Molecular Biotechnology- Principles and applications of recombinant DNA. ASM Press, Washington.
4. Gupta, P.K. 2000. Elements of Biotechnology. Rastogi Publisher, Meerut, India.
5. Kakralya, B.I.and Ahuja, I.2001. Transgenic Plants-Promise or Danger.Agrobios, India.
6. 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.
7. Reddy, S.M., Srivastava, H.P., Purohit, D.K., and Reddy, S.R.1997.Microbial biotechnology. Scientific Publishers, Jodhpur, India.
8. Schlegel, H.G.1995. General microbiology. Cambridge University Press.
9. Trehan, K.1994.Biotechnology.Wiley Eastern Ltd. New Delhi.

Special Paper- IV

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

Semester III
MYCOLOGY AND PLANT PATHOLOGY
B O 3.42 Integrated Disease Management (Special paper II)
(Concepts and Application I)

Total Lectures – 60

UNIT –I

1. Principles of Plant Pathology: History, Classification of crop diseases: Viral, Bacterial, Fungal and Nematode. Deficiency of micronutrients. **05**
2. Seed Pathology : Methods of detection of internal and external seed borne Fungi, Bacteria and Viruses, biodeterioration and mycotoxins. **10**

UNIT-II

3. Role of enzymes and toxins in disease development. Cell wall degrading enzymes ; Cellulolytic , Pectolytic, Proteolytic and Lipolytic. Toxins lycomarsmine, alternic Acid, Fusaric acids, Piricularin, Victorin, aflatoxins. **15**

UNIT-III

4. Physiology and Biochemistry of host pathogen interaction, Respiration, Photosynthesis, Proteins, Nucleic acids, phenol metabolism and plant growth regulators. **15**

UNIT-IV

5. Genetics of host pathogen interaction, gene for gene hypothesis, protein for protein hypothesis, antigen and antibody reaction. Immunoglobulines, application of immunological techniques, physiological specializations. **15**

Practicals (2 Units, Any 8)

UNIT-I 1,2 & 3.Production of Pectolytic, Cellulolytic, Amylolytic enzymes.
4. Estimations of nucleic acids from healthy and infected plants.
5. Use of Biocontrol agents against plant pathogens.
6. Extraction and detection of aflatoxins from fungi.

UNIT- II 7. Estimation of protein from healthy and infected plants.
8 & 9.Study of external and internal seed mycoflora.
10. Immunological techniques-purification and fragmentation of immunoglobulins.
11 & 12. Study of symptomology and histo-pathology of diseases mentioned in the theory.

REFERENCE BOOKS:

Agrios, G.N.(2006):Plant Pathology (5th Edition).

Aneja K.R.(1993) : Experiments in Microbiology,Plant Pathology and Tissue

Cooke, A.A.(1981):Diseases of Tropical and Subtropical Field, Fiber and Oilplants.

Gangopadhyay S. (1994): Clinical Plant Pathology.

Gangulee, H. S. and A.K.Kar (1992):College Botany Vol. II.

Kuijit, J. (1969): The Biology of parasitic flowering plants. Uni. Of California Press,U.S.A.

Mahadevan, A. and R. Sridhar (1982): Methods in Physiological Plant

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

Ny vall, R.F.(1979): Field Crop Diseases Handbook.

Padoley, S.K. and P.B.Mistry: A manual of Plant Pathology.

Paul Khurana, S.M.(1998):Pathological problems of Economic Crop Plants and their Management.

Plank J.E.Van der (1963): Plant Diseases, Epidemics and Control.

Plank,J.E.Van der (1968): Disease Resistance in Plants.A.P.London and New York.

Rangaswamy G. (1975): Diseases of crop plants in India.

Singh, R.S.(1963): Plant Diseases.

SEMESTER III

CYTOGENETICS AND PLANT BREEDING (SPECIAL PAPER – II)

B O 3.43: PLANT BREEDING

Theory (4 Units, 60 Lectures)

Unit 1: a) Objectives of Plant Breeding **(1);** b) Domestication, Selection under domestication; Introduction, Quarantine; and Acclimatization of plants **(2);** c) Germplasm: Gene pool concept, Genetic erosion, Exploration and collection of germplasm, conservation and utilization **(2);** d) Mechanism of pollination control: self-incompatibility and male sterility **(10).**

Unit 2: a) Inheritance of qualitative and quantitative characters **(8);** b) Biometrical techniques in plant breeding: Introduction, Assessment of variability, Components of variance, Genetic diversity **(7).**

Unit 3: a) Aids to Selection: Correlation coefficient analysis, Path analysis and Discriminant functions **(5);** b) Choice of parents and breeding procedures: Diallele, partial diallele, Triallele, Line tester, Generation mean analysis, Biparental cross analysis with various designs and Varietal adaptation **(10).**

Unit 4: a) Breeding for biotic and abiotic stresses: Disease and Insect resistance; Drought, Salinity, Heat and cold resistance (1**0);** b) Mutation breeding **(5).**

Practical (2 Units, Any 8)

11. To study the effect of mutagens on germination, seedling growth and on mitosis (02).
12. To study crossability between cultivars and their wild relatives (2).
13. Germplasm collection, cataloging, data storage and retrieval (02).
14. Study of pollen germination and demonstration of incompatibility.
15. Study of Cytoplasmic male sterility.
16. Estimation of heritability (02).
17. Designing field experiments (02)
18. Metroglif analysis.
19. D^2 analysis.
20. Screening of germplasm for biotic and abiotic stresses (03)

Suggested readings:

Special Paper- I

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

Special Paper- II

19. Singh, B. D. 2000. Plant breeding- Principles and methods. Kalyani Publishers, Ludhiana.
20. Sharma, J. R. Principles and practice of plant breeding. Tata McGrow Hill Publ. Co. Ltd., New Delhi.
21. Siddiqui B. A. and Khna S. 1999 Breeding in crop plants. Mutation and In vitro mutation breeding . Kalyani Publishers New Delhi
22. IAEA 1995 Induced mutations and Molecular techniques for crop improvement. Proc FAO/IAEA Symposium Vienna
23. IAEA 1991 Plant Mutation Breeding crop improvement Proc. FAO/IAEA Symposium (Vol 1&2)Vienna
24. Micke A. 1991 Induced Mutation for crop improvement. Gamma Field Symposia No.30 Institute of Radiation Breeding Pullman USA.
25. Allard R. W. 1960 Principles of Plant Breeding John Wiley and Sons New York.
26. Hays H. K. , Immer F.R. and Smith D.C. 1955 Methods of Plant Breeding. McGraw Hill Book Company Inc New York.

27. Fehr W. R. 1987 Principles of Cultivar Development (2 Volumes) MacMillan Publishing Co. New York.
28. Poehlman J.M. 1986 Breeding Field Crops AVI Publishing Company Connecticut.
29. Sharma J. R. 1998 Statistical and Biometrical techniques in Plant Breeding New Age International Publishers New Delhi.
30. Singh R. K. and Singh B. D. 1997 Biometrical Methods in Quantitative genetic Analysis. Kalyani Publishers, New Delhi.
31. Vijendra Das L. D. 2000 Problems Facing Plant Breding CBS Publishers New Delhi
32. Rosielle A. A. and Hamblin J. 1981 Theoretical aspects of selection for yield in stress and non- stress environments Crop Sci, 21: 932-946.
33. Levitt J. 1980 Response of Plants to Environmental Stress: Water, Salt and Other stresses. Academic Press, New York.
34. Bulm A. 1988 Plant Breeding for stress Environments. CRC Press Florida.
35. Chopra V. L. 1989 Plant Breeding .oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
36. Roy Darbeshwar 2000, Plant breeding analysis and exploitation of variance. Narosa Publishers New Delhi.

Journals:

9. Indian Journal of Genetics and Plant Breeding.
10. Journal of Genetics
11. Journal of Cytology and Genetics
12. Cytologia
13. Caryologia
14. International Journal of Food Science and Technology
15. Mutation Breeding Newsletter
16. International Journal of Plant Breeding

SEMESTER III

Special Paper - I ENERGY, ECOLOGY & ENVIRONMENT

BO 3.34 PAPER- XI: ENVIRONMENT AND ITS ASPECTS

Total lectures: 60 **Total Practicals: 11**

UNIT 1:

7. Abiotic Environment: Leibigs Law of minimum, Law of limiting factors. **(5)**

8. Environment in Terrestrial Ecosystems: **(5)**

Atmosphere

Climate- Classification of climate climographs. **(5)**

UNIT 2:

9. Environment in Aquatic Ecosystem:

i. Marine Environment- light, waves, currents, winds, tides. **(9)**

ii. Fresh water Environment – Wind- currents. **(6)**

UNIT 3:

10. Soils: formation, composition, soil profile, soil types of India. **(15)**

UNIT 4:

11. Land use classification, planning and management. **(7)**

12. Water: Resources and Management. **(8)**

Practicals: (2 Units any 8)

UNIT 5:

12. Analysis of water samples from polluted and non-polluted lakes for DO.
13. Field visits to Industrial area.
14. Study of effect of effluents on plant growth.
15. Determination of BOD at R.T.
16. Study of wilting coefficient.

UNIT 6:

17. Determination of quality of water by physical parameters (colour, EC, pH, TSS, TDS and TS).
18. Study of MPN as hydrobiological character.
19. Study of EC and pH of the soil.
20. Study of soil profile.
21. Determination of organic matter from soil.
22. Some ecological instruments used in air and water pollution studies.

SEMESTER III

(SPECIAL PAPER II) – ENERGY, ECOLOGY & ENVIRONMENT

BO-3.44 POPULATION AND COMMUNITY ECOLOGY

Total lectures: 60 **Total Practicals: 11**

UNIT 1:

1) **Population Ecology**: Population Regulation,
Density dependant and Independent Regulation- Role of
Different factors, Genecology-Ecads, Ecotypes, etc.
Human Population Dynamics and predication. **(15)**

UNIT 2:

2) Community Ecology:

A) Community as a unit: Clementsian unit of vegetation. **(4)**

B) Community nature: Individualistic and organismic nature of communities, community stratification. **(11)**

UNIT 3:

C) Functional Aspects of community: Community Metabolism, Community Periodism. **(6)**

D) Community Stability: Maturation of Communities, Regulation of communities, community stability- Ecotone and Edge effect. **(6)**

E) Community as Indicator. **(3)**

UNIT 4:

F) Biodiversity: Levels, Global biodiversity, Biodiversity in India, Hot spots- Global and Indian, Threats to Biodiversity, Conservation of Biodiversity. Indian Biodiversity **(15)**

Practicals: (2 Units Amy 8)

UNIT 5:

11. Study of the Litter production.
12. Determination of similarity index.
13. Determination of association index.
14. Study of stratification and physiognomy.
15. Study of population dynamics.

UNIT 6:

16. Study of Vegetation by transect method.
17. Study of community bisects.Community function – Biomass production measurement, Biomass profile for the community.
18. Determination of IVI.
19. Estimation of phytoplankton biomass in terms of chlorophyll.
20. Visit to local protected or conserved area.

SEMESTER III

B O-3.35 ANGIOSPERM TAXONOMY

(Special Paper-I)

Unit-I	**1**	**PRINCIPLES AND PRACTICES IN PLANT TAXONOMY:** Definitions and concepts, importance of taxonomy and need for classification, hierarchical classification, general and special purpose classifications, Alpha and Omega taxonomy, taxonomy as synthetic discipline.	**4**
	2	**THE NEW GLOBAL TAXONOMY INITIATIVES:** Systematic agenda-2000, systematic knowledge and value of biodiversity, the missions of systematic agenda-2000. Taxonomy and conservation of biodiversity.	**4**
	3	**A BRIEF HISTORY OF PRE-DARWINIAN CLASSIFICATIONS:** i) Systems based on habit: Theophastus, Albert Magnus, Otto Brunfels, Jerome Bock, Andrea Cesalpino, Jean Bauhin, Joseph Pitton *de* Turnfort, John Ray; ii)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.	**7**
Unit-II	**4**	**A BRIEF HISTORY OF POST DARWINIAN CLASSIFICATIONS:** The evolutionary theory by Darwin and Wallace, i) Systems based on phylogeny:The Englarian School of thoughts: August Wilhelm Eichler, Adoph Engler, Alfred Rndle, Karl Christian MezAugust A. Pulle, Carl Skottberg, B. Hayata; the Ranalian School of thoughts: Richard von Wettstein,Charles E. Bessey, Hans Hallier, John Hutchinson, Oswald Tippo, Karl Mez, G. Gunderson, Lyman Benson.	**10**
	5	**RECENT SYSTEMS OF CLASSIFICATIONS:** By Armen L. Takhtajan, Authur Cronquist, R. M. T. Dahlgren and Robert F. Thorne.	**5**
Unit-III	**6**	**GENERAL EVOLUTIONARY TRENDS IN FLOWERING PLANTS:** With reference to habit and habitat, leaf structure, nodal anatomy, xylem and phloem, inflorescence, flower, androecium, pollen grains, gynoecium, placentation, ovules, seeds, seedlings and fruits.	**5**
	7	**TAXONOMIC HIERARCHY:** Ranks of Taxa, Forms of scientific names; major categories: division, class, order, family; minor categories: genus, species and infraspecific categories.	**3**

	8	**NOMENCLATURE:** A brief history of International Code of Botanical Nomenclature [ICBN]; Divisions; Principles; Nomenclatural terminology-Type method (typification)-holotype, isotype, syntype, lectotype, paratype, neotype; Effective and Valid publication; Priority; Scientific names-Correct name, Autonym, Basionym, Homonym, Synonym, Tautonym; alternative, ambiguous, illegitimate, naked, rejected and superfluous names.	**7**
Unit-IV	**9**	**MORPHOLOGICAL VARIATIONS, SYSTEMATIC POSITION, INTERELATIONSHIPS, PHYLOGENY AND ECONOMIC IMPORTANCE OF FOLLOWING FAMILIES:** Magnoliaceae, Lauraceae, Piperaceae, Aristolochiaceae, Nymphaeaceae, Moraceae, Urticaeae, Casuarinaceae, Alismataceae, Hydrocharitaceae, Najadaceae, Aponogetonaceae.	**15**
Unit-I		**PRACTICALS/LABORATORY EXCERCISES** • Exercises on nomenclature problems: Author citation, principle of priority, transfer of taxa, effective and valid publication etc • Describing new taxon, deposition of type, Latin diagnosis and abbreviations used in citations. • Phytography: preparation of scientific botanical description of a plant specimen • Study of morphology and general evolutionary trends in flowers, stamens and carpels of primitive families viz. Magnoliaceae, Ranunculaceae, Papaveraceae, Dilleniaceae, Alismataceae, Aponogetonaceae, Nymphaeaceae, Nelumbonaceae, Lauraceae, Hydatellaceae	**15**
Unit-II		• Study of different types of ovules, placentations and evolutionary trends therein. • Descriptions, Sketching, classification and identification of families: Magnoliaceae, Lauraceae, Piperaceae, Aristolochiaceae, Nymphaeaceae, Moraceae, Urticaeae, Casuarinaceae, Alismataceae, Hydrocharitaceae, Najadaceae, Aponogetonaceae and identification of wild and cultivated plant species using regional and national floras. Any additional practical/s based on theory syllabus will be added	**15**

		whenever necessary.	

Reference books and Journals:

- 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 Tommorow 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 Com. Ltd. 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 & Distributers, New Delhi.
- Lawrence George H. M. 1951. ***Taxonomy of Vascular Plants***. Oxford and IBH Publ. Co. Pvt. Ltd. New Delhi .
- Takhtajan, A. 1962. ***Flowering plants- Origin and Dispersal.***
- Hutchinson, J. 1959. ***Families of Flowering plants***.
- Judd Walter S., Cmpbell C. S., Kollogg, E. A., Stevens P.F. and M. J. Donoghue 2008. Plant Systematics. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.

Semester III

ANGIOSPERM TAXONOMY(Special Paper-II)

B O-3.45 MODERN TRENDS IN ANGIOSPERM TAXONOMY

Unit-I	**1**	**EMBRYOLOGY IN RELATION TO TAXONOMY:** Embryological characters of taxonomic importance, utilisation of embryological data in solving taxonomic problems at different levels.	**5**
	2	**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.	**5**
	3	**PALYNOTAXONOMY:** Pollen morphology-Polarity, symmetry, NPC of pollen, exine stratification, excrescences, L/O pattern, palynogram; pollen characters of taxonomic importance.	**5**
Unit-II	**4**	**PHYTOGEOGRAPHY, ECOLOGY, GENETICS AND TAXONOMY:** Phytogeography and speciation; adaptations, ecological variations, genetic variations and plant systematics.	**3**
	5	**NUMERICAL TAXONOMY:** Phenetic methods in taxonomy [Taxometrics]: principles, construction of taxonomic groups, OUTs, unit characters, character coding, measurement of resemblances, cluster analysis, phenons and ranks, discrimination, nomenclature and numerical taxonomy, applications, merits and demerits. Cladastics and cladogram, parsimony analysis, cladastics and classification.	**5**
	6	**CYTOTAXONOMY:** Chromosome number, Basic chromosome number, polyploidy, aneuploidy, chromosome morphology, karyotype, chromosome banding, meiotic analysis and plant systematics, scope and limitations**.**	**7**
Unit-III	**7**	**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, chemical protein analysis procedures, analysis of aminoacid sequence and its significance in systematics; serology and taxonomy: history, precipitation reaction, techniques, antigen, antisera antibody, application of serological data in systematics.	**7**

	8	**ULTRASTRUCTURAL SYSTEMATICS:** SEM and TEM studies and plant systematics; SEM and plant surface stucture, TEM and dilated cisterneae of endoplasmic reticulum and sieve element plastids, applications of data in the classification of higher taxa.	**3**
	9	**MOLECULAR SYSTEMATICS:** Molecular diagnostic tools, restriction fragment length polymorphism (RFLP's), Random amplified polymorphic DNA (RAPD), Polymerage chain reaction (PCR) analysis, specific applications of RAPD in molecular systematics. Molecular data and systematic position of Hydatellaceae.	**5**
Unit-IV	**10**	MORPHOLOGICAL, VARIATIONS, SYSTEMATIC POSITION, INTERELATIONSHIPS, PHYLOGENY AND ECONOMIC IMPORTANCE OF FOLLOWING FAMILIES: Gentianaceae, Cuscutaceae, Boraginaceae, Plantaginaceae, Lentibulariaceae, Lobeliaceae, Asteraceae, Costaceae, Pontederiaceae, Dioscoriaceae, Burmanniaceae, Orchidaceae.	**15**
Unit-I		**PRACTICALS/LABORATORY EXCERCISES** • Microtome technique for study of embryological characters • Study of wood character, vessels, storied and nonstoried wood • Semipermanent pollen preparations by acetolysis method and study of different pollen morphotypes. • Study of chomosomes, chromosome banding and Karyotype analysis • Interpretation of flavonoid data for taxonomy using PC/TLC / protein profile analysis	**15**
Unit-II		• Practical based on numerical taxonomy • 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 • Descriptions, Sketching, classification and identification of families: Gentianaceae, Cuscutaceae, Boraginaceae, Plantaginaceae, Lentibulariaceae, Lobeliaceae, Asteraceae, Costaceae, Pontederiaceae, Dioscoriaceae, Burmanniaceae, Orchidaceae and identification of wild and cultivated plants represented in local flora.. Any additional practical/s based on theory syllabus will be added whenever necessary.	**15**

(Atleast 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.)

Selected readings:

- 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 Tommorow Publications, New Delhi.
- Erdtman, G. 1952. ***Pollen Morphology and Plant Taxonomy. Angiosperms.*** Almquist and Wiksell. Stockholm.
- Fahn. 1979. ***Plant Anatomy***.
- 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 Publication Com. Ltd. 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 & Distributers, New Delhi.
- Lawrence George 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 Arunkumar and Archana Sharm. 1980***. Chromosome Technique: Theory and Practices*** (3rd ed.) Butterworths, London.
- Judd Walter S., Cmpbell C. S., Kollogg, E. A., Stevens P.F. and M. J. Donoghue 2008. Plant Systematics. Sinauer Associates, INC,Publishers.Sunderland, Massachusetts, USA.

M. Sc. PART II (SEMESTER III)

MARINE BOTANY (SPECIAL PAPER I)

BO – 3.36 GENERAL MARINE BOTANY

Total Lectures : 60

UNIT 1: MARINE PLANT GROUPS AND ORGANISMS: Introduction and classification, Brief idea of Plankton, Nekton, Benthos. Marine phytoplankton- dinoflagellates. nanoplankton, ultraplankton, coccoliths. **6**

MARINE FUNGI, ACTINOMYCETES, LICHENS. AND BACTERIA: Brief idea. **5**

CORALS, FOSSIL MANGROVES: Brief introduction. **4**

UNIT 2: MICRO AND MACROALGAE: Taxonomy, cytology, ultrastructure, salient features of Myxophyceae (Cyanophyceae), Bacillariophyceae, Chlorophyceae, Rhodophyceae and Phaeophyceae. Life histories of a few important species **.** **15**

UNIT 3: BIODIVERSITY OF MANGROVES: Brief idea of Creek, Estuary, Lagoon and Delta. Definition of the term 'mangrove', Distribution –biogeography of Indian mangroves, East and West coast mangroves, Mangrove shores and forests. Salient features of important mangrove families such as Rhizophoraceae , Sonneratiaceae Avicenniaceae, Myrsinaceae, Acanthaceae etc. **15**

UNIT 4: SALT MARSHES: Taxonomy, Distribution, Morphological and anatomical adaptations. **5**

SEA GRASSES: Taxonomy, distribution, adaptations, morphology, anatomical features. **5**

SAND DUNE VEGETATION: Formation of coastal sand dunes. Dune vegetation, Restoration and protection of dune ecosystem. **5**

PRACTICAL COURSE I

UNIT 5: a) Study of characteristic features of Chlorophyceae Ex.

Enteromorpha,Chaetomorpha*, *Ulva ,Caulerpa, Bryopsis etc.

b) Study of characteristic features of Phaeophyceae Ex. ***Padina, Dictyota, Sargassum*** etc.

c) Study of characteristic features of Rhodophyceae Ex. ***Gracilaria, Gelidium , Hypnea*** etc.

d) Sampling and identification of phytoplankton.

e) Demonstration of phytoplankton / algal culture technique.

UNIT 6: a) Study of mangrove associates and /or halophytes(***Aeluropus,Halophila*** etc.)

b) Type study of mangroves from Rhizophoraceae.

c) Type study of mangroves from Avicenniaceae and Sonneratiaceae.

d) Type study of mangroves from Myrsinaceae and Acanthaceae.

e) Study of sand dune plants (***Spinifex,Ipomoea*** etc.).

M. Sc. PART II (SEMESTER III)

MARINE BOTANY PAPER XII (SPECIAL PAPER II) BO-3.46

BO-3.46 PHYSIOLOGY AND BIOCHEMISTRY OF MARINE PLANTS

Total Lectures: 60

UNIT 1:

PHOTOSYNTHESIS IN MARINE ALGAE: Fine structure and properties of Algal plastids, Photosynthetic pigments in different algal groups, Photosynthetic carbon fixation, Photosynthesis in marine macroalgae- light absorption, effect of low light condition, photosynthetic rate.C_3 versus C_4 characteristics in marine algae**.** **8**

STORAGE AND STRUCTURAL COMPONENTS IN ALGAE: Seaweed polysaccharides- Chemical structure, properties and extraction of Agar, Carrageenan and Alginic acid, Low molecular weight compounds in algae. **7**

UNIT 2: PHOTOSYNTHESIS IN MANGROVES: Stomatal behaviour, Carbon fixation Initial products of photosynthesis, Photosynthetic enzymes, Role of aspartate, Accumulation of free amino acids, Photorespiration**.** **7**

BIOACTIVE COMPOUNDS IN MANGROVES: A brief idea of occurrence and importance of these compounds**.** **5**

Effect of flooding on growth of halophytes. **3**

UNIT 3: MINERAL NUTRITION : Nutrient requirement- Essential elements, vitamins for growth of algae. Availability in sea water, Uptake, Factors affecting, Metabolic role of essential nutrients**,** **5**

SALT REGULATION IN HALOPHYTES: Salt glands and salt secretion. Ultrastructure of salt glands, Salt glands in mangroves, Significance of vivipary. Leaf succulence, selective ion absorption**.** **5**

SALINITY AND METABOLISM: Influence of salinity on photosynthesis of halophytes. Induction of CAM. Membrane transport under salinity. Effect of salinity on growth and phytohormones**.** **5**

UNIT 4: **REGENERATION IN MANGROVES:** Methods of natural and artificial regeneration in mangroves**.** **5**

MARINE ALGAL RESEARCH IN INDIA: Important Research centers in India and their work. **5**

MANGROVE RESEARCH IN INDIA: Measure research centers in India and their contribution. **5**

PRACTICAL COURSE II

UNIT 5:

a) Estimation of pigments from marine algae. chlorophyll a, b ,c, d, carotenoids, phycobilins etc.

f) Isolation of agar agar from algal material.

g) Extraction and Estimation of alginic acid and carrageenan from marine algae.

h) Estimation of total carbohydrates from marine algae.

i) Determination of organic matter content from sediment.

UNIT 6:

a) Determination of TAN of succulent marine plants (Ex ***Sesuvium,Lumnitzera*** etc.)

b) Regeneration study in some mangrove species.

c) Determination of free amino acid content in saline and nonsaline plants.

d) Estimation of proline from saline and nonsaline plants.

e) Estimation of tannins from bark/ stems of different mangroves.

SEMESTER III

PLANT BIOTECHNOLOGY (SPECIAL PAPER- I)

B 0 3.37 : PLANT TISSUE CULTURE- I

Theory (4 Units, 60 Lectures)

Unit 1:

a) **Plant tissue culture**: Objective and goals of Plant tissue culture, laboratory design and development, operation and management **(3);** b) **Plant tissue Nutrition**: Basic principles of in vitro culture, factors influencing morphogenesis, Physiological significance of tissue nutrition **(7);** c) **Media preparation**: Media preparation and handling, sterilization technique, equipment and apparatus, procedure of media preparation and stock solution **(5).**

Unit 2: a) **Types of Culture:** Explant culture, Callus formation and its culture, Callus desiccation, organogenesis, meristem culture, axillary bud culture – protocols and schedules of observation **(10);** b) Somaclonal variation; selection **(5).**

Unit 3: a) Organ culture anther/ovary culture, embryo rescuing, synseed **(4);** b) Hardening of tissue cultured plants **(2);** c) Cell suspension culture, cell line isolation **(5);** d) Hairy root culture **(4).**

Unit 4: a) Green house technology; conservation, operation, maintenance, management **(10);** b) Cryopreservation, its importance and future prospects **(5).**

Practical (2 Units, Any 8)

1&2.	Media preparation	(2)
3.	Sterilization techniques	(1)
4&5.	Callus culture	(2)
6&7.	Organogenesis	(2)
8&9.	Cell suspension culture	(2)
10.	Techniques of hardening	(1)
11.	Visit to commercial R&D green houses, agro based industries	(1)

SEMESTER III

(SPECIAL PAPER- II) PLANT BIOTECHNOLOGY

B O 3.47: MOLECULAR BIOTECHNOLOGY AND GENETIC ENGINEERING.

Theory (4 Units, 60 Lectures)

Unit 1: a) Fundamentals of molecular biotechnology **(2);** b) Vectors in gene cloning and their selection **(6);** c) Molecular research procedure; Gene amplification, basic PCR, its modification, application, DNA polymorphism **(7).**

Unit 2: a) Use of various enzymes in recombinant DNA technology **(6);** b) 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 jumping **(9).**

Unit 3: a) Isolation, sequencing and synthesis of genes: Isolation of genes, DNA sequencing, synthesis, gene synthesis machines **(10);** b) Plant genetic engineering: gene transfer techniques, protoplast technology **(5).**

Unit 4: a) Genomics, Proteomics and Bioinformatics **(10);** b) Immunology **(5).**

Practical (2 Units, Any 8)

1.	Isolation of genomic DNA	(1)
2&3.	DNA detection and purification by gel- electrophoresis	(2)
4.	DNA estimation	(1)
5.	Isolation of proteins	(1)
6.	Isolation of plasmid DNA	(1)
7&8.	2D electrophoresis of protein	(2)
9&10	Bacterial transformation	(2)
11.	*Agrobacterium* mediated gene transfer technique.	(2)
12.	Isolation of protoplast	(1)
13.	Restriction digestion of DNA	(1)

Special Paper II:

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

Semester –IV

PLANT PHYSIOLGY

BO 4.1- Plant Physiology and Metabolism

Total Lectures-60

Unit -I

9. Membrane transport and translocation of water and solutes:
   Mechanism of xylem and phloem transport, phloem loading and unloading, passive and active solute transport, membrane transport of proteins. Root microbe interactions in facilitating nutrient uptake. **(06)**
10. Photochemistry and Photosynthesis:
    General concepts and historical background, evolution of photosynthetic apparatus, photosynthetic pigments and light harvesting complexes, photooxidation of water, mechanism of electron and proton transport, carbon assimilation- the Calvin cycle, Rubisco, significance of photorespiration. Sub classification of C4 plants, ecological significance and modification of CAM. Biosynthesis of starch and sucrose. (09)

Unit -II

11. Respiration and lipid Metabolism:
    Overview of plant respiration, Anaerobic respiration, modern concept of electron transport and ATP synthesis. Inhibitor of respiration, glyoxylate cycle, synthesis of membrane lipids, structural lipids and storage lipids and their catabolism, gluconeogenesis. **(09)**

12. Phytohormones:
    Biosynthesis and mechanism of action of Phytohormones: auxin, gibberellin, cytokinin, ethylene and ABA. **(06)**

Unit -III

13. Nitrogen and Sulphur Metabolism:
    Nitrogen fixation, Nitrogenase, “nif” genes, regulation of nitrogen fixation, products of nitrogen fixation and their transport, mechanism of nitrate uptake and reduction, transamination, nitrogen metabolism in relation to photosynthesis and respiration, Sulphate uptake, transport, reduction and assimilation. **(09)**

14. The flowering process:

Photoperiodism and its significance, endogenous clock and its regulation, floral induction and development- genetic and molecular analysis, role of vernalization.

(06)

Unit –IV

15. Stress Physiology:

    A brief idea of plant responses to water deficit, salinity, metal ion stress, freezing and heat stress, oxidative stress and drought resistance mechanism.

    (09)

16. Signal Transduction: --

    Overviews, receptors and G- proteins, phospholipids signaling, role of cyclic nucleotides, Calcium-Calmodulin cascade, protein kinases and phosphatases, specific signaling mechanisms. e.g. two component sensor – regulator system in bacteria and plants. (06)

Practicals :-

Unit –I

10) Study of enzyme ATPase
11) Sugar and amino acids analysis of phloem sap, with paper chromatography.
12) Determination of Chlorophyll a / b ratio of C3 and C4 plants.
13) Determination of rate of respiration in germinating seeds under aerobic and anaerobic conditions.
14) Study of enzyme lipase.

Unit –II

15) Effect of red and far red light on seed germination and study of photomorphogenesis.
16) Estimation of nitrate in different plant parts.
17) Study of enzyme glutamate oxaloacetate transaminase.
18) Study of nitrate reductase in plants.
19) Study of effect of PEG induced water stress on seed germination.

Reference Books-

1. Miller, P (1973) : Phytochemistry Vol.I, II and III.
2. Epstein, E (1972) : Mineral nutrition of plants : Principals and prespectives.
3. Bonner, J. and Varner, E. (1976): Plant Biochemistry.
4. Gregory, P (1976) : Biochemistry of Photosynthesis.
5. Devlin, R.M. and Witham (1975): Plant Physiology.
6. Beevers, H (1976): Nitrogen Metabolism in plants.
7. Stump, F.A. and Conn, E.E. (1981) : Biochemistry of Plants. A Comprehensive Treatise Vol. II, III, IV, IX and XII.
8. Mukharjee S.P. and ghosh A.N. (1996) Plant Physiology.
9. Wilkins, M.B. (1976): Physiology of Plant Growth and Development.
10. Noggle, G.R. and Fritz, G. J. (1976): Introductory Plant Physiology.
11. Marschner, H. W. (1986): Mineral nutrition of Higher Plants.
12. Salisburry, F.B. (1971): The biology of Flowering.
13. Krishnamurthy, H.N. (1992): Physiology of Plant Growth and Development.
14. Salisbury, G.B. and Ross, F.V.(1990): Plant Physiology.
15. Levitt, J. (1969, 1980): Responses of Plants to Environmental Stress.
16. Taiz L. and Zeiger F. (2004): Plant Physiology.
17. Pessarkli M. (2005): Handbook of Photosynthesis. II nd Edition.

SEMESTER IV

COMMON PAPER IV Elective IV

BO 4.2 PAPER XIV: PLANT STRUCTURE, DEVELOPMENT & REPRODUCTION

Total Lectures 60

Unit -I

Embryology :

8. Gametophyte in Angiosperms: outline of development of male and female gametophyte. **(04)**
9. Ultrastructure of gametophyte: Vegetative cell, generative cell, pollen wall, pollen tube, abnormal male gametophyte and their function. **(06)**
10. Ultrastructure of female gametophyte: Synergids, Eggs, antipodal, central wall. **(05)**
11. Pollen: Structure of stigma and style, Chemotropism, Pollen wall proteins, Stigma surface proteins, Post fertilization events. **(04)**

Unit –II

12. Experimental Embryology: Techniques for anther, ovary, nucellus, endosperms, embryo culture and their significance. **(04)**
13. Types of apomixis: Dilpospory, apospory. Causes, consequences and significances of apomixis. **(04)**
14. Polyembryony: Classification, causes, experimental induction and partial importance. **(03)**

Unit -III

Anatomy: **(15)**

5. Shoots development :- Organisation of shoots apical meristem (SAM) cytological and molecular aspects of SAM; Control of cell division and cell to cell communication; Control of tissue differentiation especially xylem and phloem **(04)**
6. Leaf growth and Differentiation :- Determination, control and leaf forms : Differentiation of epidermis (with special Suggested readings:- to stomata and trichomes) and mesophylls. **(04)**

7. Root development:-
   Organisation of root apical meristem(RAM) , Vesscular tissue differentiation , Lateral roots , root hairs, root- microbes interaction.
8. Application:-
   Utility in systematics, archaeology climatic studies and crime detection.

Palynology : 10

Palynology :Scope and branches with special Suggested readings:-s to (01)

Palynotaxonomy : Pollen morphology and plant taxonomy with Suggested readings:- to Gymnosperms and Angiosperms. (01)

Paleopalynology : Principles, microfossil recovery theory and techniques, microfossil groups and oil exploration. (02)

Aeropalynology: Principles, techniques, pollen analysis, pollen and spore allergy, allergic properties of pollen, pollen calendar and importance. (02)

Melittopalynology: Bee colony,foraging behaviour of bees , unifloral multifloral honey, application in crop productivity. (02)

Agropalynology: Pollen viability, pollen germination, pollen storage and their significance. (02)

PRACTICALS:

Embryology:

6. Study of ultrastructure of male gametophyte with the help of slides and microphotographs.
7. Study of ultrastructure of female gametophyte with the help of slides and microphotographs.
8. Culture of any one organ: anther / ovary / endosperm / nucellus / embryo.
9. Study of few apomicts with the help of any suitable material.
10. Study of polyembryonic seeds. (Mango, Citrus)

Anatomy:

8. Study of living shoots apices by dissection using aquatic plants such as *Ceratophyllum* and *Hydrilla*.
9. Study of cytohistological zonation in the shootapical meristem (SAM) in sectioned and doubled stained permanent slides of suitable plant such as Coleus Kolanchoe, Tabacco.
10. Examine of shoot apices in a monocotyledons in both T.S. and L.S. to show the origin and arrangement of leaf primordial.
11. Study of whole roots in monocots and dicots

12. Examine of L.S. of root from a permanent preparation to understand the organization of root apical meristem & it's derivatives (use maize, aerial roots of banyan , *Pistia, Jussieua* etc.) origin of lateral roots .
13. Study of leguminous roots with different types of nodules.
14. Study of leaf anatomy – structure, stomata, trichomes, types of stomata .

Palynology:

1 Study of pollen morphotypes (by at least 6 examples)
2 Acetolysis (Honey Analysis)
3 Study of aerospora , aerospora analysis by Tilak Air Sampler and Gravity slide method.
4 Study of allergic plants and their pollen.
5 Study of fertility by TTC (Acetocarmine methods etc.)

SUGGESTED READINGS:-

Embryology:

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

Anatomy:

Barnova, M A. 1987: Historical developments of the present classification of morphological types of stomata. Bot.Res.53:53-79.
Cutter, E G 1971 Plant Anatomy
Dilcher, D D 1974: Approaches to the identification of angiosperms leaf remains. Bot.Rev. 40:2-157
Emmes, E J. and M C Danials, 1947: An introduction to plant anatomy.
Easau, K. 1962: Plant anatomy –anatomy of seed plants.
Fahn, A.1969: Secretary Tissue system
Foster, A S 1942: Practical plant anatomy
Haberland, G.1965: Physiological plant anatomy
Masueth, J D. 1936 : Plant anatomy
Metcalfe, C R and L Chalk, 1950: Anatomy of the dicotyledons

Solender, H. 1908 : Systematics anatomy of the dicots
Tomlinson, P S 1961: Anatomy of the monocotyledons.

Palynology

Cunningham, D D 1873 : Microscopic examination of air.
Fageri, K and J Inversen, 1964: Text book of pollen analysis.
Nair, P K K 1964 : Advances in Palynology.
Nair, P K K 1966 : Essentials of Palynology.
Heslop-Harrison, Y. 1971: Pollen development and physiology.
Gregory, P H, 1973: Microbiology of atmosphere.
Erdtman, G.1988 : Pollen morphology and plant taxonomy.
Tilak, S T. 1989 : Airborne pollen and fungal spores.
Shivanna K R and N S Rangaswami 1992 : Pollen Biology, A Laboratory manual.
Bhattacharya, K. , M R Majumdar and S G Bhattacharya 2006: A Text book of Palynology.
Shivanna K R and B M Johari,1985: The Angiosperm Pollen, structure and function.
Pandey and Chadha, 1992: Plant Anatomy and Embryology .

Journals:

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

Semester-IV

PLANT PHYSIOLOGY(Special Paper-III)

B O- 4.31 Stress Physiology of Plants

Total Lectures- 60

Unit –I

10. **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. **(08)**
11. **Flooding stress** - Nature of waterlogging stress. Effect of flooding stress on physiological processes in plants. Wetland and non wetland species. Mechanism of waterlogging tolerance. **(07)**

Unit –II

12. **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. **(09)**

13. **Ionic stress** - Effect of ion toxicity (iron, zinc), heavy metals toxicity and aluminum toxicity in plants, Phytoremediation, Mechanism of aluminium tolerance, Transgenic approaches. (06)

Unit –III

14. **Thermal stresses** - Effect of high and low temperatures on plant metabolism, Mechanisms of high and low temperatures tolerance, Cold hardening, Role of HSP. **(05)**
15. **Radiation stress** - Influence of high light intensity on photosynthesis, Photoprotection mechanisms, Effect of UV radiations on plants, Mechanism of UV tolerance. **(05)**

16. **Oxidative stress** - Generation of reactive oxygen species, Effect of ROS on metabolism, ROX detoxification mechanisms in plants, Transgenic approaches. **(05)**

Unit –IV

17. **Gaseous stress** - Effect of elevated CO_2 concentration on plant metabolism, Effect of air pollutant SO_2 and O_3 on plants. **(06)**
18. **Biotic stress** – Effect of fungal infection on plant metabolism, Biochemical mechanism of disease resistance, Allelopathy. **(09)**

Practicals:-

Unit –I

9) Measurement of RWC and Osmotic potential
10) Determination of chlorophyll stability index.
11) Estimation of chlorides in leaves of halophytes and non halophytes.
12) Study of protein/ amino acid profile in plants under stress.
13) Study of effect of fungal infection on peroxidase activity.

Unit –II

14) Study of phenolics in scales of onion varieties differing in disease resistance.
7 & 8) Study of free radicals scavenging enzymes, Catalase and super oxide dismutase.
9) Study of free prolein accumulation in plants under stress.
10) Study of seed germination under stress condition.

Semester-IV

B O – 4.41 Applied Plant Physiology

(Special Paper –IV)

Total Lectures-60

Unit –I

5) Crop growth and its regulation- Growth analysis of crop plants and its significance. Factors controlling crop productivity, Harvest index, water use efficiency and N use efficiency. **(06)**

6) Nutriophysiology - Physicochemical properties of soil. Classification of mineral nutrients according to function. Factors influencing mineral uptake. Foliar diagnosis of critical nutrient status. Physicochemical properties of soil, lime and gypsum as soil additives. Role of chelates in mineral utilization. Foliar applications of mineral elements. Biofertilizers, CO_2 as a fertilizer. **(09)**

Unit –II

7) Source Sink relationship in crop plants and its significance. **(06)**

8) Reproductive physiology:- Photoperiodism and vernalization. Role of PGRs in flowering, sex determination and fruit development. Ethylene and post harvest physiology. **(09)**

Unit –III

5) Plant growth regulators in Agriculture and Horticulture**.** **(15)**

Mode of applications of PGRs

i) Pre sowing soaking treatment

ii) Foliar application

iii) Other modes

Roles:

a) auxins and synthetic auxins

b) gibberellins

c) cytokinins

d) ethylene and ethylene generating compounds

e) long chain alcohols

f) brassinosteroids

g) Plant growth retardants

h) Amino acid mixtures and other commercial products. Biotonics.

Unit –IV

6) Crop weed interaction, weedicides and their mode of actions, Invading weeds. **(08)**

15) Physiological aspects of transgenic crops. **(04)**

16) A brief idea of crop physiological research in India. **(03)**

Practicals:-

Unit –I

1, 2) Growth analysis of any two crop plants (RGR, NAR, LAR, LAI, etc.)

3,4) Determination of N, P & K status of soil and crops

5) Study of effect of source manipulation on sink capacity in any crop plant.

6) Study of effect of weedicides on some aspects of weed metabolism (chlorophylls, nitrate reductase)

Unit –II

7) Effect of pre sowing-soaking treatments of PGRs on crop growth.

8) Determination of Harvest index of different crops (Wheat, chickpea and applications)

9) Effect of foliar applications of some commercial PGRs and biotonics on crop productivity parameters (carbohydrate status).

10) Effect of soil conditioners & Biofertilizers on crop growth.

Suggested readings:-

49. Cherry, J.H (1989): Environmental stresses in plants. Biochemical and Physiological mechanisms.
50. Evans, L.T.(1972): Crop Physiology.
51. Fageria, N. K.(1992): Maximizing crop yield.
52. Fertilizer association of India (1974): Fertilizer handbook of Usage.
53. Fitter, A. H. and Hay, R. K. M. S. (1987): Environmental Plant Physiology.
54. Gupta, U. S. (1972): Crop Physiology.
55. Gupta, U. S. (1975): Physiological aspects of dryland farming.
56. Hale, M.C. and Orcutt, D.M. (1987): The Physiology of Plants Under Stress.
57. ICAR handbook of Fertilizers.
58. Kozlowski, T. T. (1984): Flooding and Plant Growth.
59. Levitt, J. (1969, 1980): Responses of Plants to Environmental Stress.

60. Mansfield, C.A. (1976): Effect of air pollutant on plants.
61. Marschner, H. W. (1986): Mineral nutrition of Higher Plants.
62. McLaren, J.S. (1985): Chemical manipulation of crop growth and Development.
63. Mehrotra, R.S. (1980): Plant Pathology.
64. Paleg, L.G. and Aspinal, D.(1982): The Physiology and Biochemistry of Drought resistant in Plants.
65. Pojakoff Mayber A. and Gale, J. (1975): Plants in saline environment.
66. Rice, E. L. (1982): Allelopathy (Physiological Ecology).
67. Sharma, S. K. and Gupta, I. S. (1986): Physiological aspects of dryland farming.
68. Sinha S.K., Sane P.V., Bhargava S.C. and Agarwal P.K. (1990): Proceeding of International Congress of Plant Physiology Vol. I & II.
69. Srivastava, Y. N. Environmental pollution.
70. Turner, N. C. and Cramer, P.J.(1980): Adaptation of plants to water and high temperature stress.
71. Upeke, L. K. (1982): Tropical tree crops.
72. Yawalkar and Agarwal, Manures and fertilizers.
25.Pessarkli, M. (2004): Handbook of Plant and Crop Physiology, Marcel Dekkar Inc. NY.
26. Pessarkli, M. (2005): Handbook of Photosynthesis.
27. Nickell, L.G. (1986): Plant growth regulators in Agriculture.
28. Asana, R.D. and Sarin M.N. (1968): Crop Physiology in India IARI Publ.
29. Taiz L. and Zeiger F. (2002): The Plant Physiology

Journals

- Annual reviews of Plant Physiology and Molecular Biology.
- Indian Journal of Plant Physiology.
- Journal of Experimental Botany.
- Physiologia Plantarum Sweden.
- Plant Physiology (USA).
- Everymans Science.

Semester- IV

MYCOLOGY & PLANT PATHOLOGY

B O 4.32 Industrial Mycology (Special Paper-III)

Total Lectures – 60

UNIT- I

1. Role of fungi in industrial mycology :scope and their utility. **05**
2. Commercial fungal strain : selection,improvement,development and their maintenance. **05**
3. Fermentation: Methods and types of fermentation of alcohol and organic acid by using fungi as microorganisms. **05**

UNIT-II

4. Secondary metabolites : use of fungi in production of secondary metabolites. 15

UNIT- III

5. Antibiotics of fungal origin and their production. **06**
6. Production of Ergot alkaloids. **03**
7. Enzymes of fungal origin and their importance in industry. **15**

UNIT-IV

8. Edible fungi, their nutritional value and role in cottage industry. Large and small scale cultivation technique of *Agaricus bisporus, Pleurotus spp.,Volvarialla volavacea* and their preservation, diseases and their control, cost benefit analysis. **15**

Practicals (2 Units, Any 8)

UNIT-I

5. Study of strain maintenance using different methods.
6. Production of alcohol by fermentation technique.
7. Detection of citric acid from mycelial biomass using circular chromatography.
8. Study of antibiotics of fungal origins.

5 & 6. Production of Ergot alkaloid by using fungal elicitor.

UNIT-II

7 & 8. Preparation of spawn: Grain, Perlite and manure spawn.

9 & 10. Cultivation of mushroom.

11 & 12.Study of some enzymes of fungal origin.

REFERNCE BOOKS:

17. Casida, L.E.Jr. (1964): Industrial Microbiology.
18. Whipps, J.M. and R.D.Lumsden (1989): Biotechnology of fungi for improving plant growth.
19. Turner (1971): Fungal metabolism.
20. Atal (1978): Indian Mushroom Science-I.
21. Kannaiyan (1980): A hand book of edible mushrooms.
22. Purkhyastt (1976): Indian edible mushrooms.
23. Smith,J.F. and Barry,D.R.:The filamentous fungi Vol.I Industrial Mycology Vol.II and III.
24. Dodge, C.W.(1935):Industrial Mycology.
25. Prescott, S.G. and Dunn,C.D.(1959): Industrial Microbiology.
26. Christensen,C.M. (1975): Mould, Mushrooms and Mycotoxins.
27. Rose, A.H.(1961): Industrial Microbiology.
28. Singer, R.(1961): Mushrooms and Truffles cultivation and utilization.
29. Rhodes, A. and Fletcher, D.L.(1966): Principles of industrial microbiology.
30. Gray, W.D.(1970): The use of fungi as food and food processing.
31. Lodder, J.(1970): The Yeast.
32. Chang,S.T. and Hays, W.A.(1978): The biology and cultivation of edible mushrooms.

. 17. Aneja K.R.(1993) : Experiments in Microbiology,Plant Pathology and Tissue Culture.

21. Onions, A.H.S.D. Allsopp and H.O.W.Eggins (1981): Smith's Introduction to Industrial Mycology.
22. Barger, G. (1931): Ergot and Ergotism.
23. Fletcher, J.T.,White,P.F.and Gaze, R.H.(1989): Mushrooms: Pest and Disease Control.

Semester IV

MYCOLOGY & PLANT PATHOLOGY

B O 4.42 Integrated Disease Management (Special Paper- IV)

(Concepts and Application II)

Total Lectures – 60

UNIT –I

3. Methods of disease diagnosis, field observation, isolation and identification of Pathogens. **05**
4. 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. **10**

UNIT-II

3. 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 plants, pathogens and their management, Antibiotics and biological control of plant pathogenic fungi. Biological control Agents, VA-Mycorrhiza, *Trichoderma viride, T.harzianum, Pseudomonas flurescans, Glomus.* Use of Botanicals and other biopesticides. **15**

UNIT-III

5 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).

15

UNIT-IV

5. 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).

15

Practicals (2 Units, Any 8)

UNIT-I

2. Study of air borne fungi using air sampler.

2 & 3. Spore germination of pathogenic fungi in two different media.

4 & 5. Evaluation of fungicides and antibiotics against pathogen by spore germination by food poisoning technique.

UNIT-II

5, 6 & 7. Synergistic effect of Agrochemicals in the management of crop Diseases.

8,9 & 10. Symptomology, histopathology of the disease mentioned in the theory.

11 & 12. Collection and preservation of plant diseases.

REFERENCES BOOKS

12. D. Lalithakumari (2000): Fungal Protoplast: A Biotechnological Tool: Oxford and IBH Publishing Co. Pvt.Ltd.
13. R.E.F. Mathews (1970) : Plant Virology.
14. S.T.Tilak (1998): Aerobiology.
15. Kenneth M. Smith (1968): Plant Viruses.
16. F.C.Bawden (1964): Plant Viruses and Virus Diseases.
17. Mehrotra R.S.(1980): Plant Pathology
18. Agrios, G.N.(2006): Plant Pathology (5^{th} Edition).
19. Ny Vall, R.F.(1979): Field Crop Diseases Handbook.
20. Singh, R.S.(1963): Plant Diseases.
21. Padoley, S.K. and P.B.Mistry: A manual of Plant pathology.
22. Gangopadhyay, S.(1984): Clinical Plant Pathology.

SEMESTER IV

CYTOGENETICS AND PLANT BREEDING (SPECIAL PAPER- III)

B O 4.33: MOLECULAR GENETICS

Theory (4 Units, 60 Lectures)

Unit 1:

Microbial Genetics: Genetic studies in microorganisms with special Suggested readings: to *E. coli* and *Agrobacterium*. Genetic exchange in bacteria- an overview (Mutants, Transformation, conjugation and Transduction, Para sexuality and its significance in bacteria) **(15).**

Unit 2: a) The Genetics of Viruses: The structure and life cycle of bacterial virus, Mapping the bacterio-phage genome (Phage phenotypes, genetic recombination in phage, fine structure and deletion mapping), T_4 genetic map, bacterio-phage X 174 **(8),** b) Molecular analysis of DNA, RNA and Proteins using blotting techniques and Micro arrays **(7).**

Unit 3: The Techniques in Molecular Genetics: Basic techniques (Restriction digestion, production of recombinant DNA molecules, amplification using vectors, construction of genomic libraries, cDNA libraries and screening DNA libraries for genes of interest); The manipulation of cloned DNA sequences: *in vitro,* using phagemid vectors; *In vitro* site specific mutagenesis **(15).**

Unit 4: a) Molecular analysis of Genes and Chromosomes: PCR, Physical maps of DNA molecules based on RFLP and Fine structure maps **(8),** b) Genetics of C_4 and CAM pathways, Genes from plastids and nuclei, Regulation of expression (Transcriptional, Post transcriptional, translational, post translational and compartment specific control) **(7).**

Practical (2 Units, Any 8)

1. Media preparation for microbial cultures.
2. Isolation, culturing and growing *E. coli.*
3. Study of bacterial conjugation (02).
5. Study of bacterial transduction (02).
7. Study of transformation (02).
9. Study of *Agrobacterium* mediated transformation.
10. Study of restriction digestion analysis by gel electrophoresis (02).12. Study of southern blotting (02).

SEMESTER IV

CYTOGENETICS AND PLANT BREEDING (SPECIAL PAPER – IV)

B O 4.43: SPECIAL APPROACHES IN GENETIC IMPROVEMENT OF CROP PLANTS

Theory (4 Units, 60 Lectures)

Unit 1:

a) General introduction to concepts of genetic engineering **(2),** b) Vectors in gene cloning: Plasmids, Bacteriophages, Shuttle vectors, Ti- plasmid, expression vectors, constructing chimeric DNA **(7),** c) Isolation of the desired gene, insertion of gene in vector, transformation, selection of the transformed host cells, cloned gene expression **(6).**

Unit 2: a) Engineering plants for the production of insect resistance, herbicide resistance, resistance against plant viral diseases; Improvement of the nutritional quality of the crop **(10),** b) Transgenics, terminator technology and their ecological risks **(5).**

Unit 3: a) Genetics of Nitrogen fixation: Types of nitrogen fixation, organization and molecular analysis of *nif* genes in *Klebsiella*, structures of host gene, *Hup* gene and regulation of nitrogen fixation **(5),** b) Tissue Culture: Somaclonal variation, somatic embryogenesis, production of secondary metabolites, cell line isolation, hairy root culture **(5),** c) Greenhouse Technology: Construction, operation, maintenance and management **(5).**

Unit 4: a) Protoplast isolation and genetic engineering: Isolation of protoplast, cellular hybridization, gene transfer and protoplast modification in plant improvement, somatic hybrids for Cytoplasmic male sterility **(5),** b) Genomics- an overview: Mapping, Sequencing and functional analysis of genome; Human genome project; Bacterial, Yeast, *Drosophila, Arabidopsis* and Rice genomes **(7),** c) Proteomics and Bioinformatics **(3).**

Practical (2Units, Any 8)

1. Isolation of genomic DNA.	2. Cell line culture
3. Cloning vectors.	4. Hairy root culture
5. Induction of enzyme Nitrate reductase.	6. Gene cloning using PCR
7. Protoplast fusion and culture.	8. Study of DNA markers using RAPD
9. Somatic embryogenesis	
10. Detection and estimation of protease inhibitors from pulse seeds	
11. Isolation of protoplast by mechanical and enzymatic methods.	
12. Visit to commercial Greenhouse and submission of report.	

Suggested readings:

Special Paper- III

13. Twyman R. M. 1998 Advanced molecular Biology. Viva Books Pvt. Ltd. New Delhi.
14. Wolfe S. L. 1993 Molecular and cellular biology. Wadwith Publishing Co. California USA.
15. Lewin, B. 2000 Genes IV, V, VI. Oxford University Press, New York.
16. Brown T. A. 1998 Genomes. John Wiley and sons Singapore.
17. Alberts B. et al 1994 Molecular biology of the cell 3rd Edition Garland Publishing, New York.
18. Singh B. D. 1990 Fundamentals of Genetics. Kalyani Publishers Ludhiana.
19. Latchman D. S. 1990 Gene regulation an eukaryotic perspective. Unwin Hyman Publication London.
20. Klug W. S. and Cummings M. R. 1983 Concepts of Genetics. Charles E. Merrill Publishing Company London.
21. Jain H. K. 1999 Genetics Principles, Concepts and Implications. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
22. Gupta P. K. 1985 Genetics Rastogi Publications Meerut.
23. 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.
24. Stickeberger M. W. 1996 Genetics 3rd Edition MacMillan Publishing Co. New Delhi.

Journals:

8. Annual review of Microbiology
9. Journal of Cytology and Genetics
10. Cytologia
11. Caryologia
12. Indian Journal of Experimental Biology
13. Journal of Experimental Botany
14. Trends in Biotechnology (Elsevier)
15. Trends in biochemical Sciences (Elsevier)

Special Paper- IV

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

48. Wennacker Ernst L. 1987 From Genes to Clones; Introduction to Gene Technology VCH publishers Weinheim (Federal Republic of Germany)
49. Mount D. W. 2001 Bioinformatics Sequence and Genome Analysis. Cold Spring Harbour Laboratory.
50. Jagota A. 2000 Data Analysis and Classification for Bioinformatics. Published by Bioinformatics by the bay Press.
51. Durbin R, Sean R., Eddy, Anders Krogh, Graeme M.1999 Biological Analysis-Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press.
52. Andreas Bazevanis, B. F. Francis Ouellette and B. F. Cuellette 1998 Bioinformatics : A Practical Guide to the analysis of Genes and Proteins

Journals:

9. Indian Journal of Biotechnology
10. Indian Journal of Experimental Biology
11. Journal of Experimental Botany
12. Trends in Biotechnology (Elsevier)
13. Trends in biochemical Sciences (Elsevier)
14. Journal of Molecular Plant Pathology
15. Journal of Plant Biotechnology
16. International Journal of Food Science and Technology.

SEMESTER IV

ENERGY, ECOLOGY AND ENVIRONMENT - SPECIAL PAPER-II

BO-4.34 EXPERIMENTAL ECOLOGY AND ENERGY STUDIES

Total lectures: 60 **Total Practicals: 11**

EXPERIMENTAL ECOLOGY:

UNIT 1:

7. Methods in autecological study: Systematic position, geographic distribution, seed germination, species environment (microclimate), physical anatomy, leaf area index (LAI). **(5)**
8. Methods of Community study: Quadrats and its types, Transects, Bisects. **(3)**
9. Methods of primary productivity measurements, Global primary productivity patterns. **(7)**

UNIT 2:

10. Systems Ecology: Introduction and Elements of system ecology. **(5)**
11. Ecosystem modeling- Conceptual model, Working model. Auxiliary variables and Foresters diagram. **(5)**
12. Remote sensing techniques and its applications. **(5)**

UNIT 3:

ENERGY STUDIES:

7. Source of energy: Conventional and non-conventional sources, Biological methods, Hydrogen fuel. **(8)**
10. Biomass production by the species, techniques of producing biomass energy plants, fuel wood species and petrocrops and their potential, other energy yielding crops (Sweet sorghum). **(7)**

UNIT 4:

11. Energy from wastes. **(8)**
10. Conservation of energy **(7)**

Practicals. (2 Units Any 8)

UNIT 5:

10. Seed germination under various treatments for tree species.
11. Study of seed output and reproductive capacity.
12. Study of petro crops and other energy plants.
13. Determination of calorific value of wood.
14. Study of effect of natural light intensity on primary productivity of an aquatic ecosystem.

UNIT 6:

15. Setting up an ecological model.
16. Use of ecological model in the field study.
17. Study of Leaf Area Index.
18. Study of rooting of the cuttings.
10. Ecological data collection for computer use.
11. Study of population growth curve.

SEMESTER IV-

ENERGY, ECOLOGY & ENVIRONMENT - SPECIAL PAPER-II

BO-4.44 PAPER- XVI: ENVIRONMENTAL ISSUES, ASSESSMENT AND RESTORATION

Total lectures: 60 **Total Practicals: 10**

UNIT 1:

1) Pollution of Environment:

C) Air Pollution: Acidic precipitation, causes and consequences. Air pollution monitoring devices. **(6)**

D) Water Pollution: Classification of water pollutants: A brief account. Oxygen demanding pollutants and their activity. Pathogens, Nutrients, salts, heat, heavy metals, pesticides. Radioactive pollutants and oil pollutants. Self purification of natural streams. Oxygen sag analysis. **(9)**

UNIT 2:

2) Environmental Issues:

Ozone – Positive and negative influence of ozone. **(2)**

Air quality loss. **(2)**

Nuclear winter. **(2)**

Vehicular and Industrial gases. **(2)**

Carbon and world climates. **(2)**

3) Land Degradation: Loss of soil fertility, Mining. **(5)**

UNIT 3:

4) Impact Assessment – EIA:

EIA – Global Scenario, In India, Methodology. **(8)**

Environmental Auditing and Monitoring- Role of plants and microbes. **(7)**

UNIT 4:

5) Ecology and Human Welfare:

Natural resources- Conservation and management. **(3)**

Recycling of resources. **(3)**

Waste management. **(3)**

Vermitechnology. **(3)**

Ecotourism and ecofriendly measures **(3)**

Practicals.

UNIT 5:

11. Study of Biological Indicators.
12. Study of IUCN Red list categories.
13. Study of wetland macrophytes.
14. Effect of effluents on soil microflora.
15. Study of garbage.

UNIT 6:

16. Measurement of vehicular pollution.
17. EIA study-I.
18. EIA study-II.
19. Comparison of plant communities from polluted and non-polluted areas.
20. Measurement of dust fall.

Semester IV

B O-4.35 ANGIOSPERM TAXONOMY FLORISTICS AND BIOSYSTEMATICS

(Special Paper-III)

Unit-I	**1**	**FLORISTICS**: Need and significance of floristic studies, methodology, analysis and data presentation.	**3**
	2	**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, color charts, outstanding botanical libraries.	**7**
	3	**HERBARIUM AND BOTANICAL GARDENS:** Herbarium as a store house of plants and plant information, its role in research and teaching; Botanical and experimental gardens and their role in teaching, training and conservation of plants. Important Herbaria and Botanical Gardens of the world and India.	**5**
Unit-II	**4**	**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.	**5**
	5	**HISTORY OF BOTANICAL EXPLORATION IN INDIA:** Beginning of botany in India, contributions made in earlier phase by Garcia d'Orta, C. acosta, Van Rheede, John Burman, John Koenig, Robert kid, Buchnan, Roxbugh, N. Wallich, William Griffith, Robert Wight, Thomas Thomson, J. D. Hooker and recent phase by Collet, Brandis, T. Cooke, Duthie, Fyson, Gamble, Haines, Parkinson, Prain, Santapau, and present works with special emphasis on Maharashtra. Botanical Survey of India (BSI).	**10**
Unit-III	**6**	**BIOSYSTEMATICS:** Aims, concepts of species, steps in biosystematic study, biosystematic categories- ecotype, ecospecies, cenospecies, camparium, methods in biosystematic studies, ecotypic variations and taxonomy, scope and limitations.	**5**
	7	**SPECIES CONCEPT:** Concept of taxa, concept of species- Nominalistic, Typological, Biological and alternative species concepts; concept of genus and family.	**5**

	8	**SPECIATION:** Kinds of speciation- quantum, Mayrean, catastrophic, local ecological, geographic, phyletic; speciation and evolution of species.	5
Unit-IV	9	**MORPHOLOGICAL VARIATIONS, SYSTEMATIC POSITION, INTERELATIONSHIPS, PHYLOGENY AND ECONOMIC IMPORTANCE OF FOLLOWING FAMILIES:** Dilleniaceae, Clusiaceae, Tiliaceae, Lecythidaceae, Bigoniaceae, Passifloraceae, Caricaeae, Salicaeae, Arecaeae, Pandanaceae, Araceae, Lemnaceae.	15
Unit-I		**PRACTICALS/LABORATORY EXCERCISES** • Study of materials and methods of preparation of herbarium • Preparation of Botanical keys • Study of ecotypes/ variations in population of species • To know using computer • To identify family with the help of computerized Key • Study of Exotic plants (weeds) found in the region	
Unit-II		• Study of Endemic plants of India in light of IUCN Red List Categories. • Study of medicinal plants of the region • Descriptions, Sketching, classification and identification of families: Dilleniaceae, Clusiaceae, Tiliaceae, Lecythidaceae, Bigoniaceae, Passifloraceae, Caricaeae, Salicaeae, Arecaeae, Pandanaceae, Araceae, Lemnaceae and identification of wild and cultivated plants represented in local flora. Any additional practical/s based on theory syllabus will be added whenever necessary.	

Selected Readings

- 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 Tommorow Publications, New Delhi.
- Naik, V. N. 1984. ***Taxonomy of Angiosperms*** Tata McGraw-Hill Publication Com. Ltd. 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 & Distributers, New Delhi.
- Lawrence George 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.
- Rao, R. R. 1994. ***Biodiversity of India (Floristic Aspects).*** Bishen Singh Mahendra Pal Singh, Dehra-Dun.
- Judd Walter S., Cmpbell C. S., Kollogg, E. A., Stevens P.F. and M. J. Donoghue 2008. Plant Systematics. Sinauer Associates, INC,Publishers.Sunderland, Massachusetts, USA.

Semester IV

B O-4.45 ANGIOSERM TAXONOMY

BPHYLOGENY AND FLORAL BIOLOGY OF ANGIOSPERMS

(Special Paper- IV)

Unit-I	**1**	**ORIGIN OF ANGIOSPERMS:** Pre-cretaceous and Cretaceus 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, stachyospory-phyllospermae theory, pteridosperm theory, pentoxylales theory and durian theory; monophyletic verses polyphyletic origin of angiosperms.	**9**
Unit-II	**2**	**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;* Sonnertiaceae: *Sonnertioxylon, Sonnertiorhizos, Sahnianthus, Enigmocarpon;* Guttiferae: *Indocarpa,* Myrtaceae: *Sahnipushpam;* Malvaceae: *Sahniocarpon, Harissocarpon, Daberocarpon, Chitaleypushpam.* Fossil angiosperms and palaeoecology of India.	**6**
Unit-III		**PHYTOGEOGRAPHY:** Geological time scale, geographical history, Continental Drift, Land Bridges, shifting of poles, theories of differentiation and natural selection, types and areas of natural distribution, centre of origin, theory of tolerance, phytogeographic regions of the world, Botanical provinces of India and their characteristic vegetation with emphasis on Vegetation and Phytogeography of the Western Ghats.	**5**
	7	**CONSERVATION BIOLOGY:** Biodiversity, its importance, assessment, loss and conservation, ethical principles of conservation biology, World organisation for conservation of biodiversity, Red List categories of IUCN, means and ways for conservation**.**	**5**
	8	**ENDEMISM:** Concept of endemism, categories, biodiversity of India, megacentres of endemism in India; Keystone and flagship species, endemic plants of India with special reference to Western ghats and Maharashtra, sacred grooves and their importance.	**5**

Unit-III		**FLORAL BIOLOGY:** Sex in flowers, sex distribution in plants, types of pollination, chasmogamy and cleistogamy; biology of floral parts-calyx, corolla, androecium, pollen, style and stigma; anemophily; hydrophily; ornithophily; cheiropterophily; entemophily-bee. carpenter bee, fly, moth, butterfly and wasps flowers; floral diversity and evolutionary steps toward asclepiad flowers. Co-evolution of angiosperms, insects and fungi.	**15**
Unit-IV	**9**	**MORPHOLOGICAL VARIATIONS, SYSTEMATIC POSITION, INTERELATIONSHIPS, PHYLOGENY AND ECONOMIC IMPORTANCE OF FOLLOWING FAMILIES:** Podostemonaceae, Rhizophoraceae, Santalaceae, Loranthaceae, Viscaceae, Polygalaceae, Sapindaceae, Apiaceae, Xyridaceae, Eriocaulaceae, Hydatellaceae, Typhaceae.	**15**
Unit-I		**PRACTICALS/LABORATORY EXCERCISES** • Study of characters of anemophilous flowers. • Study of characters of hydrophilous flowers. • Study of characters of cheiropterophilous flowers. • Study of characters of flowers entemophilous: bee. Carpenter bee, fly, moth, butterfly and wasps flowers.	**15**
Unit-II		• Study of fossil angiosperms of India with the help of slides and specimens • Practical based on Theory of Continental Drift • Descriptions, Sketching, classification and identification of families: Podostemonaceae, Rhizophoraceae, Santalaceae, Loranthaceae, Viscaceae, Polygalaceae, Sapindaceae, Apiaceae, Xyridaceae, Eriocaulaceae, Hydatellaceae, Typhaceae. and identification of wild and cultivated plants represented in local flora. Any additional practical/s based on theory syllabus will be added whenever necessary.	**15**

(In second term of IV Semester, at least two local tours and an excursion of about one week duration has to be conducted for students opting for, 'Taxonomy of Angiosperms' as their specialization to study vegetation, pollination mechanism, ecology and flowering plant species of suitable region. Student has to submit herbarium specimens (50), permanent or semi permanent slides (5) preserved plant specimens, tour report, laboratory work-book and project work report(if any) at the time of practical examination.)

Selected Readings:

- 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 Tommorow 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 Com. 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 & Distributers, New Delhi.
- Lawrence George 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 BotanicaGardens 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., Cmpbell C. S., Kollogg, E. A., Stevens P.F. and M. J. Donoghue 2008. Plant Systematics. Sinauer Associates, INC,Publishers.Sunderland, Massachusetts, USA.

M. Sc. PART II (SEMESTER IV)

BO-4.36 MARINE BOTANY PAPER XV (SPECIAL PAPER III)

MARINE ECOLOGY

Total Lectures : 60

UNIT 1:

MARINE ENVIRONMENT : , Oceans. Sea as an environment. Abiotic factors - Chemical (salinity, O_2, CO_2, nutrients) Physical (light, temperature, wind, tidal action, waves, etc) and Geological (oceans, ocean floor)factors. Biotic factors - floral and faunal components. Types of Coasts, Estuaries. **10**

PRIMARY PRODUCTIVITY OF ESTUARINE ECOSYSTEM: An over view, factors affecting, Role of phytoplankton, Water blooms and red tide phenomenon**.** **5**

UNIT 2:

ECOLOGY OF MARINE ALGAE: Zonation pattern and seasonality**.** **5**

ECOLOGY OF MANGROVES: Occurrence, diversity, distribution, zonation structure in mangrove ecosystem. Ecological significance. Anatomical, physiological, morphological adaptations in mangroves, Vivipary and its role in mangroves**.** **10**

UNIT 3:

MICROBIAL ECOLOGY OF COASTAL ECOSYSTEM: Mycorrhizal relations, Coastal vegetation and nitrogen fixation, Detritus based food chain**.** **6**

CORAL REEFS: Occurrence, distribution and types. Calcification, reef algae, Natural and anthropogenic stress ,Restoration and conservation of coral ecosystem, Concept of Marine Park**.** **9**

UNIT 4: MARINE POLLUTION: Types, sources and impact. Toxic metal pollution, Oil, sewage, pesticide, radioactive pollution and effect of waste disposal on marine ecosystem, Biomagnification**.** **10**

CONSERVATION OF MANGROVE ECOSYSTEM: Need for conservation, Human impact, Threats and conservation measures. Restoration and management-
Role of Global institutions and NGOs in India **.** **5**

PRACTICAL COURSE III

UNIT 5: a) Determination of EC, pH, salinity, and chlorinity of seawater .

b) Determination of nitrate from seawater.

c) Determination of BOD of polluted water.

d) Determination of oil and grease / hydrocarbon content of polluted sea water.

e) Determination of phosphate from seawater.

UNIT 6: a) Study of zonation pattern in algae and mangroves

b) Study of vivipary in mangroves.

c) Study of salts glands, trichomes, sclerides in mangroves .

d) Study of phenological events in different mangroves species.

e) Microbe analysis of sediments (Sulphur bacteria) from estuaries.

M. Sc. PART II (SEMESTER IV)

BO-4.32 MYCOLOGY & PLANT PATHOLOGY

MARINE BOTANY PAPER XVI (SPECIAL PAPER IV)

APPLIED MARINE BOTANY

Total Lectures: 60

UNIT 1:

METHODS OF ANALYSIS: Primary productivity measurement (biomass harvesting, litter fall, gas exchange, modelling technique).Standing crop, Species diversity index, Similarity index etc. **8**

MANGROVE SURVEY BY REMOTE SENSING APPLICATION: Use of remote sensing technique in mapping of mangrove vegetation, Use of GPS. **7**

UNIT 2:

METHODS OF COLLECTION AND PRESERVATION OF MARINE ALGAE: Collection, Chemical preservation, Herbarium technique, Storage of specimen**.** **5**

COMMERCIAL CULTIVATION OF SEAWEEDS: Traditional and recent methods. Mariculture of ***Porphyra ,Laminaria, Undaria ,Gracilaria*** etc**.** **8**

DIATOMS: Application and uses. **2**

UNIT 3:

UTILIZATION OF SEAWEEDS: Species used as food and fodder, application to soil as a fertilizer or manure, Medicinal uses, Source of iodine. Industrial applications of seaweeds**.** **10**

LABORATORY CULTURE AND CULTIVATION OF ALGAE : Use of natural and synthetic culture media, difficulties in getting axenic culture. **5**

UNIT 4:

COASTAL BIORESOURCES: Bioresource Profile. Wild bioresources - food , feed, fodder, fire wood, timber, medicinal products, potential genetic resources, ornamentals. **8**

Domestic bioresources - crops, cereals, pulses, oil crops, horticultural crops, live stock, aquaculture, apiculture**.** **7**

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PRACTICAL COURSE IV

UNIT 5: a) Determination of primary productivity of estuarine ecosystem.

b) Study of herbarium technique in marine algae.

c) Study of diatoms (cleaning, preparation and observation)

d) Demonstration of phytoplankton / algal culture technique.

e) Determination of total ash/mineral content from seaweeds.

UNIT 6: a) Effect of seaweed concentrate on seed germination and plant growth.

b) Study of economically important mangrove species (used for food / fodder / timber / medicines etc).

c) Study of major faunal components from mangrove ecosystem.

d) Determination of S.D.I. and similarity index of mangroves.

e) Detection of bioactive compounds in some mangrove species by TLC.

SEMESTER IV

PLANT BIOTECHNOLOGY (SPECIAL PAPER- III)

B O 4.37: PLANT TISSUE CULTURE- II: APPLICATIONS AND PROSPECTS.

Theory (4 Units, 60 Lectures)

Unit 1:

a) Application of Biotechnology in conservation of plant generic resources, Gene banks (5), b) Application of tissue culture in Agriculture: Plant improvement through tissue culture technology; production of resistant lines to biotic and abiotic stresses (10).

Unit 2: a) Applications of tissue culture in horticulture: micropropagation of some tree species like *Morus, Ficus* etc. **(5),** b) Application of tissue culture in forestry: *In vitro* establishment of Mycorrhiza forest species, orchids, and other related improvements in forest species Eg. *Tectona, Pinus* etc. **(8),** c) Prospects in plant tissue culture industry in India; Applications in public sector **(2).**

Unit 3: a) Secondary metabolite production- Secondary metabolites from callus, cell cultures, cell suspension, biotransformation. Procedure for process design and product recovery from cultured plant cells. Factors affecting product yield. Secondary metabolites from immobilized plant cell **(15).**

Unit 4: a) Transgenic plants for crop improvement **(5),** b) Marker genes and their use in transformed plants, selectable markers, reporter genes **(4),** c) Molecular farming, Bioreactor, edible vaccines, edible antibodies **(6).**

Practical (2 Units, Any 8)

1.	Cell suspension culture.
2&3.	Hairy root culture.
4.	Anther, embryo culture.
5.	Somatic embryogenesis.
6.	Study of synseeds.
7.	Study of transgenic plants.
8&9.	Isolation and culture of any two industrially important microorganisms.
10.	Preparation of biofertilizers.
11.	Study of Nitrate reductase activity.

SEMESTER IV: PLANT BIOTECHNOLOGY (SPECIAL PAPER- IV)
B O 4.47: APPLICATION, REGULATION AND PATENTING BIOTECHNOLOGY

Theory (4 Units, 60 Lectures)

Unit 1: a) Biotechnology in Agriculture: Ethical aspects and public acceptance; Bioethical principles for agricultural biotechnology **(5),** b) Biological Nitrogen Fixation: Mechanism of N_2 fixation, Symbiotic N_2 fixation, Mechanism of N_2 fixation in root nodules, Nod genes, Nif genes, Hup genes **(5),** c) Use of microbes in Industry and agriculture **(5).**

Unit 2: a) Application of Biotechnology in Environmental protection: Pollution control, Phytoremediation immobilized microbial cells, wastewater treatment, microbes in leaching of metals **(10),** b) Economic and legal issues of biotechnology **(5).**

Unit 3: a) Regulating the use of Biotechnology in recombinant DNA technology, Food, food ingredients and GMO's – cost benefit analysis of GMO's **(6),** b) Global biotech scenario, public verses private enterprises, International organizations involved in biotechnological inventions, cooperative programmes **(5),** c) Biotechnological spotlights **(4).**

Unit 4: a) Intellectual property; IPR: Intellectual Property Rights, Intellectual Property protection, IPR and Plant Genetic Resources GATT and TRIPS **(5),** b) Patent systems in India, Sources of patent information; a case study **(5),** c) Patenting biotechnological inventions: Patent of higher plants, Patent of genes and DNA sequences, Plant breeders rights and farmer's right **(5).**

Practical (2 Units, Any 8)

1&2.	Collection, Identification and conservation of land races of crop plants.
3.	Preparation of questionnaire for acceptance of Biotech products.
4&5.	Culture of *Thiobacillus* and its use in bioleaching.
6&7.	Use of bioscavengers in water and soil treatment.
8.	Study of GMOs.
9&10.	Formulation of patent proposal.
11.	Visit to Biotech firms, Agro biotech fields.

Suggested readings:

Special Paper- III

1. Altman, A. 1998. Agricultural Biotechnology. Marcel Dekker, New York.
2. Chavala, H.S. 1998. Biotechnology in crop improvement. International Book Distributing Co. New Delhi.
3. Glick, B.R. and Pasternak, J.J.1994.Molecular Biotechnology- Principles and applications of recombinant DNA. ASM Press, Washington.
4. Gupta, P.K. 2000. Elements of Biotechnology. Rastogi Publisher, Meerut, India.
5. Kakralya, B.I.and Ahuja, I.2001. Transgenic Plants-Promise or Danger.Agrobios, India.
6. 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.
7. Reddy, S.M., Srivastava, H.P., Purohit, D.K., and Reddy, S.R.1997.Microbial biotechnology. Scientific Publishers, Jodhpur, India.
8. Schlegel, H.G.1995. General microbiology. Cambridge University Press.
9. Trehan, K.1994.Biotechnology.Wiley Eastern Ltd. New Delhi.

Special Paper- IV

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